Improved Spatial Fire Economics Modeling

National Fire Decision Support Center

JOINT FIRE SCIENCE PROGRAM

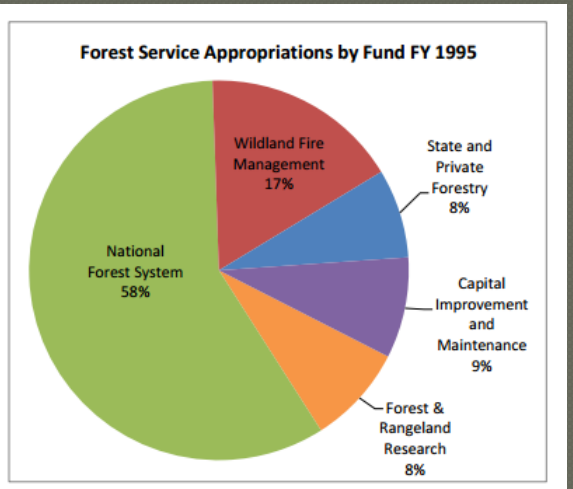
FIRESCIENCE.GOV

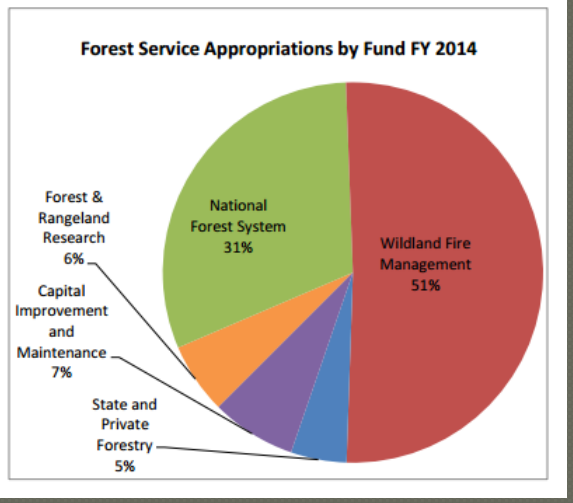
Research Supporting Sound Decisions

Matthew Thompson[a]
Karin Riley[b]
Michael Hand[a]
Joe Scott[c]

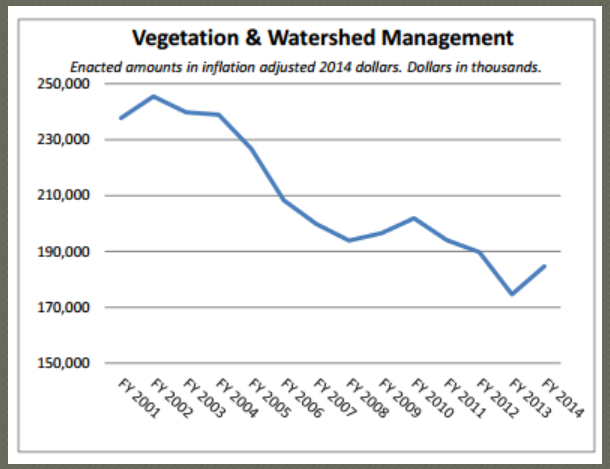
a US Forest Service
b University of Montana
c Pyrologix, LLC

Motivation
Escalating Costs





"The increasing cost of fighting wildland fire has had a negative and lasting impact on the Forest Service's non-fire, mission critical activities."
(USFS 2014)

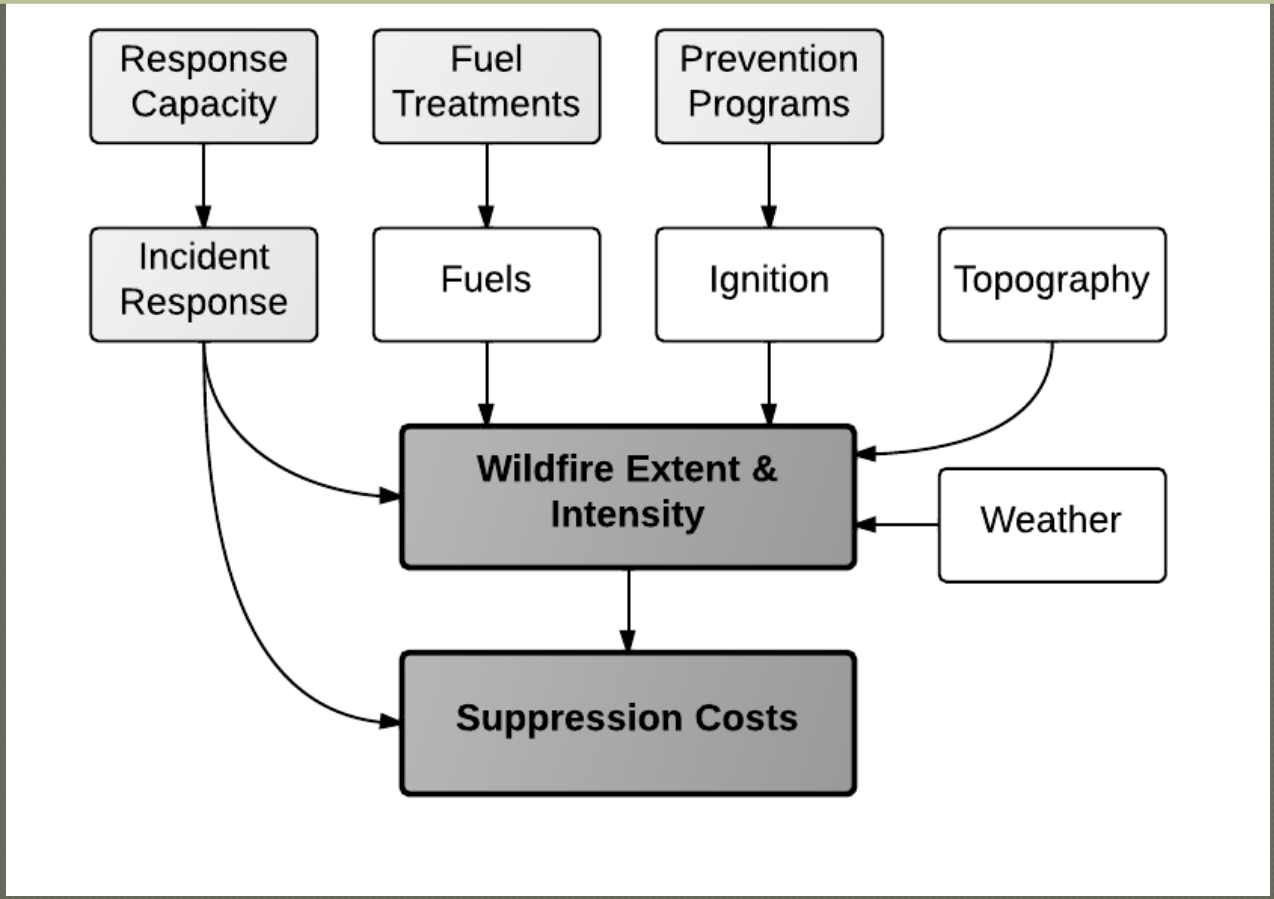


http://www.fs.fed.us/sites/default/files/media/2014/34/nr-firecostimpact-082014.pdf

Motivation

Evaluate Management Options

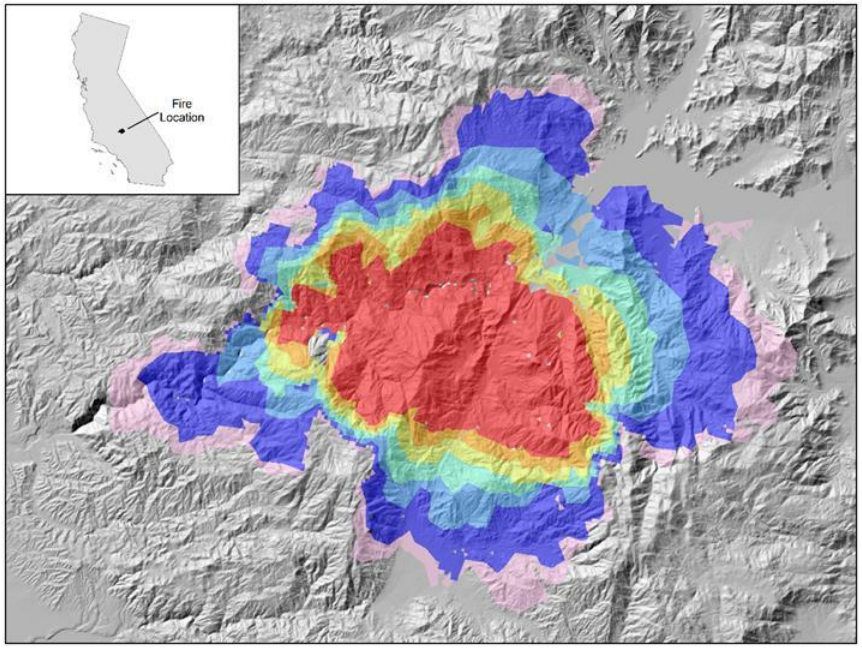
How do we evaluate the potential impacts of mitigation investments on future wildfire management costs?

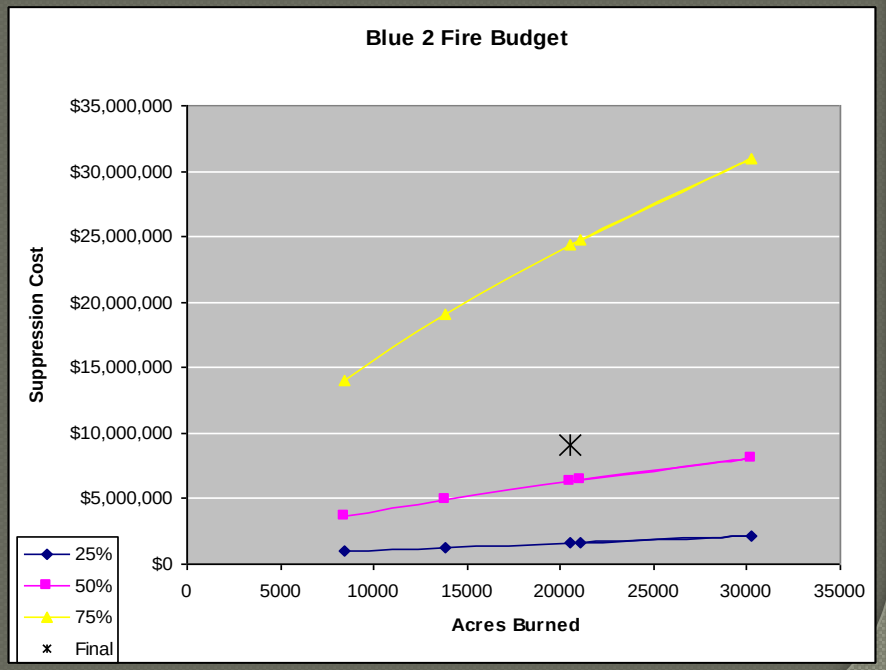


Motivation

Build from Decision Support

Active Wildfire Incident Management:
Fire Spread Probability & Suppression Cost Potential

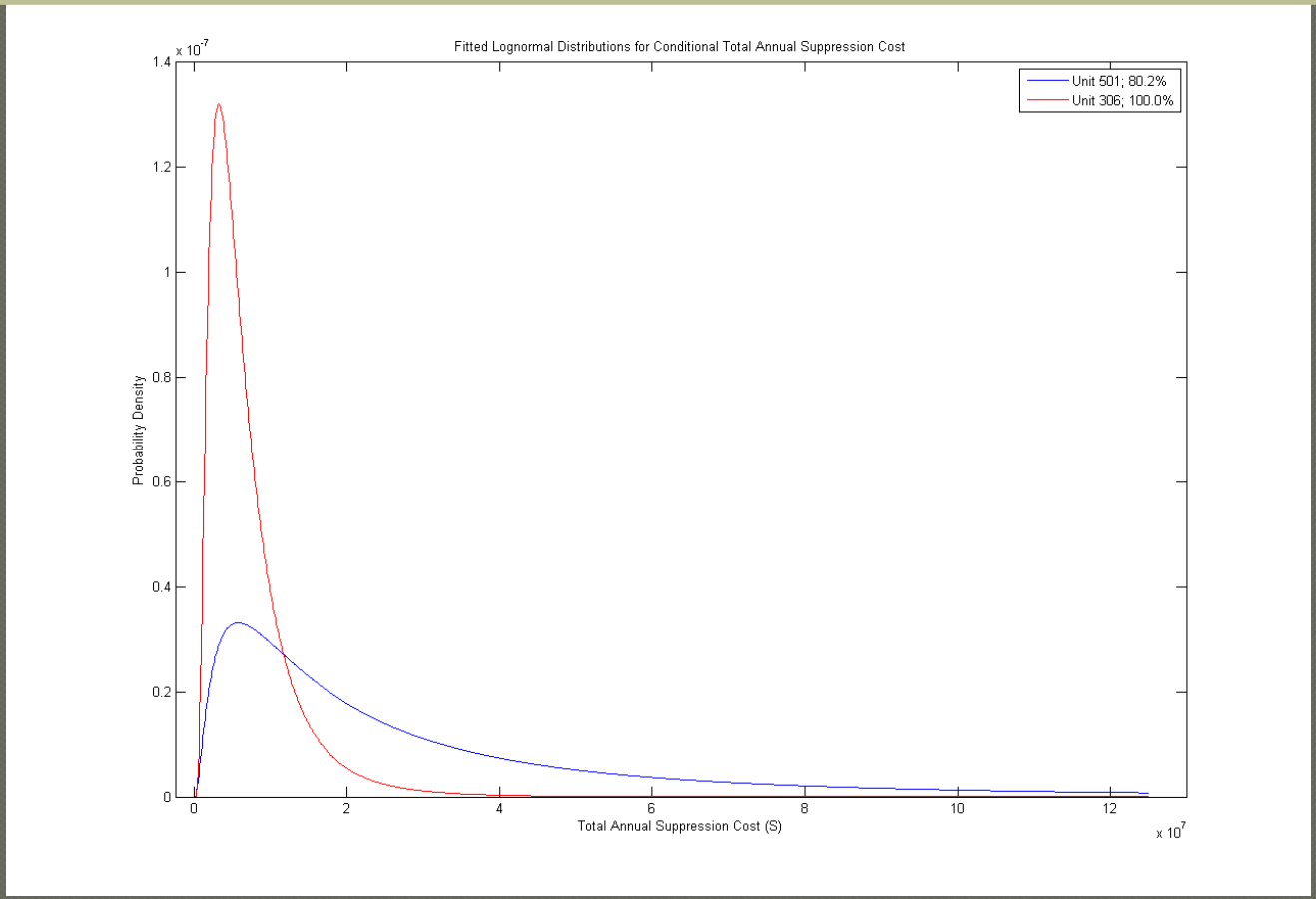




Motivation

Leverage Fire Cost Modeling

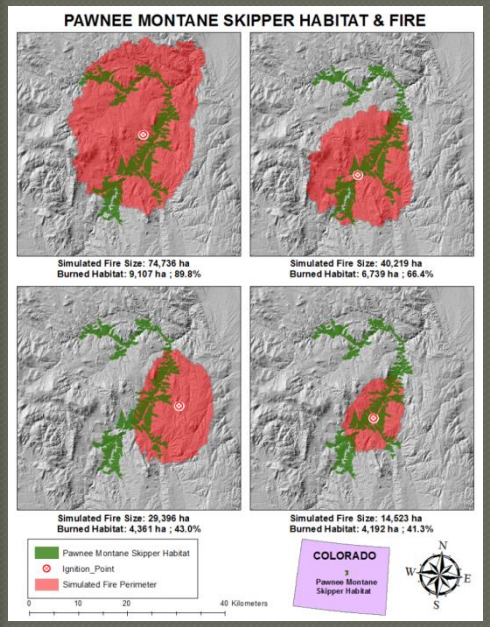
Linking Fire & Cost Models: Probabilistic Modeling of Suppression Costs

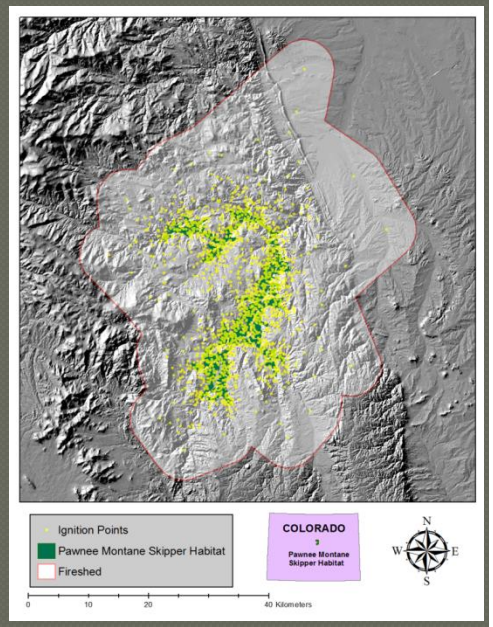


Motivation

Leveraging New Fire Modeling

Increasing Use of Simulated Perimeters: The Size, Shape, and Location of Fire





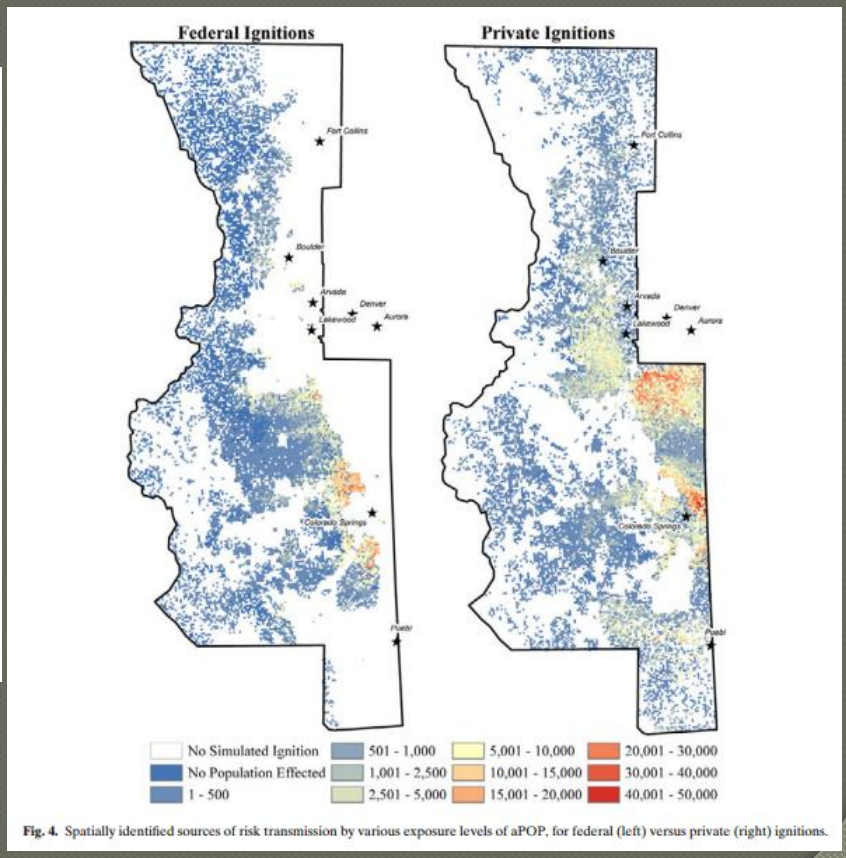


Fig. 4. Spatially identified sources of risk transmission by various exposure levels of aPOP, for federal (left) versus private (right) ignitions.

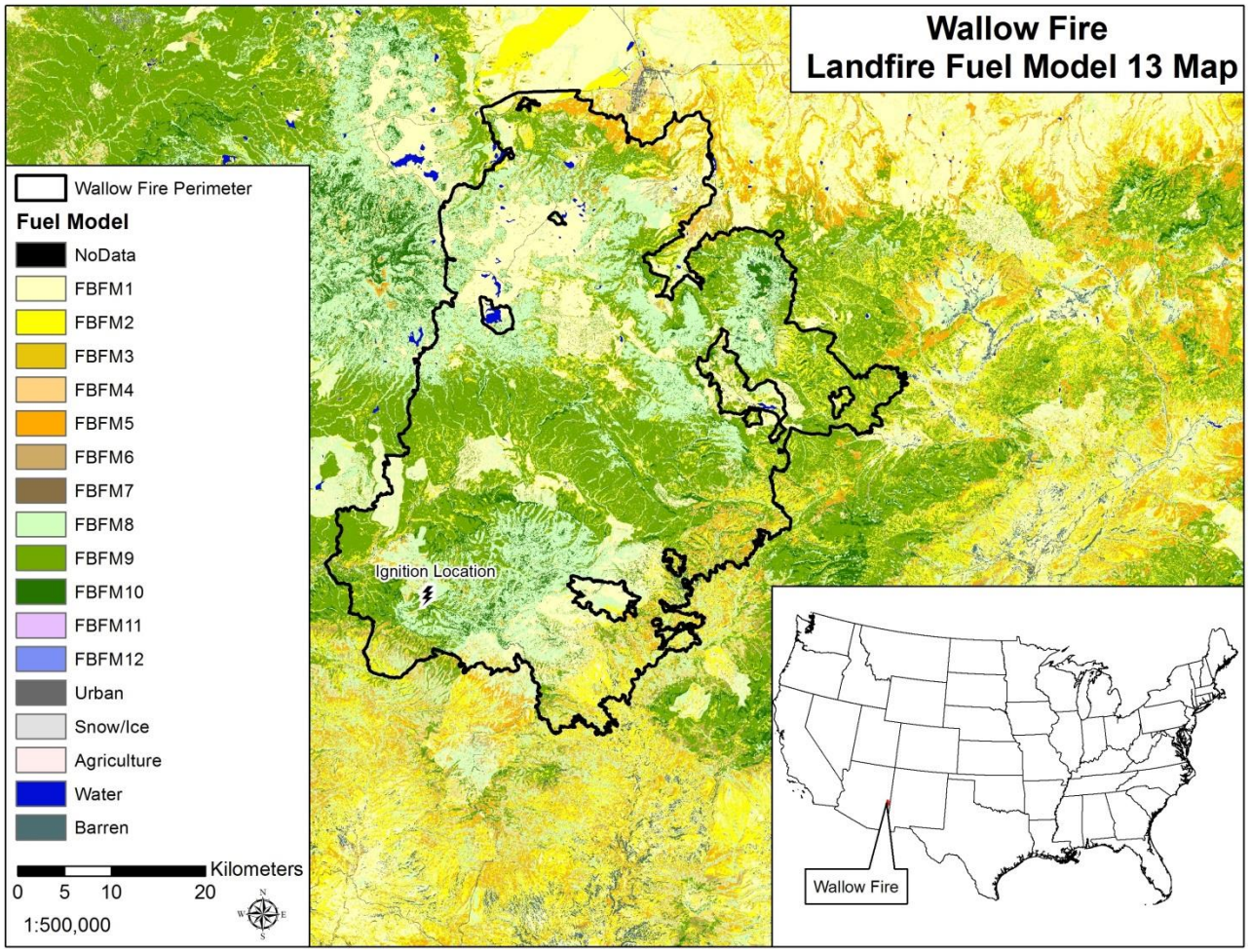
Motivation

Leverage Fire Cost Modeling

Ignition Point Model (SCI)	Perimeter Model ("Spatial" SCI)
ERC at time and point of ignition	Maximum avg. ERC and std. dev. of ERC during fire
Distance from ignition point to Wilderness Area boundary	Share of area burned within Wilderness Area
Ignition within grass, brush, slash, timber fuels (Y or N)	Share of area burned in grass, brush, slash, timber fuels
Housing value within 5, 10, 20 miles of ignition	Housing value *inside perimeter*, 5, 10, 20 miles of perimeter

Spatial SCI
Example: Surface Fuels

Wallow Fire
(eastern Arizona)
- $95.5 million
- 29 May, 2011
- 217,785 hectares
- Ignition fuels: Timber
- Burned area fuels:
  Grass = 29%
  Brush = 7%
  Timber = 69%



Spatial SCI Example: ERC

ERC – Relative index (0-100 scale) of fire-weather conditions to proxy fuel flammability and potential fire intensity

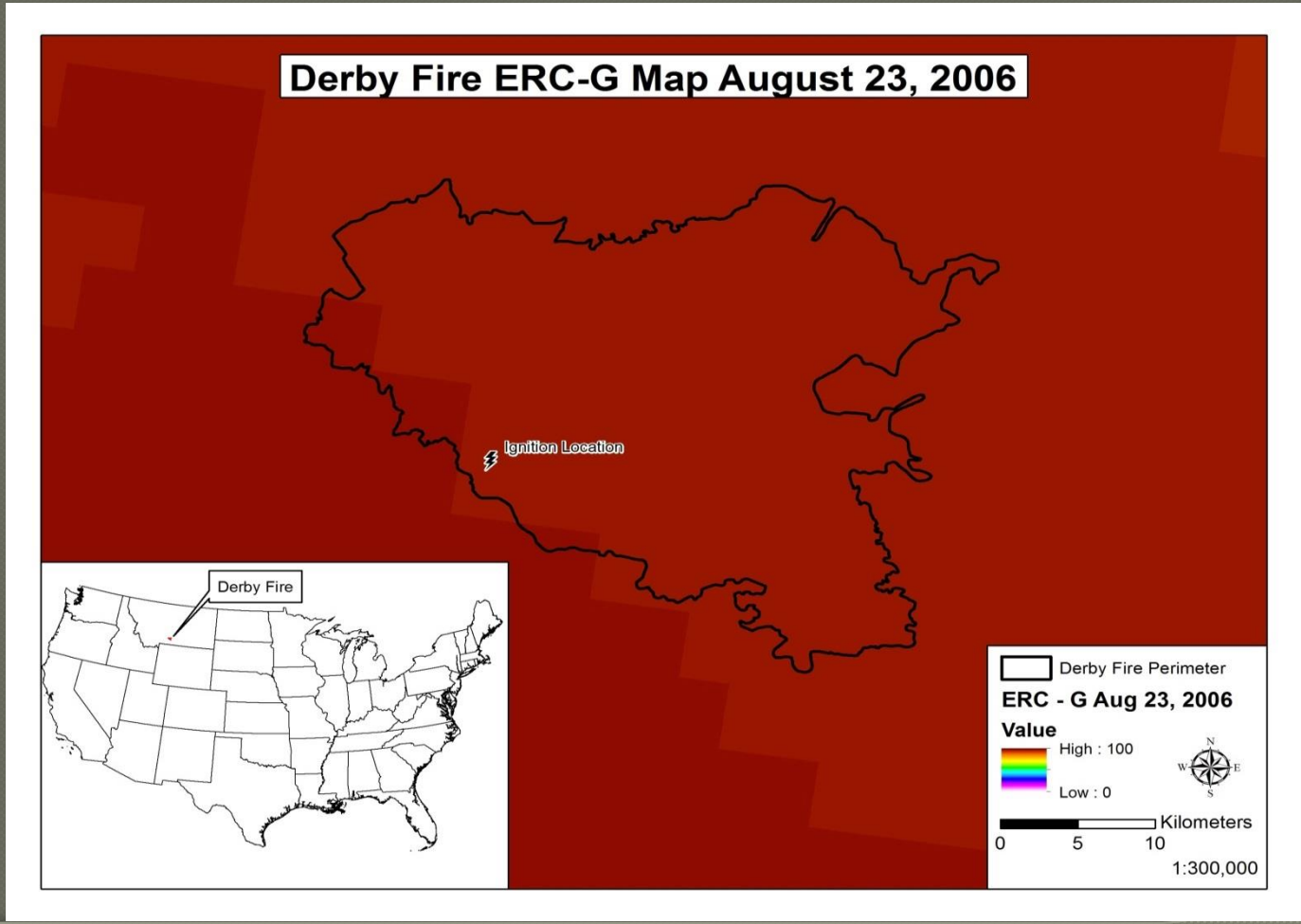
Derby Fire (southwest Montana)

$12.8 million
84,485 hectares

Ignition-point ERC = 96.2

Spatial avg. ERC, 23 Aug. = 99.7

Spatial avg. ERC std. dev., 23 Aug. = 1.37



Spatial SCI Example: ERC

ERC – Relative index (0-100 scale) of fire-weather conditions to proxy fuel flammability and potential fire intensity

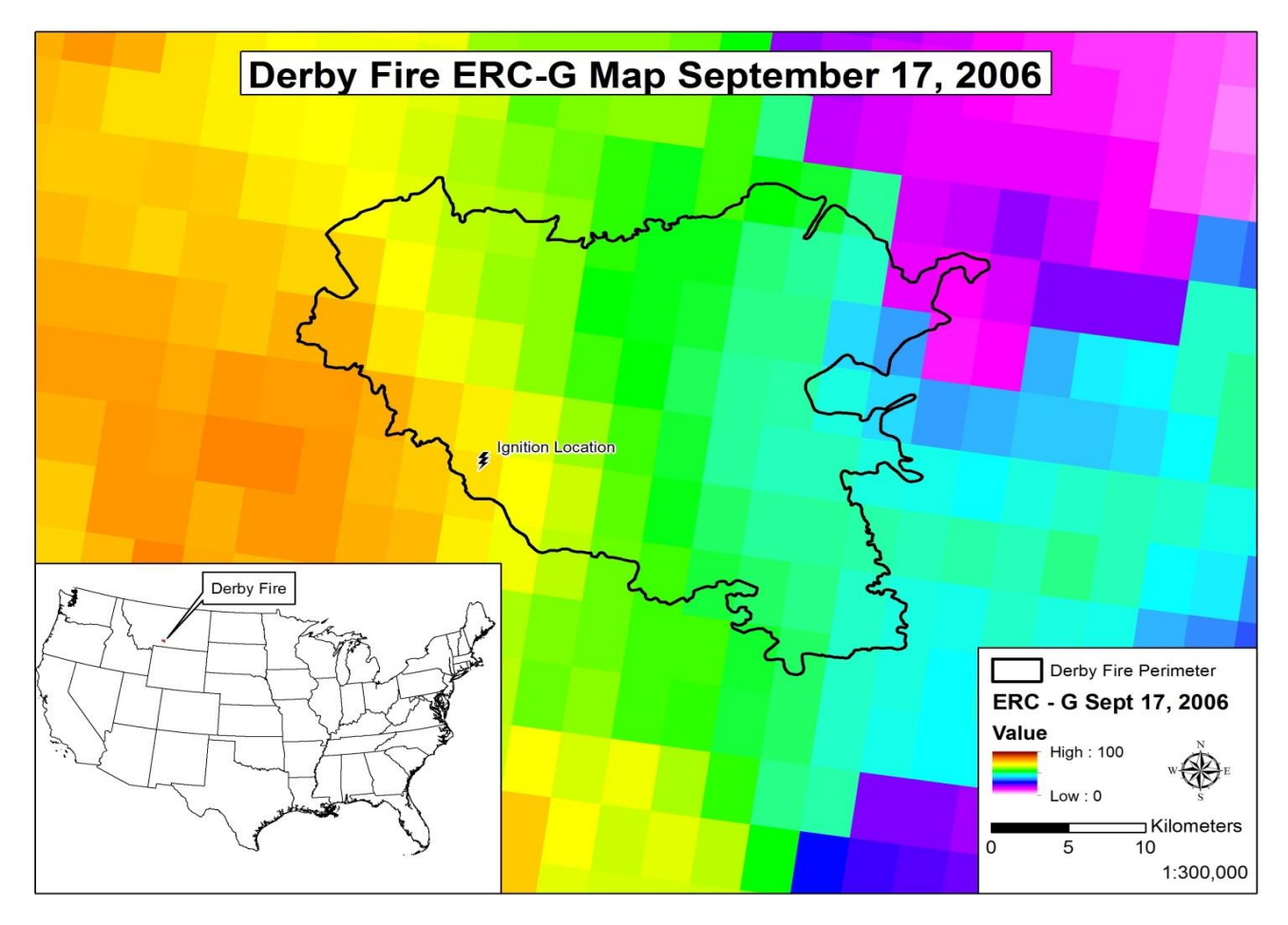
Derby Fire (southwest Montana)

$12.8 million
84,485 hectares

Spatial avg. ERC, 17 Sept. = 23.4

Spatial avg. ERC std. dev., 17 Sept. = 5.6

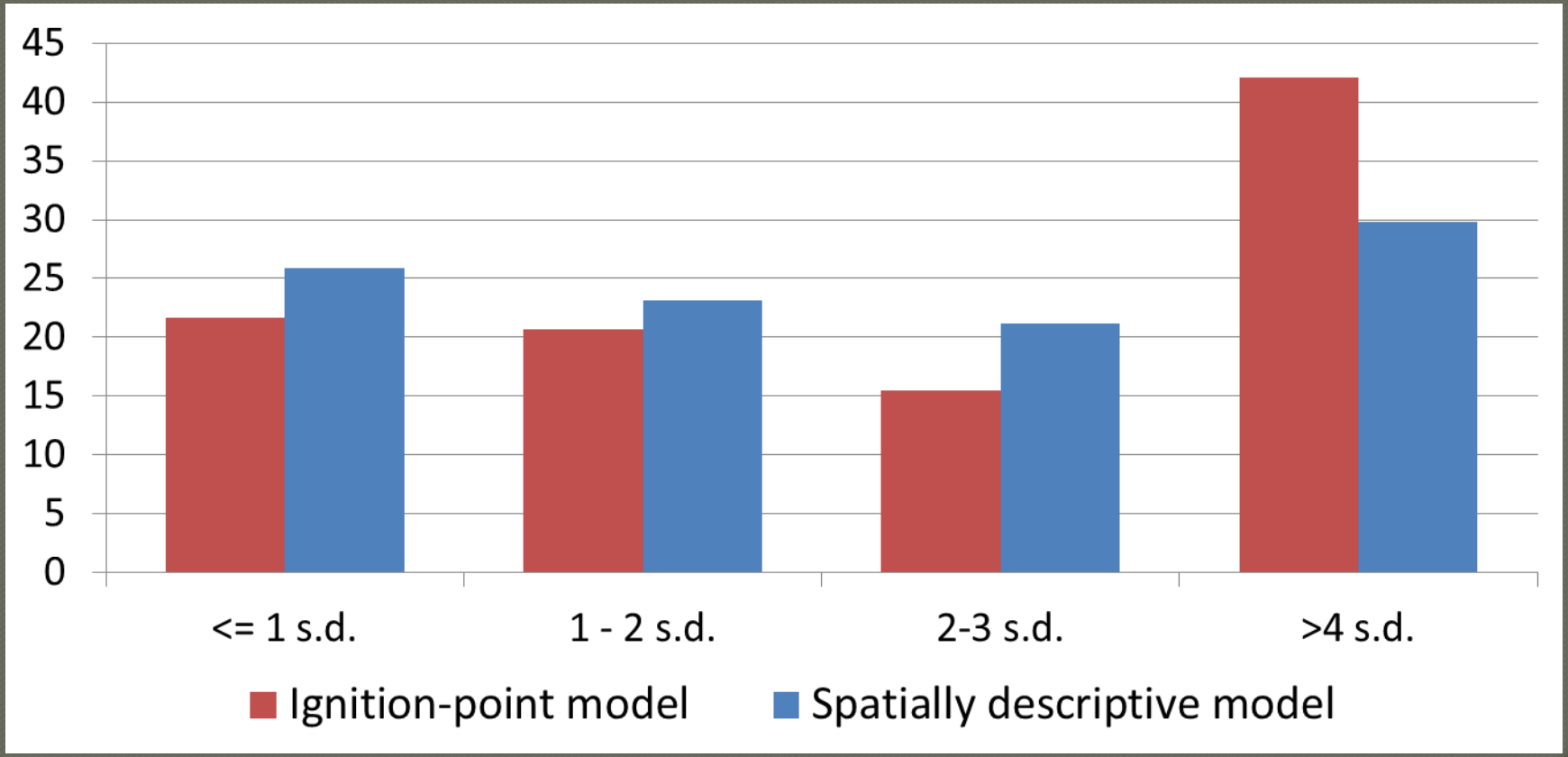
Overall temporal ERC std. dev. = 37.0



Results

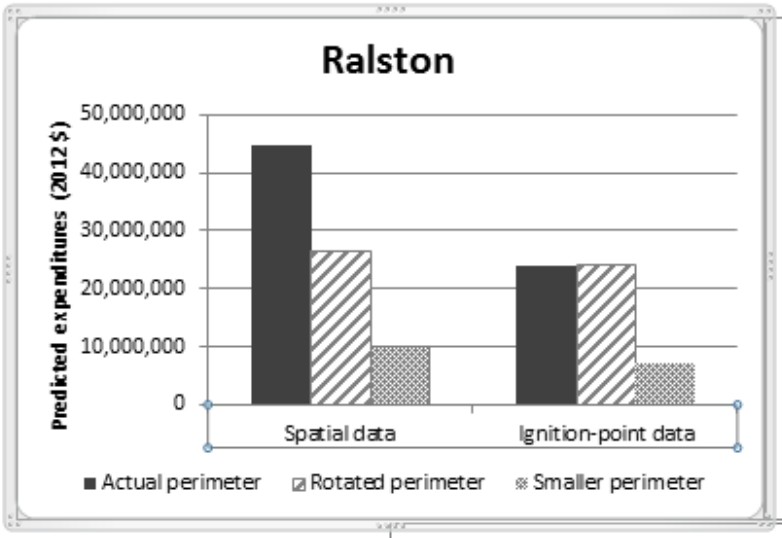
Comparing Prediction Accuracy

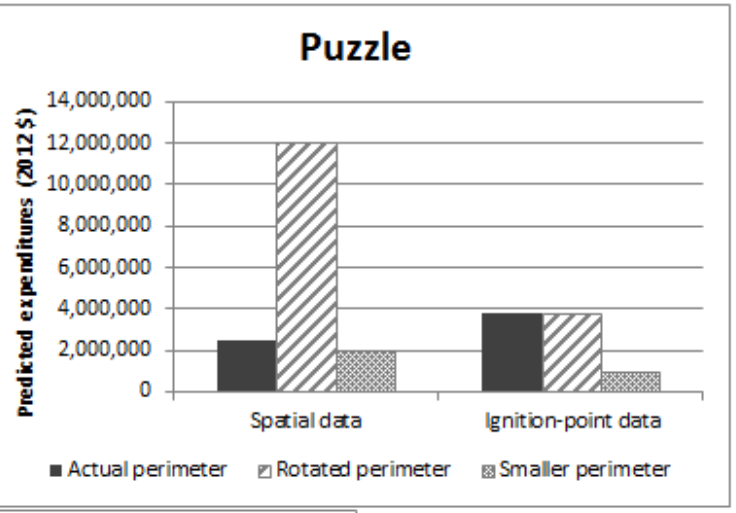
Distribution of standardized prediction residuals (in standard deviation units)

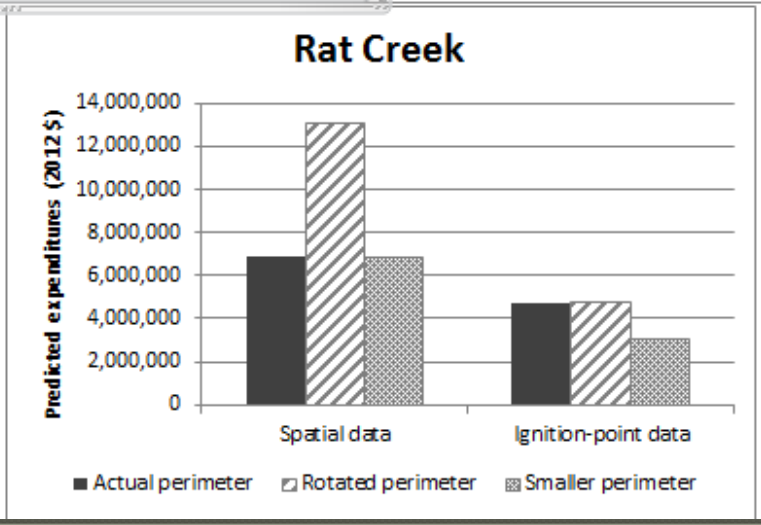


Results
Comparing Predictions

Figure 5: Predicted expenditures for three fires with hypothetical counter-factual fire perimeters, by model





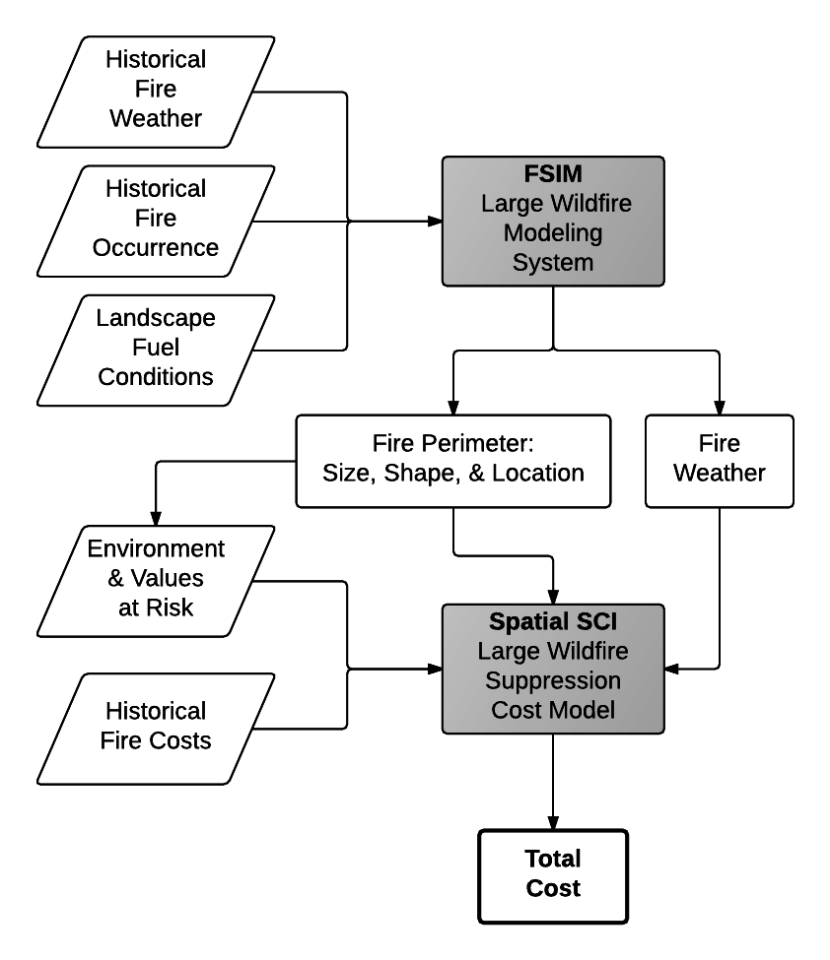


What can we do with this model?

- Modestly better predictions
- Identify differences in expenditures for simulated fires
  - Where and under what conditions a fire burns is as important as size
  - Active incident decision support
  - Evaluate alternative fire and fuel management policies

Methods

Suppression Cost Modeling



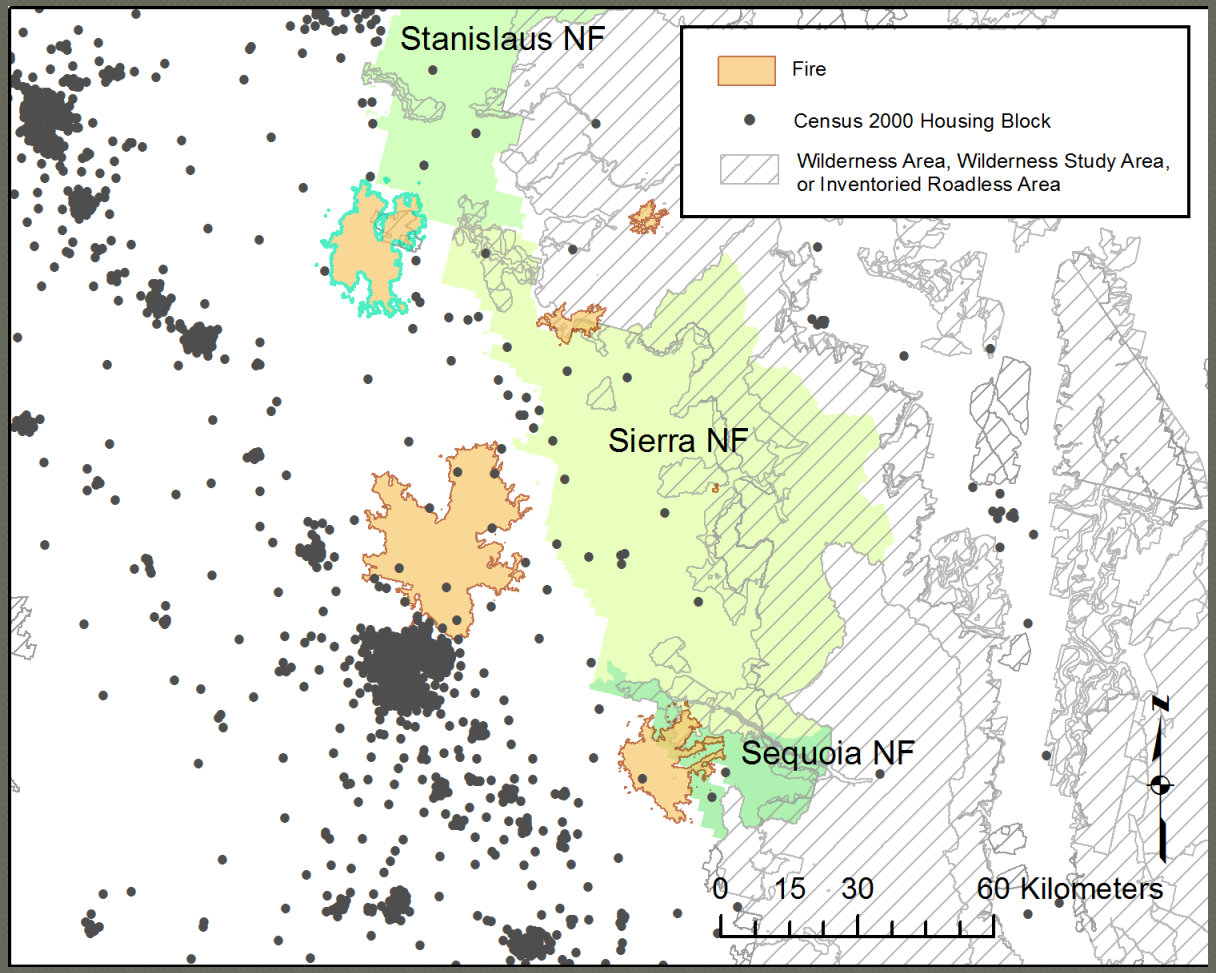
Foundation is stochastic fire modeling outputs

Assign costs on a per fire basis

Capture geographic variation in expected suppression costs

Generate cost distributions

Preliminary Results



Total Cost:
$140,835,156

Total Size:
31,721 ha

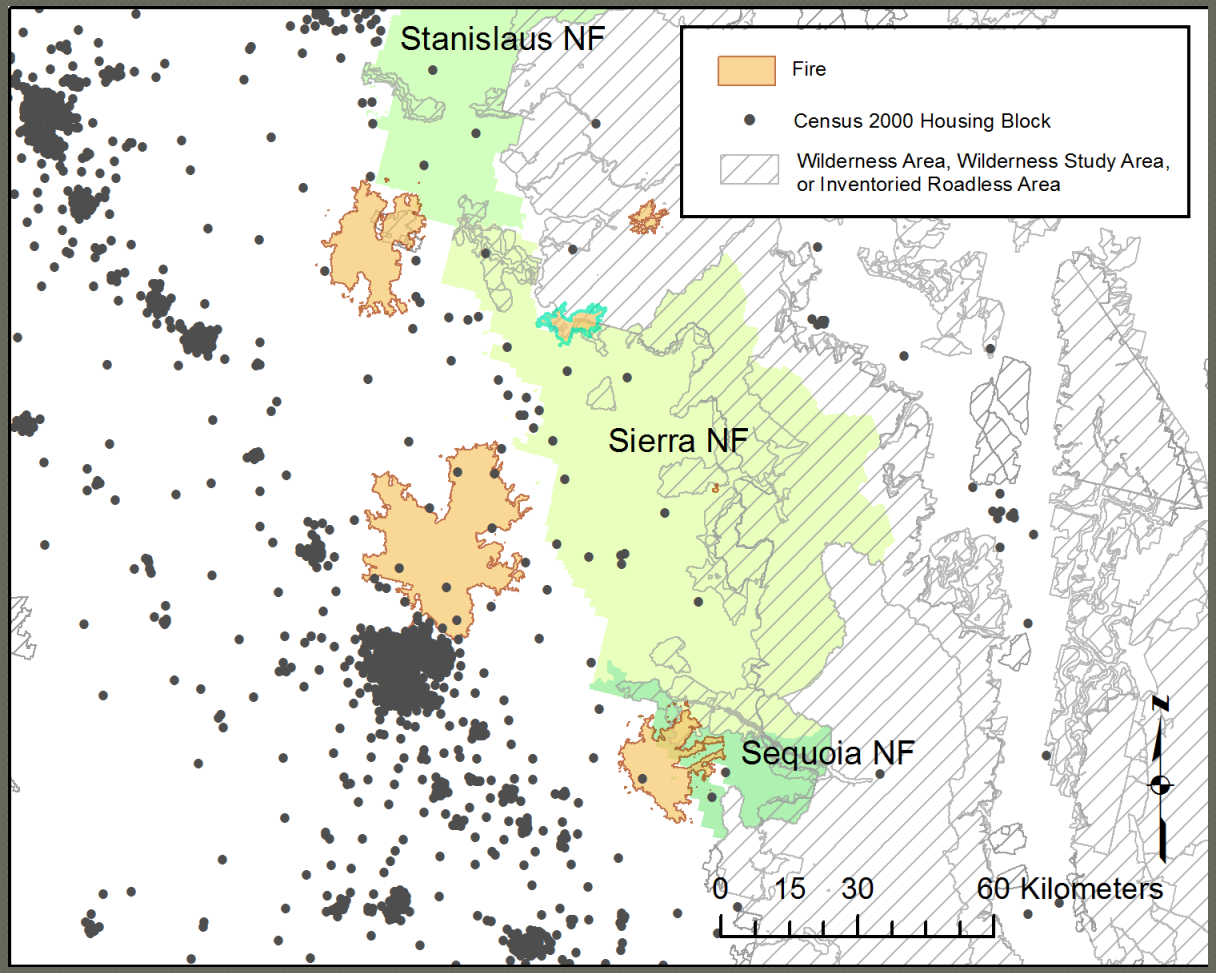
Housing Value (20m):
$2.84 B

Wilderness:
0.00%

Timber:
16.57%

ERC Std Dev:
0.51

Preliminary Results



Total Cost:
$119,649,041

Total Size:
5,605 ha

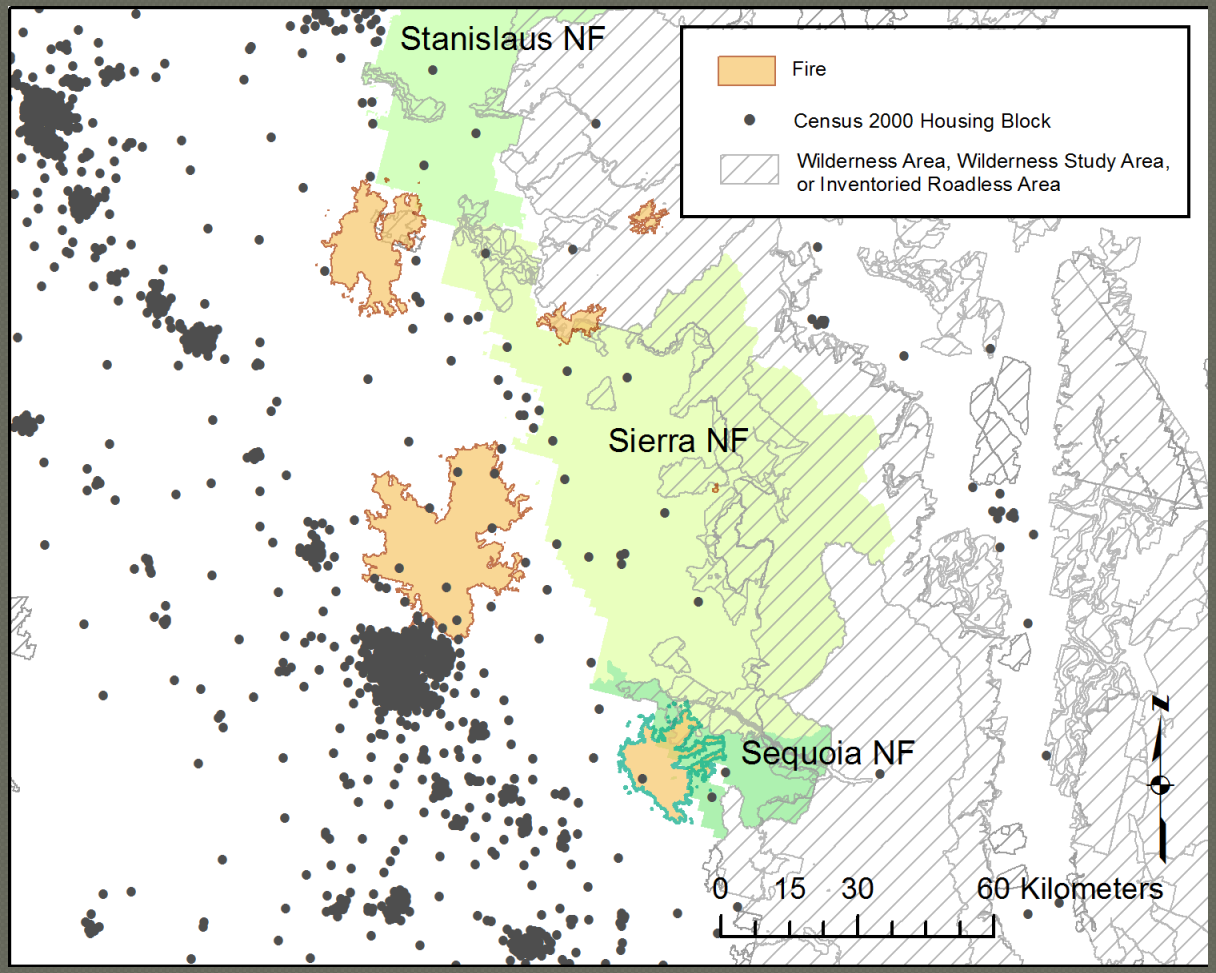
Housing Value (20m):
$1.06 B

Wilderness:
55.80%

Timber:
85.37%

ERC Std Dev:
0.50

Preliminary Results



Total Cost:
$38,609,045

Total Size:
24,800 ha

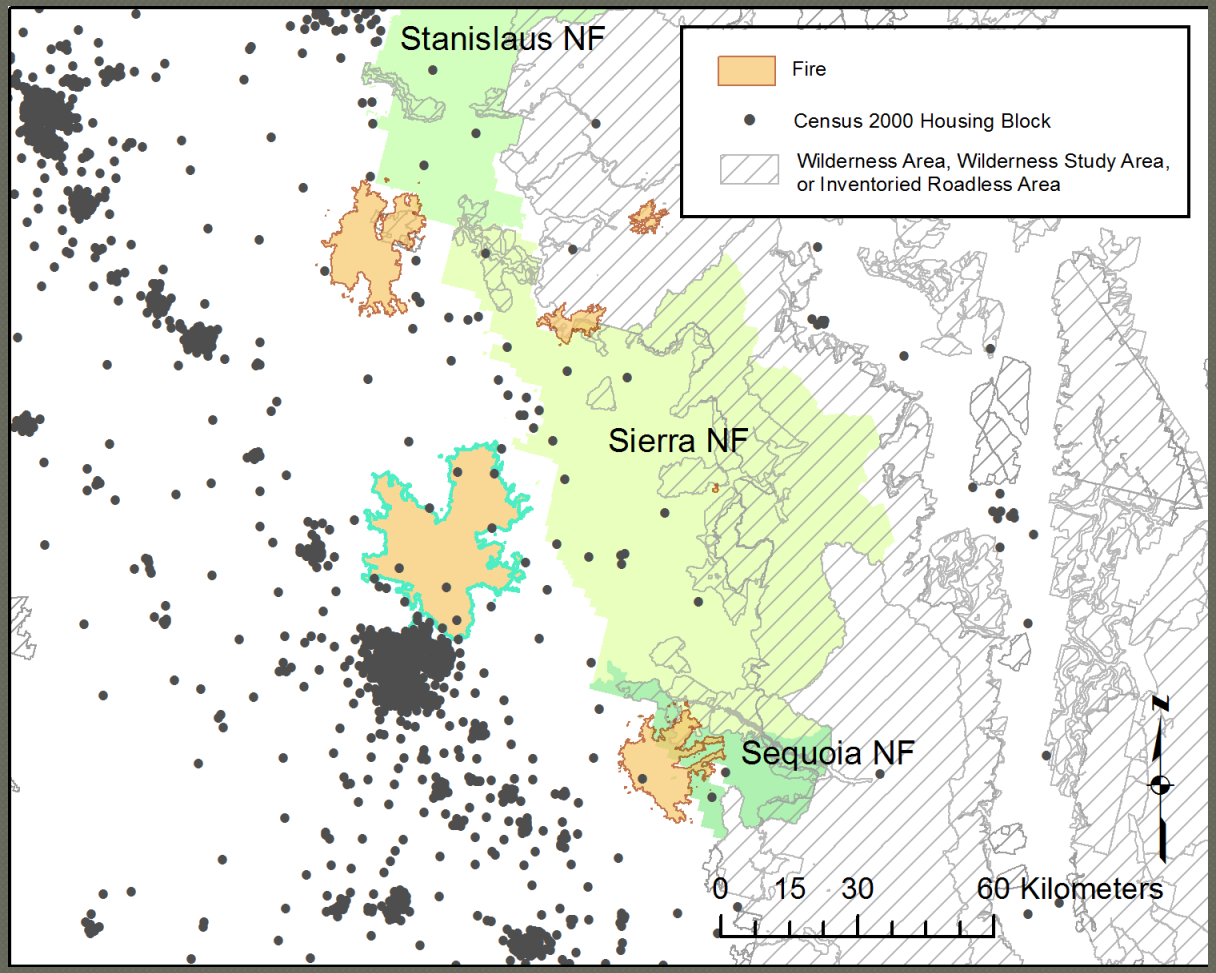
Housing Value (20m):
$2.83 B

Wilderness:
0.00%

Timber:
34.42%

ERC Std Dev:
0.83

Preliminary Results



Total Cost:
$12,649,370

Total Size:
75,151 ha

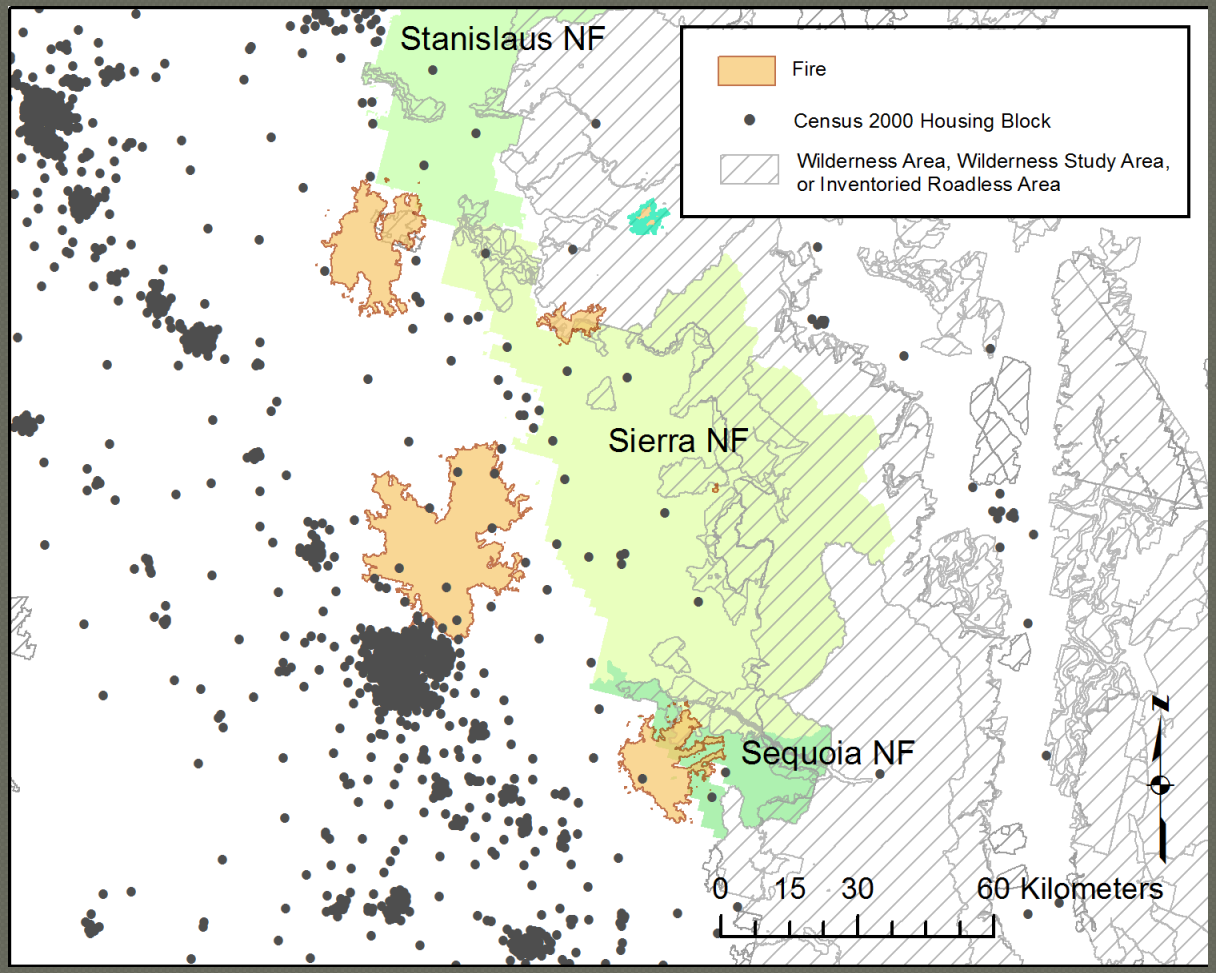
Housing Value (20m):
$12.79 B

Wilderness:
0.00%

Timber:
4.27%

ERC Std Dev:
4.39

Preliminary Results



Total Cost:
$5,831,075

Total Size:
2,330 ha

Housing Value (20m):
$0.06 B

Wilderness:
100.00%

Timber:
47.33%

ERC Std Dev:
4.33

Next Steps

- Sierra National Forest Case Study Landscape
- Alternative fuels management policies
  - North et al. (2015) Journal of Forestry
- Alternative suppression policies
  - Ongoing Forest Plan Revision efforts
- Integrate with landscape risk analysis

Questions?

Spatial SCI
Leverage Fire Cost Modeling

Evaluating Total Cost vs. Cost per Acre