Forest Ecosystem Management Issues and Opportunities in the United States

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IUFRO

Given Topics

- Integrating ecosystem services into forest [illegible]ns management: from the academic vision to the on-[illegible]lementation
  - Different forest operations app[illegible]wnerships
  - Ecosystem services that
  - People who care
  - Methods [illegible]l perspectives
  - Business m[illegible]services
  - Foreseeable
  - …

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ISSUES & OPPORTUNITIES


Photo credit: John McColgan, BLM

Wildfires

- Extremely severe, large fires
- Real threats to people and forest ecosystems

Southern California

October 2007

50-60 mph winds
Burned 200,000 ha
3 people died
1,300 homes destroyed
500,000 people evacuated
1,000 firefighters fought

Wildfires

Colorado Spring, CO

June 2012

7,300 ha burned
1 person died
32,000 residents evacuated
346 homes destroyed
$450 million insurance claimed

Wildfires

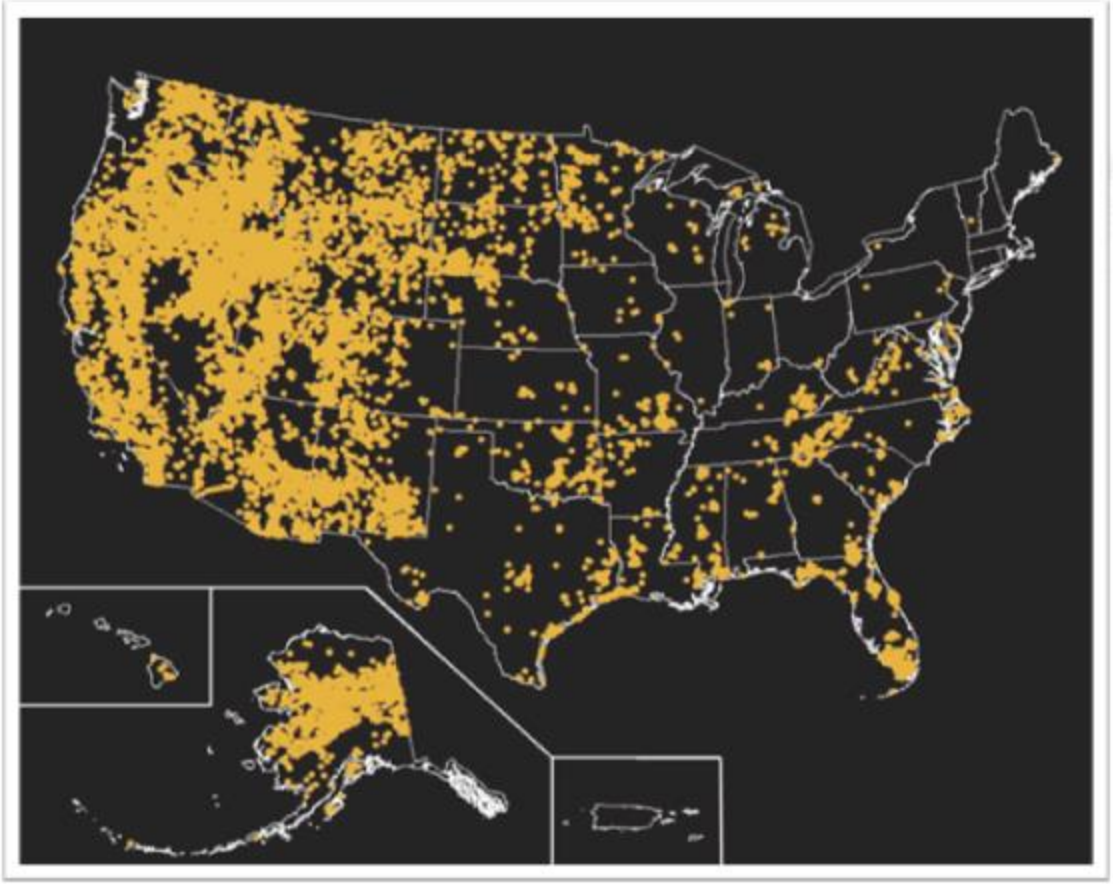
Gila NF, New Mexico

June 2012

120,000 ha burned
1,200 firefighters fought
$23 million of suppression cost

Wildfires

ÅWildfires > 250 acres (1980 – 2003)



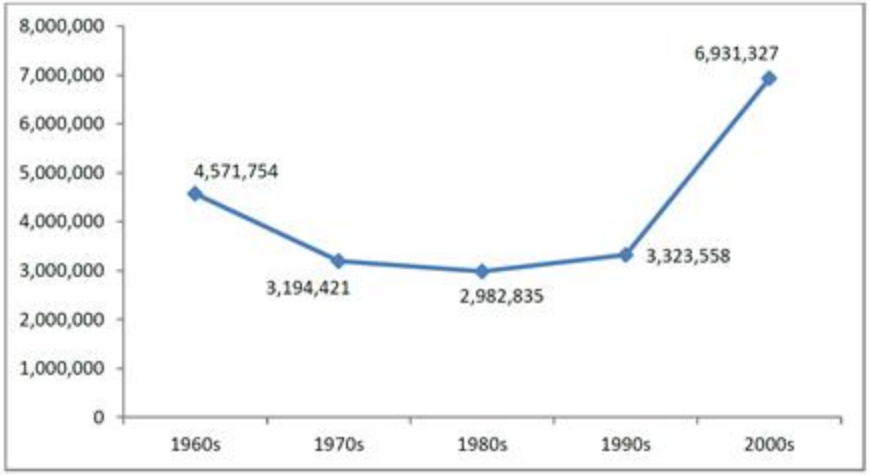
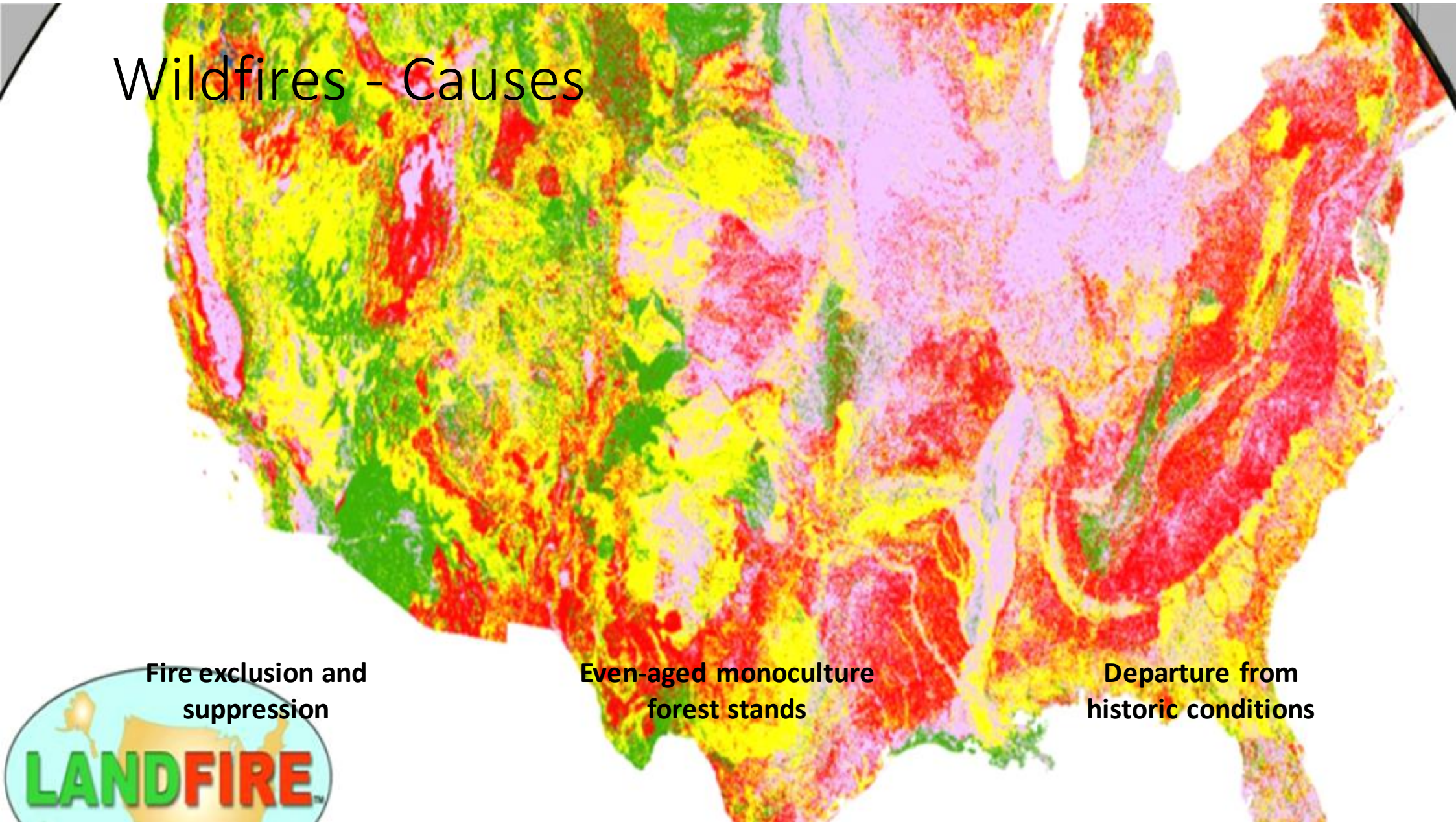


Figure 2 - Average annual acres burned, by decade. Rising firefighter effectiveness and other factors steadily lowered the number of acres burned until the 1990s, when a slight rise was followed by a sharp increase in the 2000s due to fuel buildups and worsening fire weather conditions.

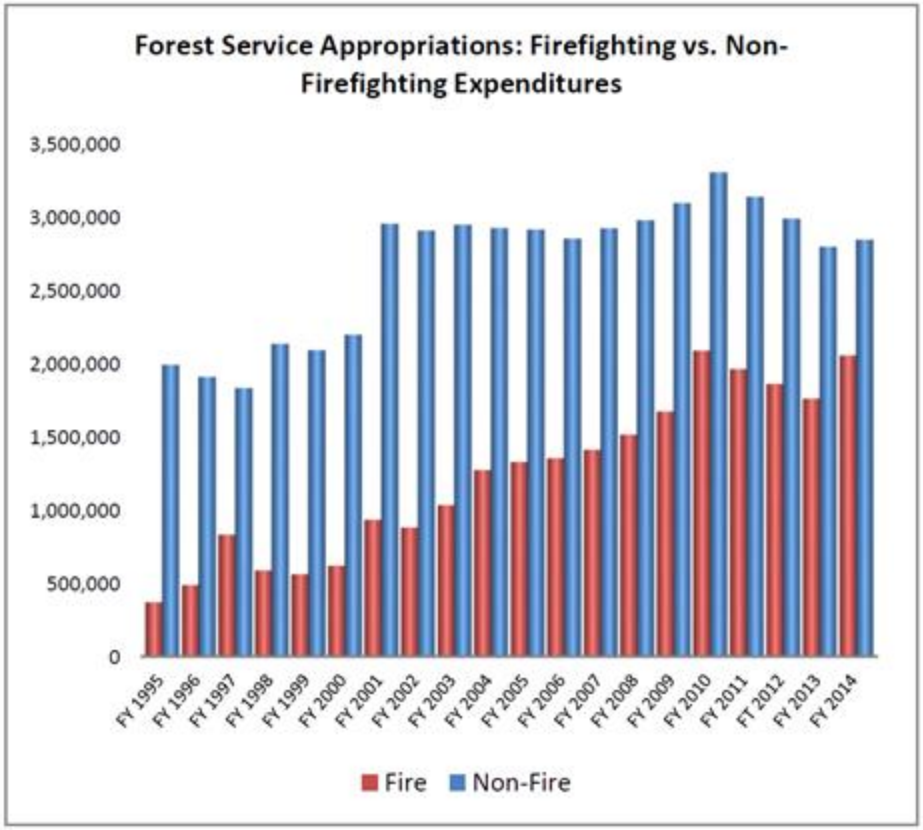
(Source: USFS, BLM)

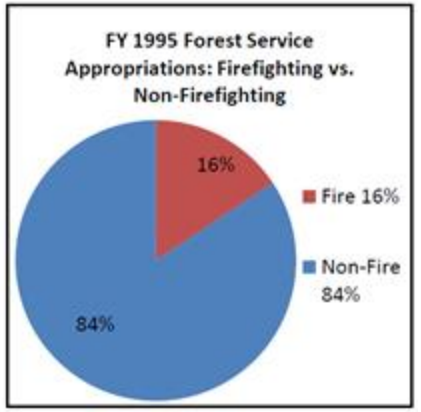
Wildfires - Causes

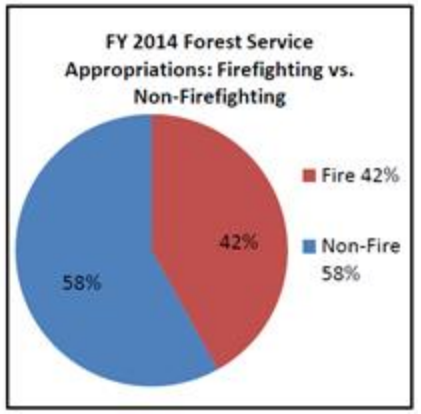


Wildfires - Consequences

ÅLarge federal budget spent on fire suppression every year



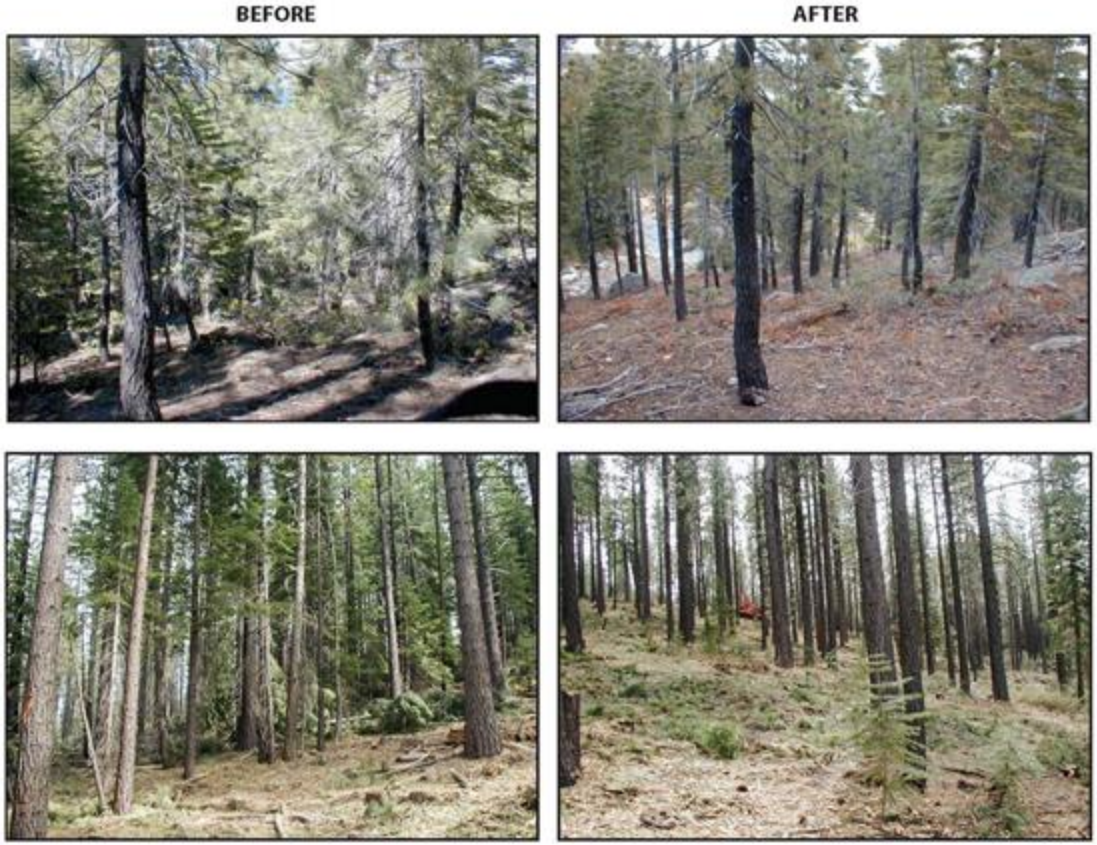


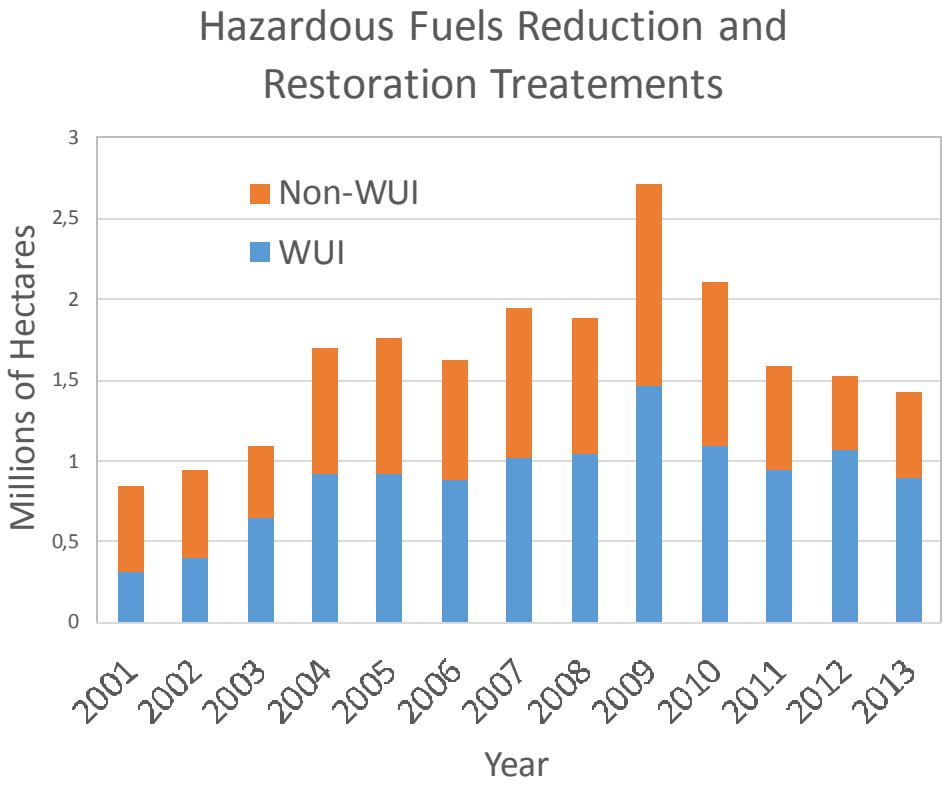


(USFS 2014)

Wildfires – Current Efforts

- Fuel reduction and restoration treatments





Opportunities

Wildfires – Opportunities

ÅFire Suppression – Equipment Design and St

Photo credit: Obie O

Wildfires – Opportunities

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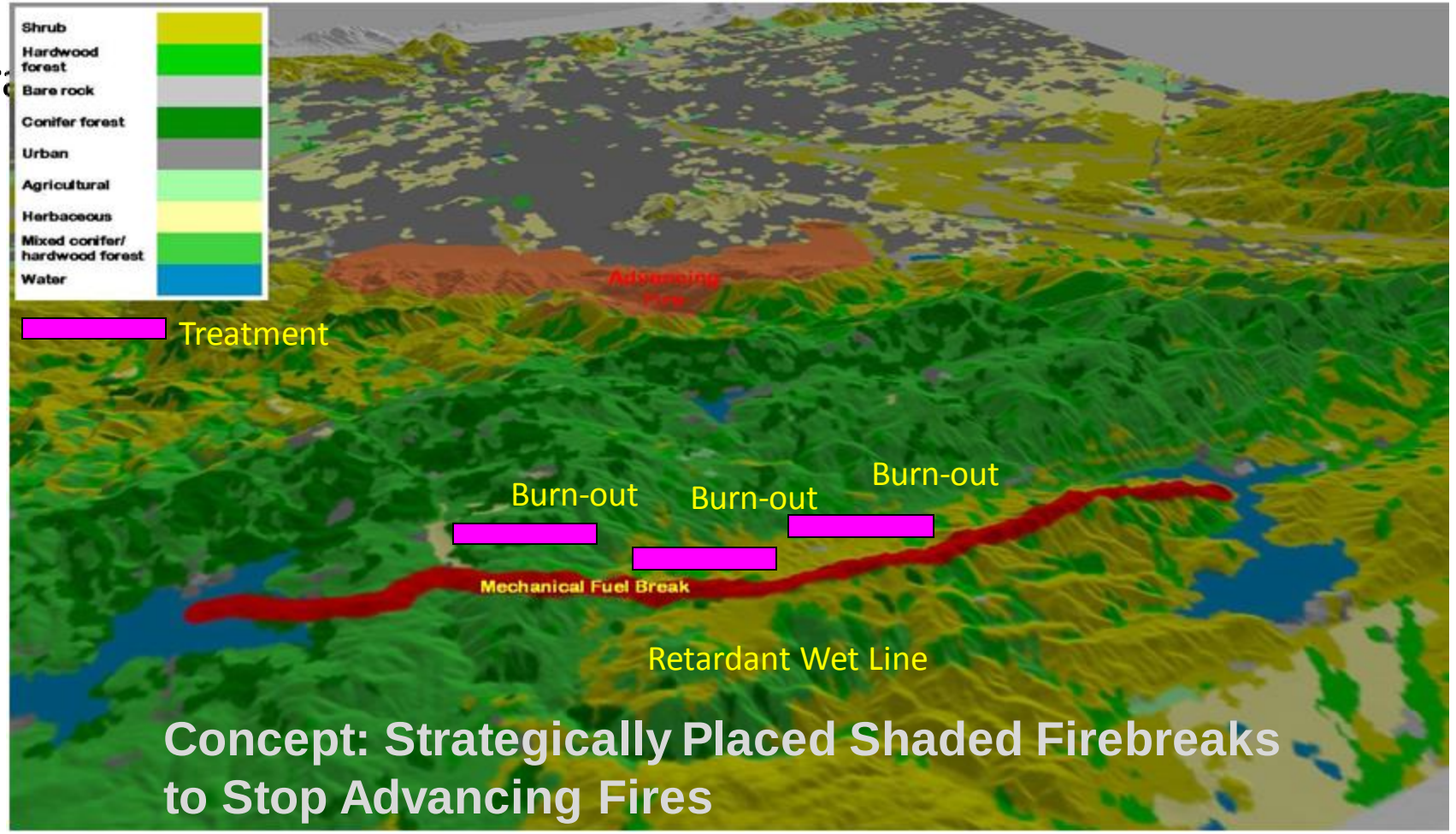
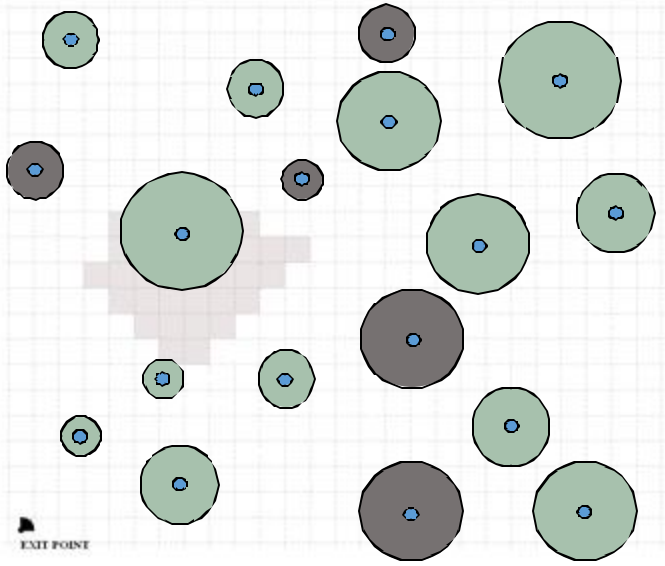


Source: Obie O'Brien and Bryce Stokes, USFS

Wildfires – Opportunities

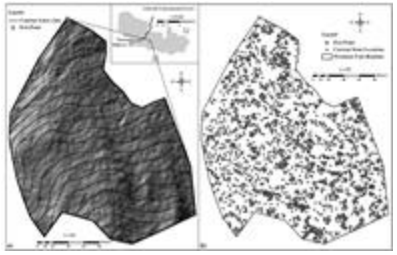
- Cut tree selection
  - Operations Research
  - Fire Behavior Modeling
  - Remote Sensing & Precision Forestry



Wildfires – Opportunities

DEM and Stem Map

LiDAR-derived data



Crown Fire

Logistic regression models

Skidding Cost

Tree-level skidding cost model

Optimization

Minimize fuel connections and costs

Wildfires – Opportunities

DEM and Stem Map

LiDAR-derived data

Crown Fire

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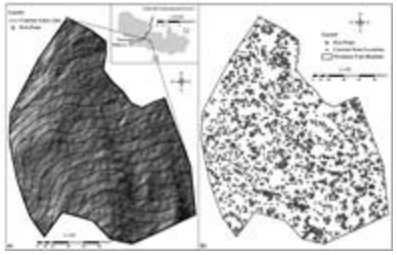
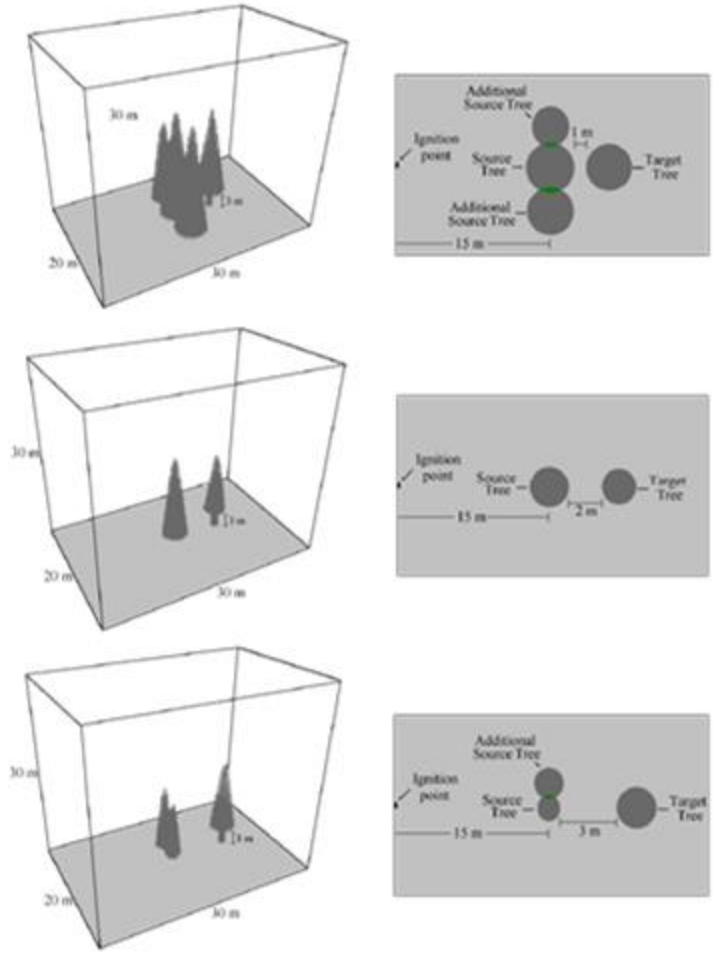
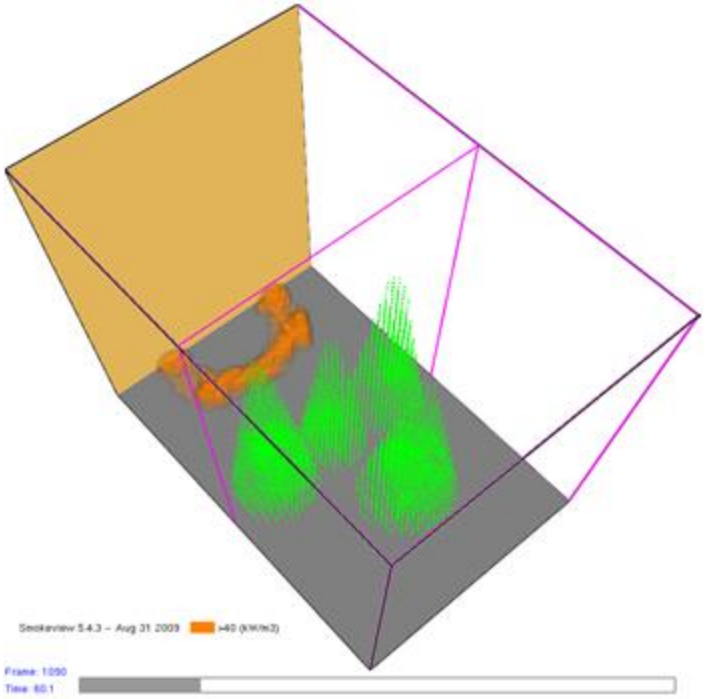


$$P = \frac{e^{g(x)}}{1 - e^{g(x)}}$$

Wildfires – Opportunities

- Tree-level crown fire initiation and propagation models
  - Wildland-urban fire dynamics simulator (WFDS)
  - Different tree arrangements representing various tree sizes and spatial distribution
  - Crown fire initiation
    - Tree sizes (i.e., CBH, HT)
  - Crown fire propagation
    - Tree sizes (i.e., DBH, CW)
    - Tree spacing
    - Tree density

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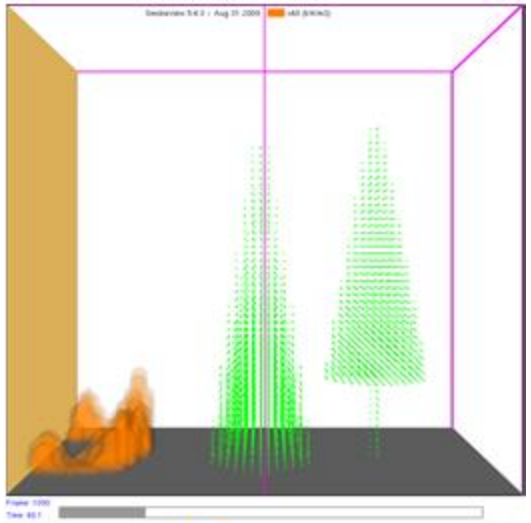

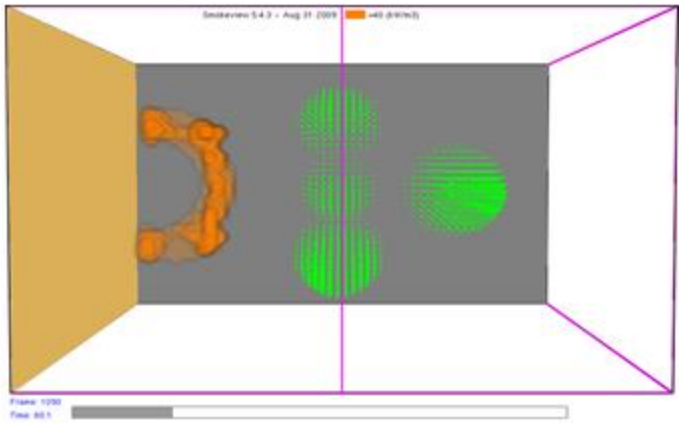

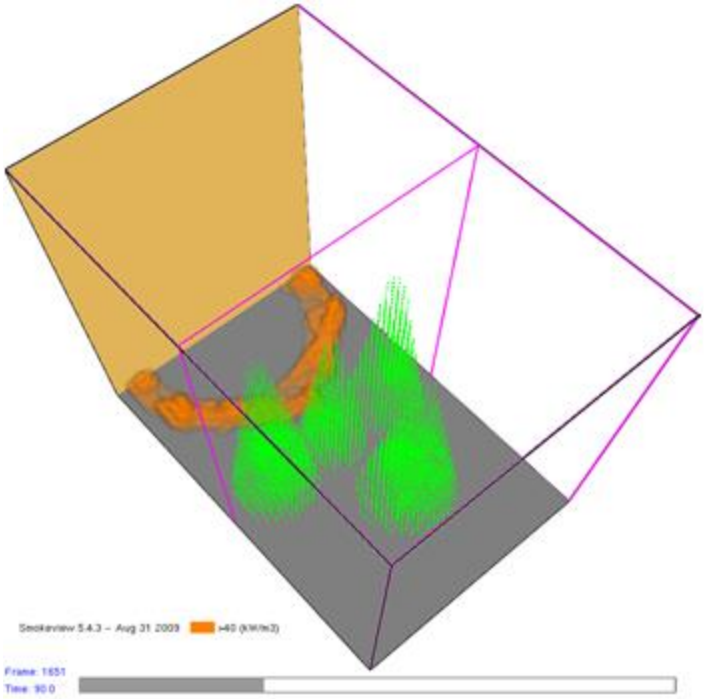
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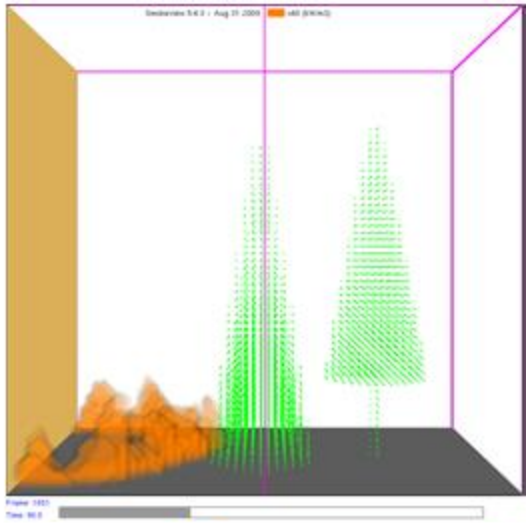

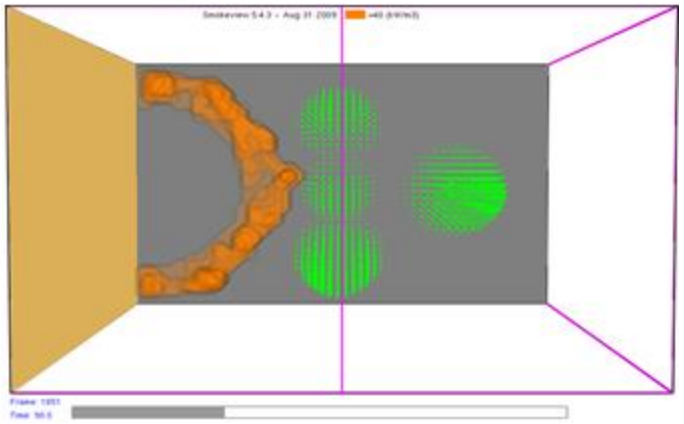

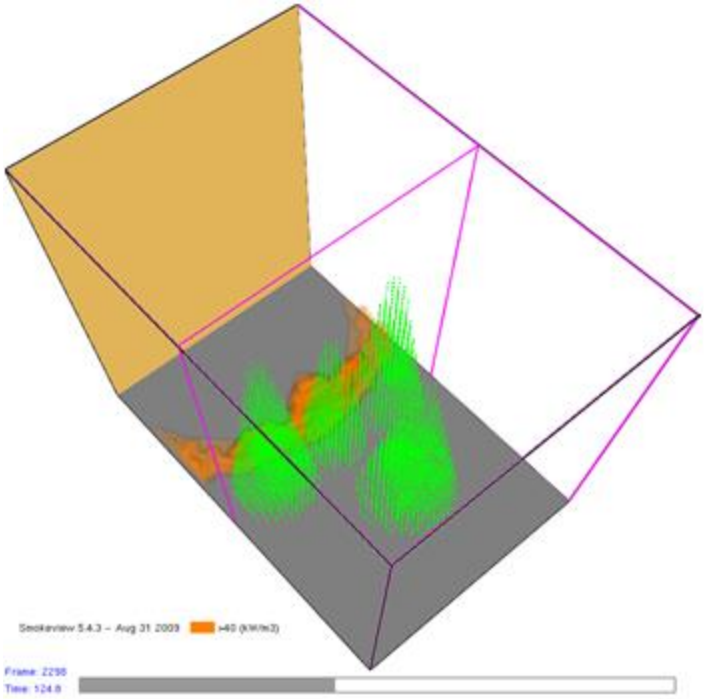
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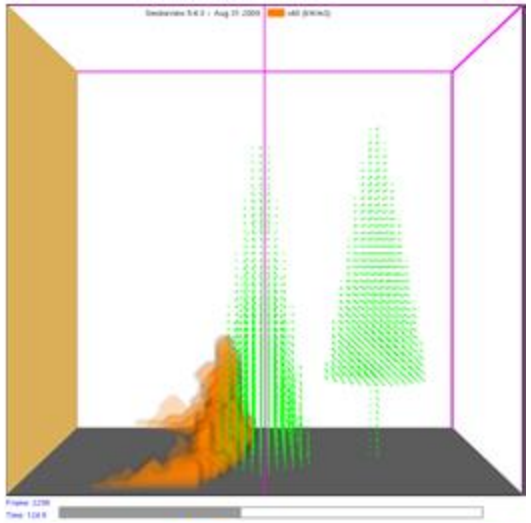

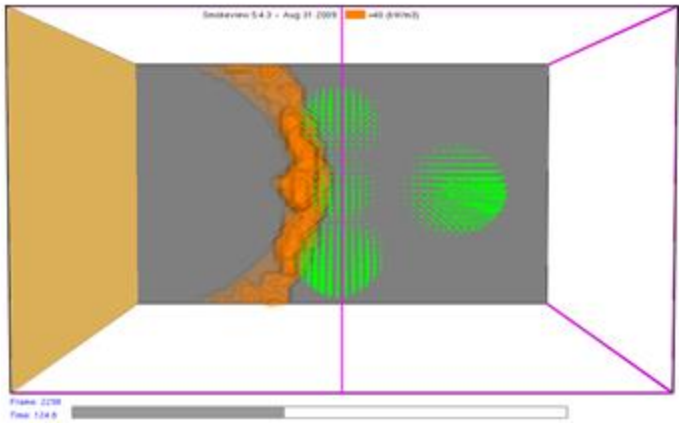

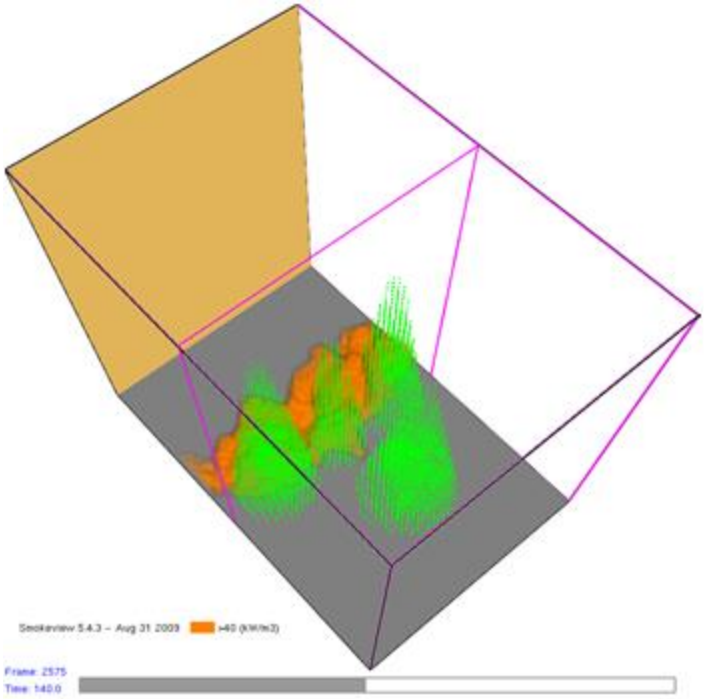
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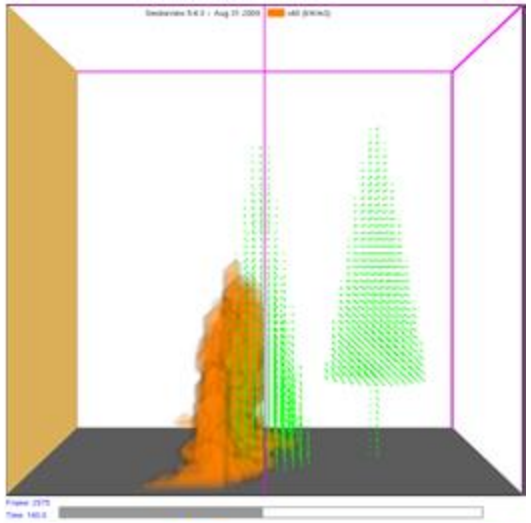

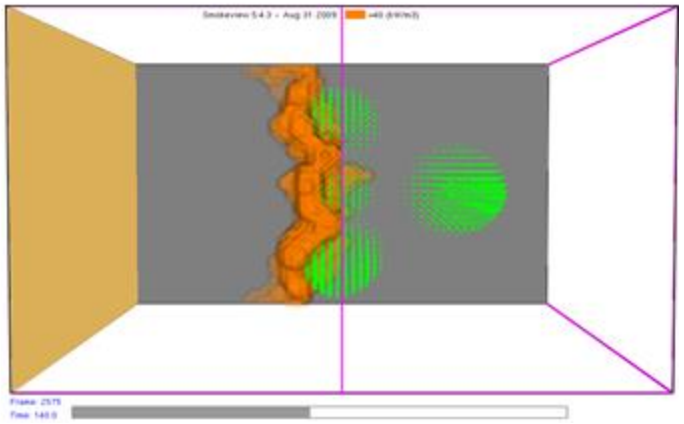

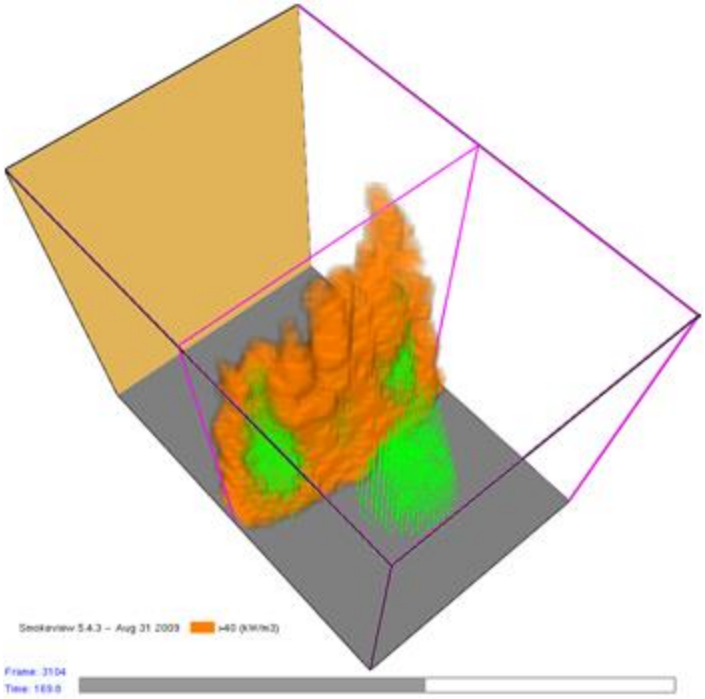
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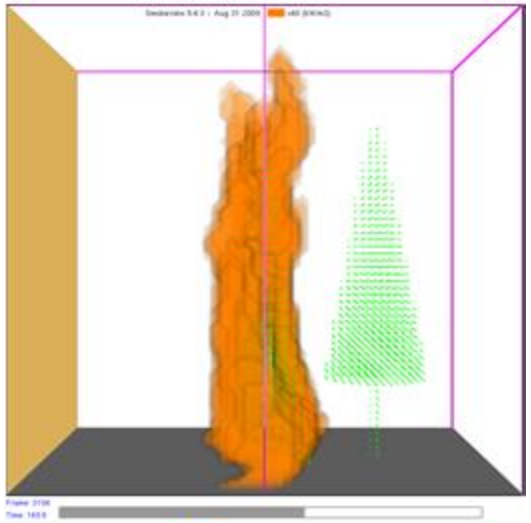

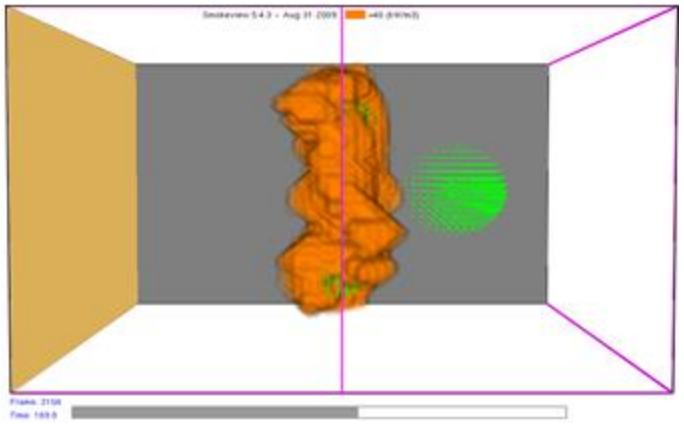

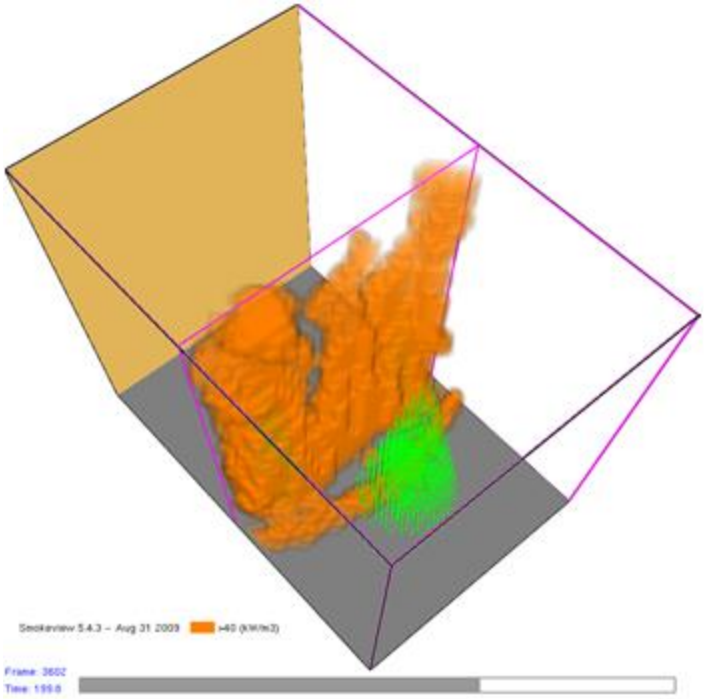
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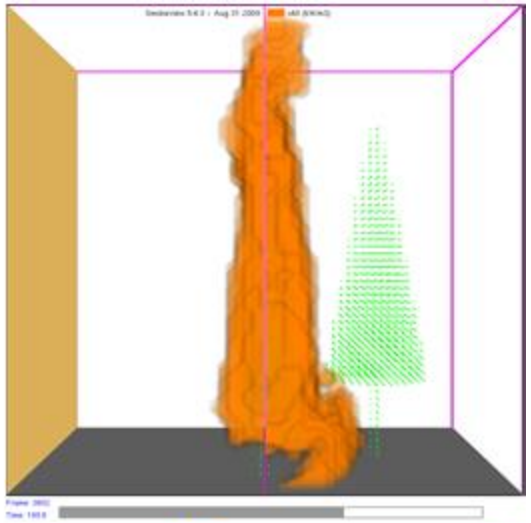

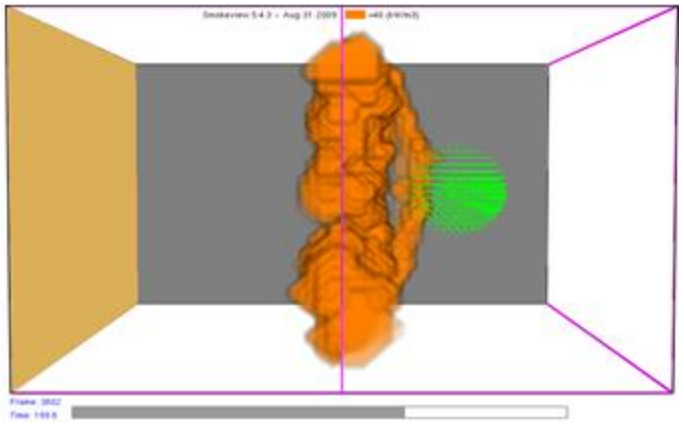

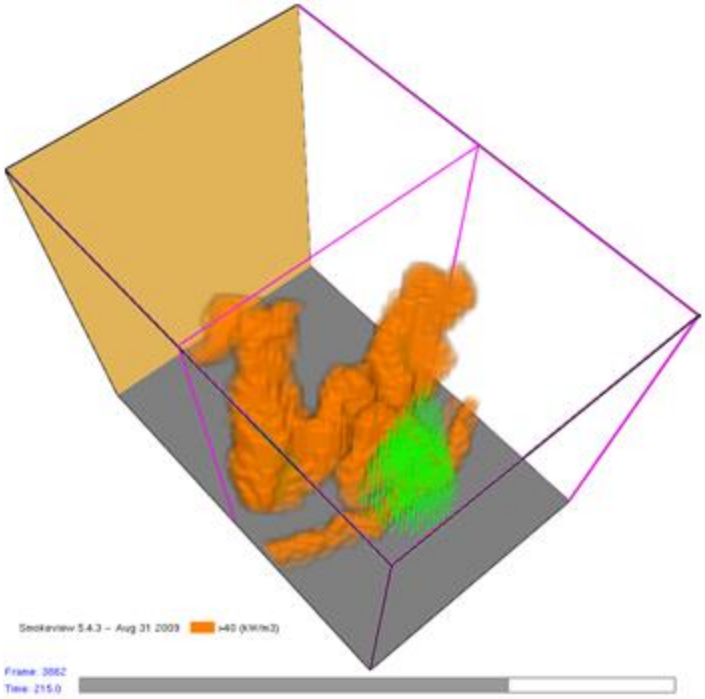
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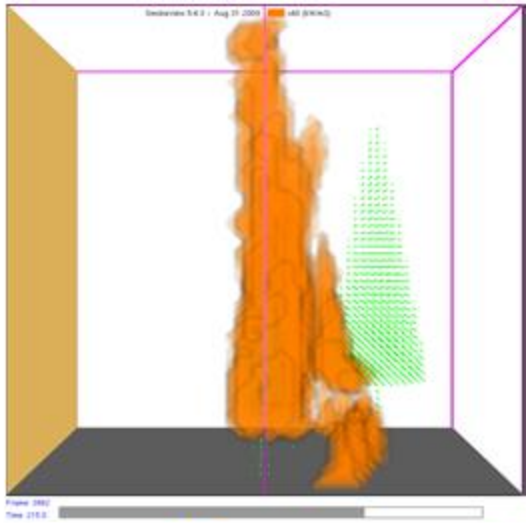

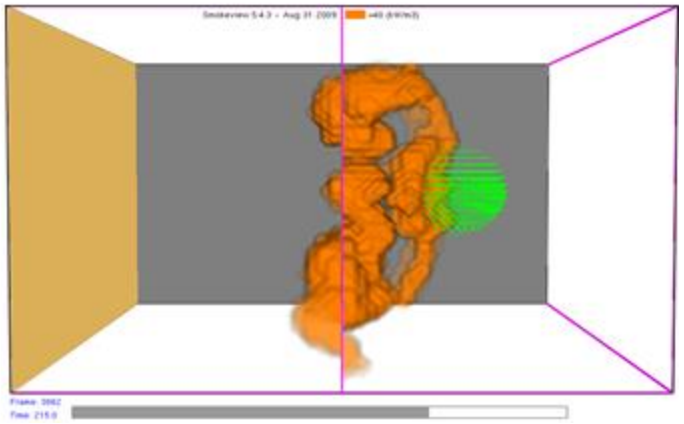

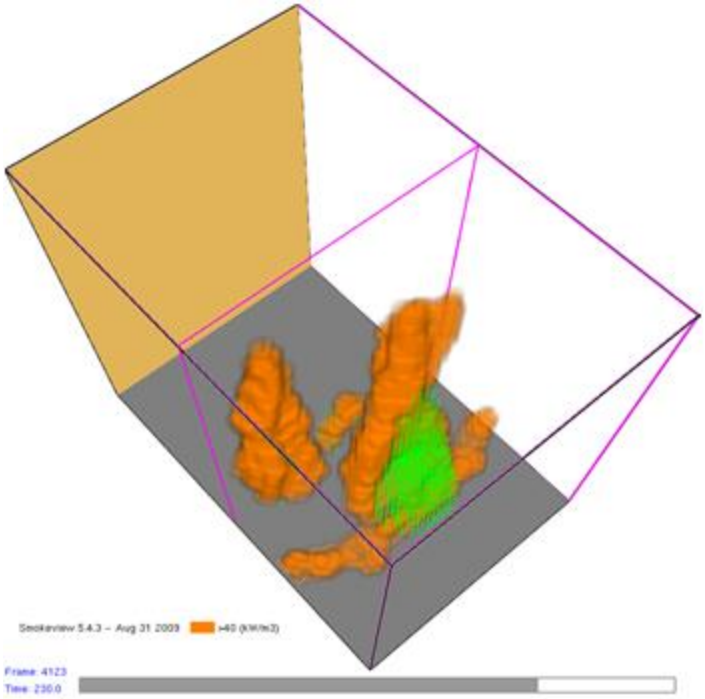
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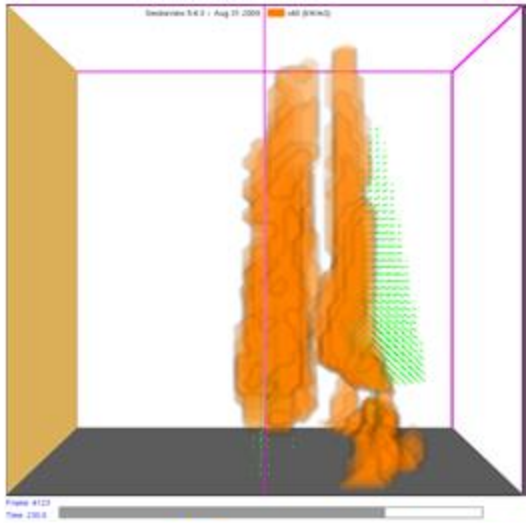

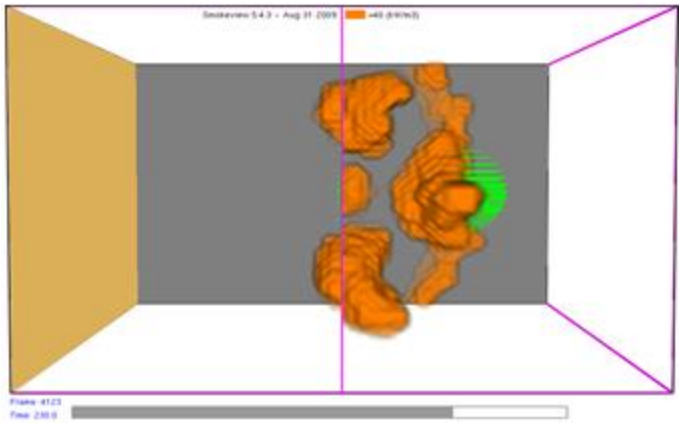

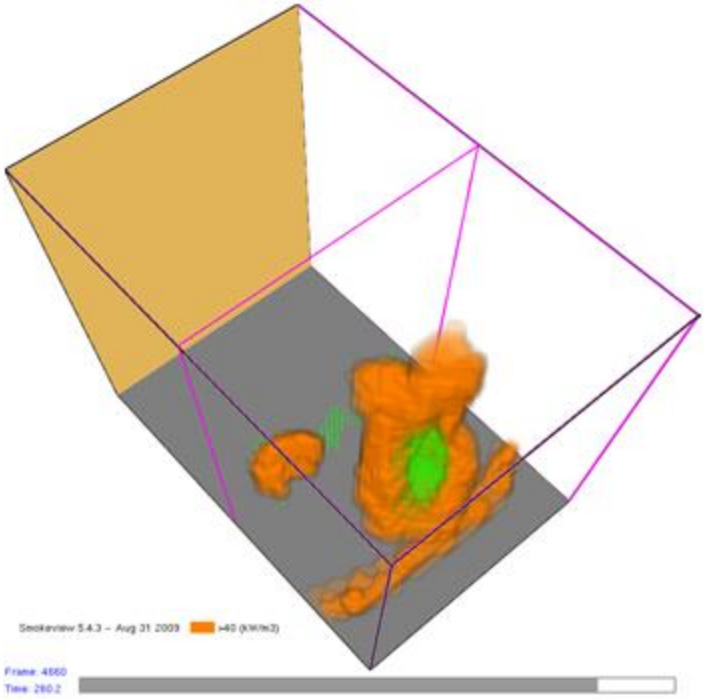
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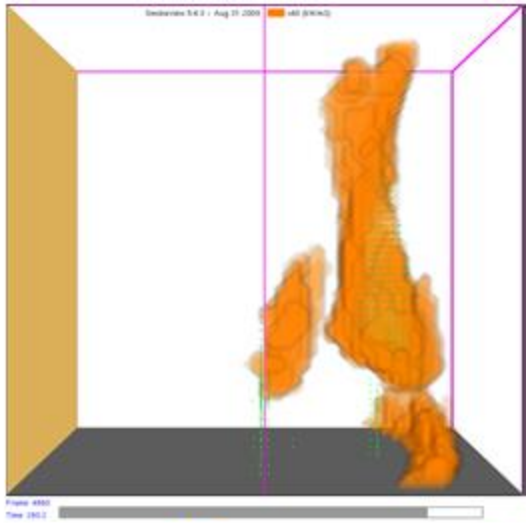

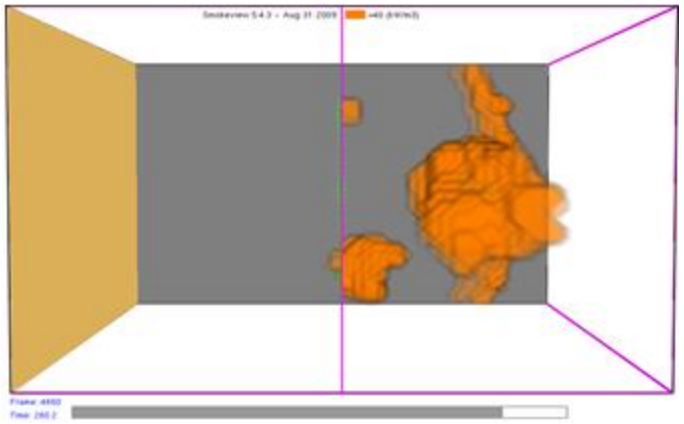

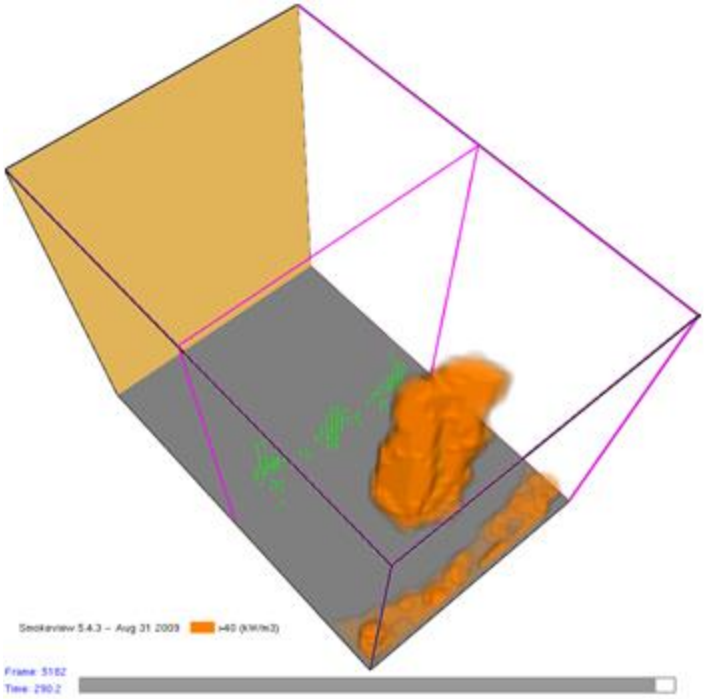
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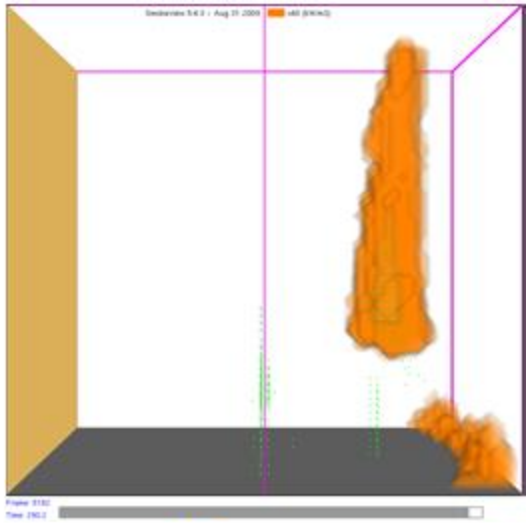

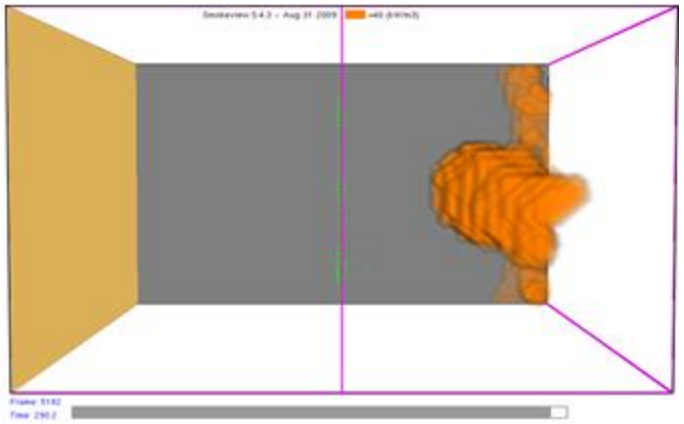

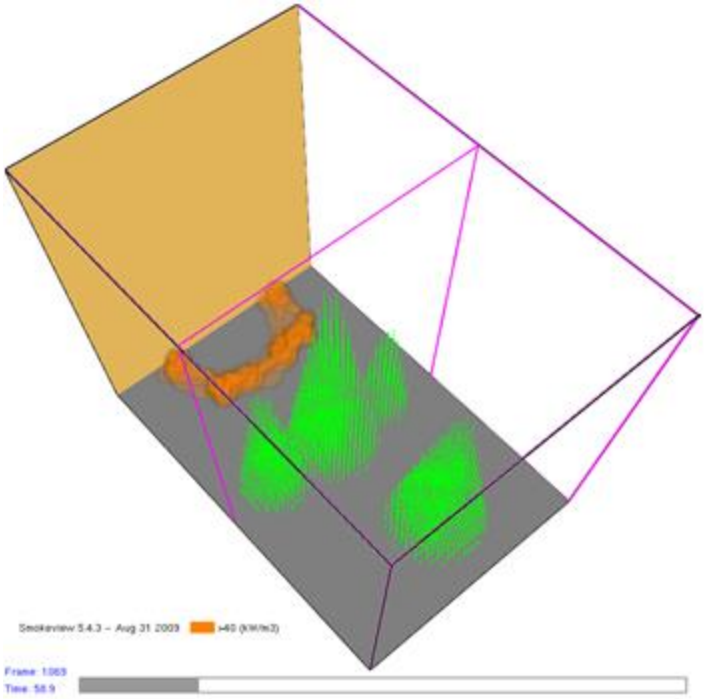
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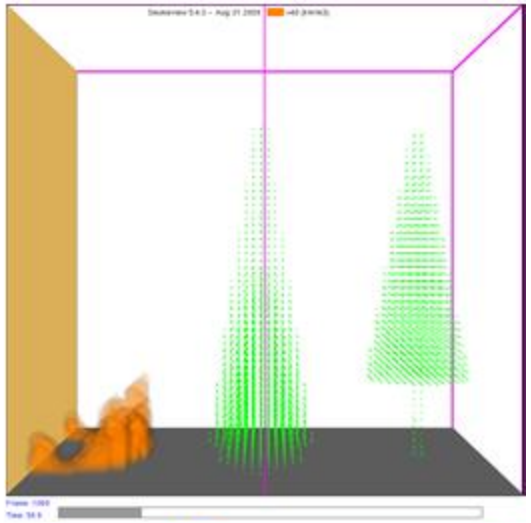

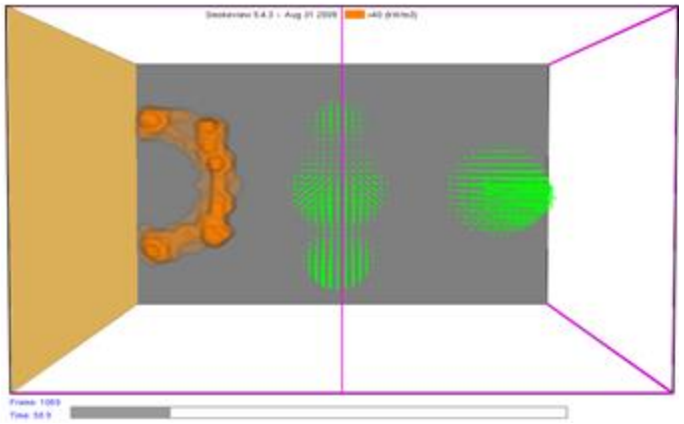

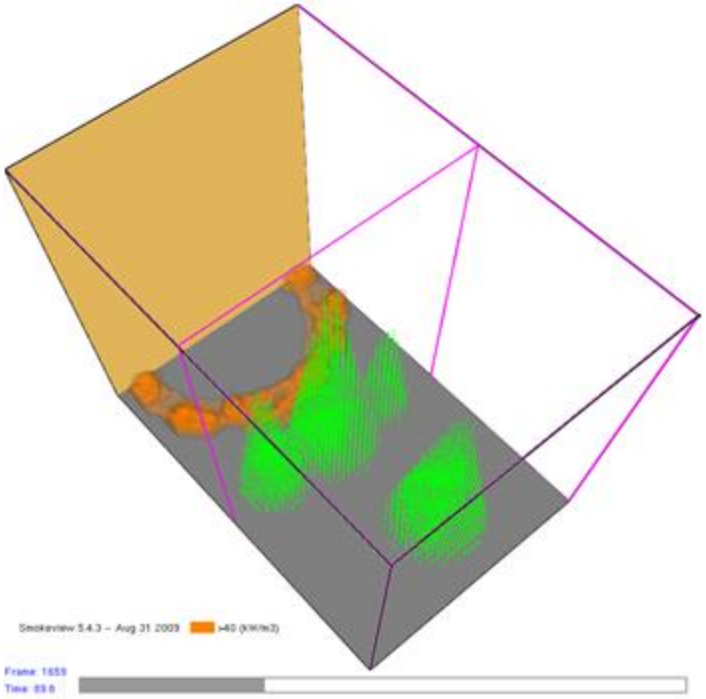
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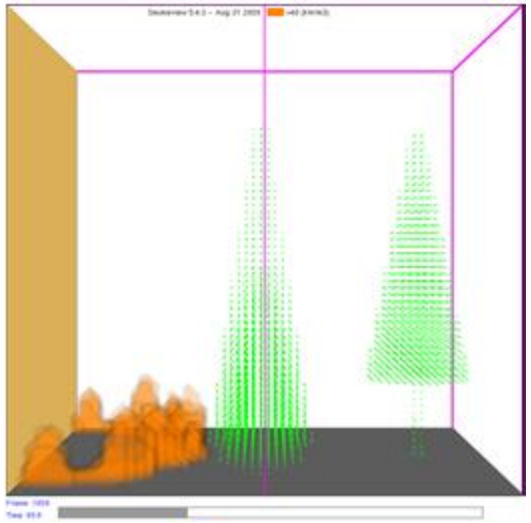

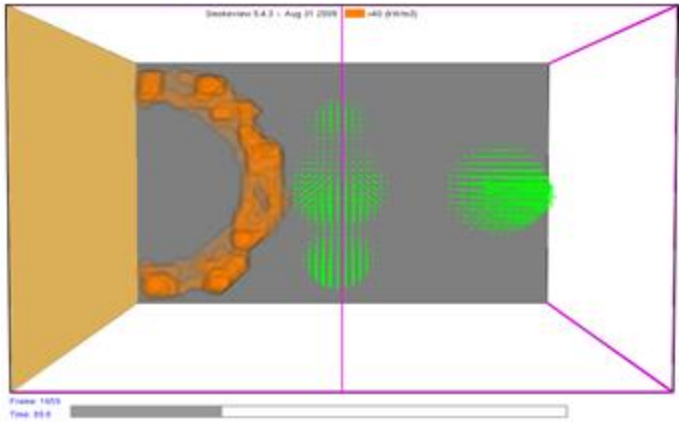

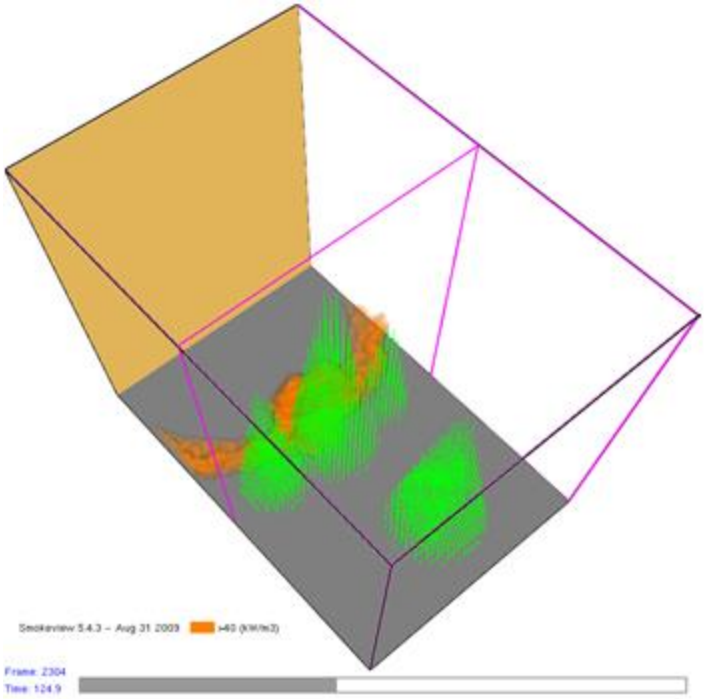
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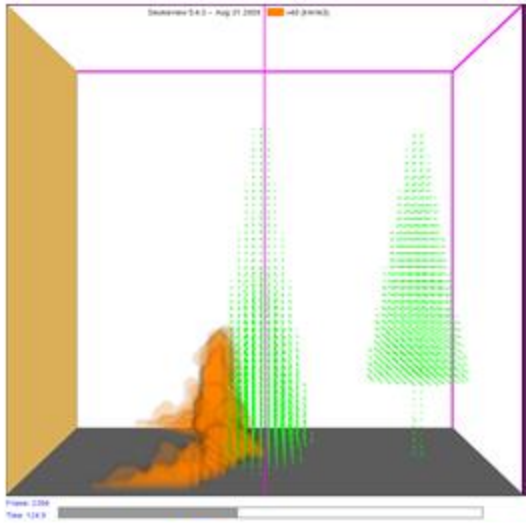

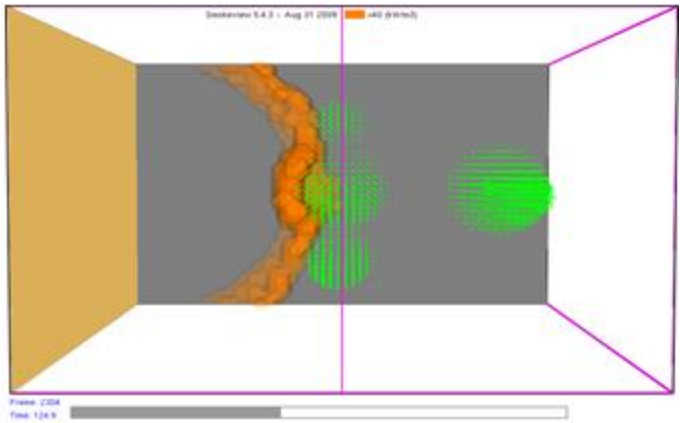

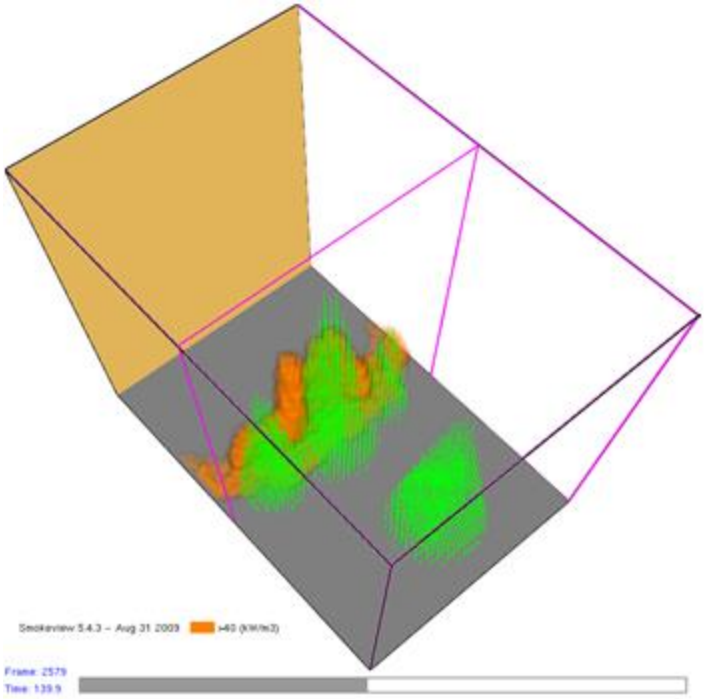
Smokeview 5.4.3 – Aug 31 2009
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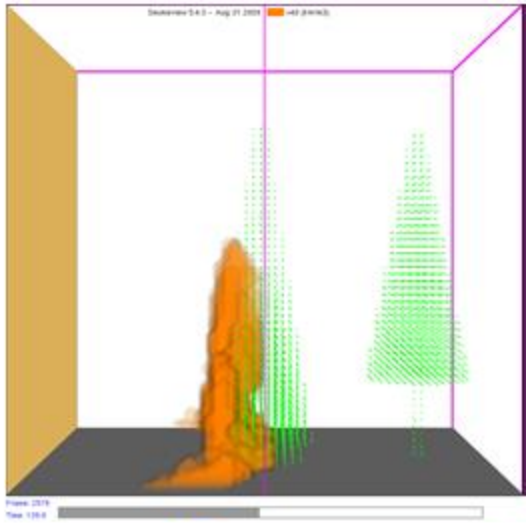
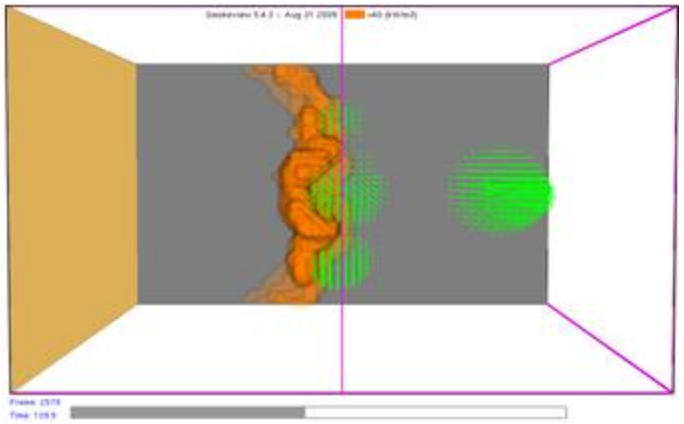
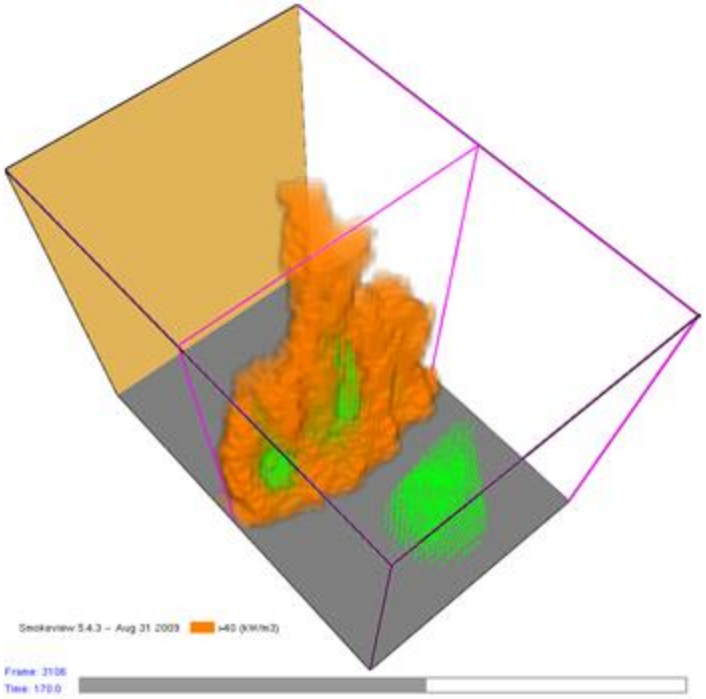
Frame: 2579
Time: 139.9






Smokeview 5.4.3 – Aug 31 2009
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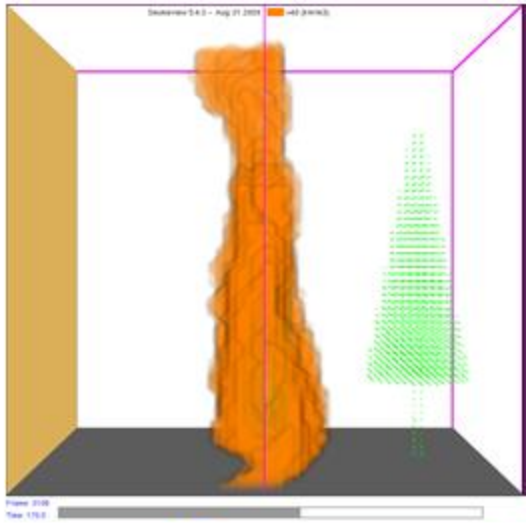
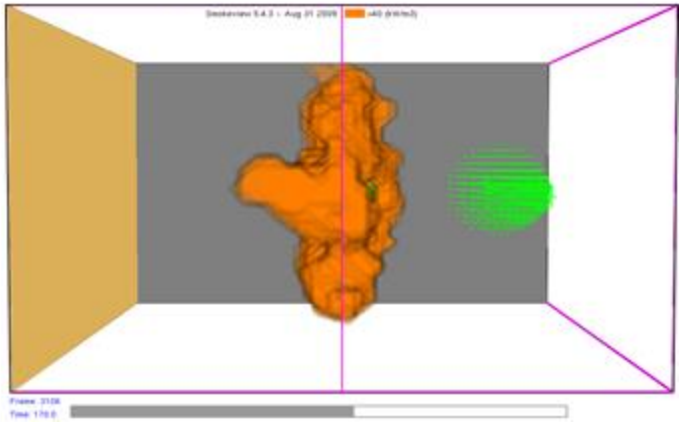
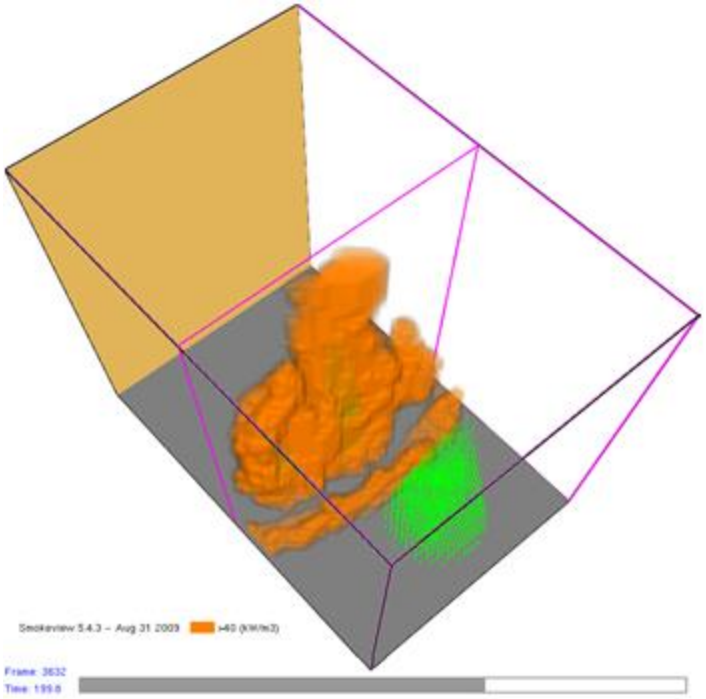
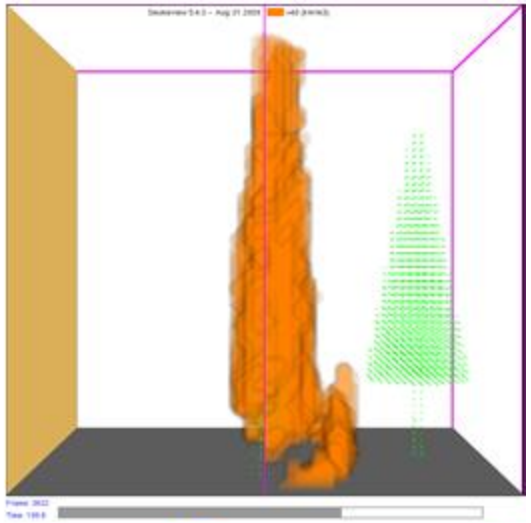
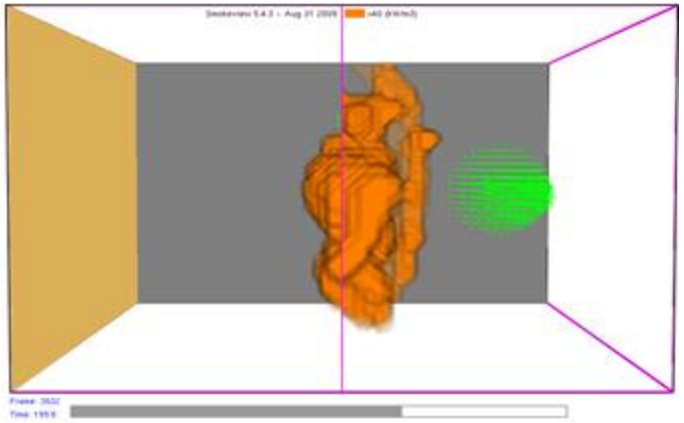
Frame: 3106
Time: 170.0

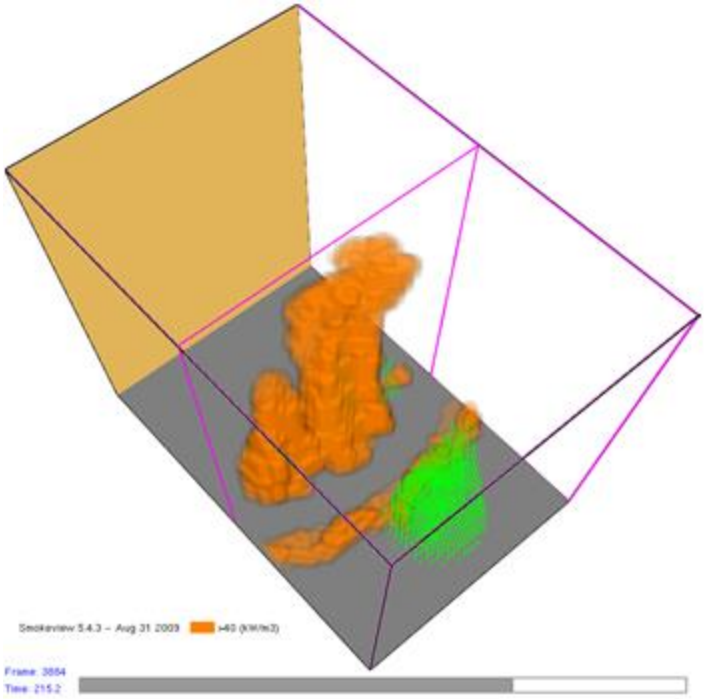





Smokeview 5.4.3 – Aug 31 2009
>40 (kW/m3)
Frame: 3632
Time: 199.8






Smokeview 5.4.3 – Aug 31 2009
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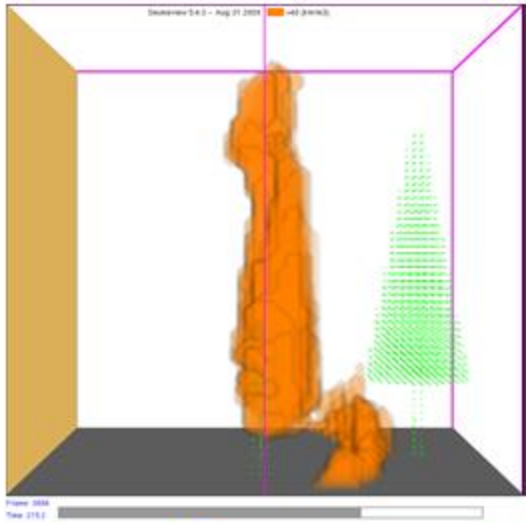
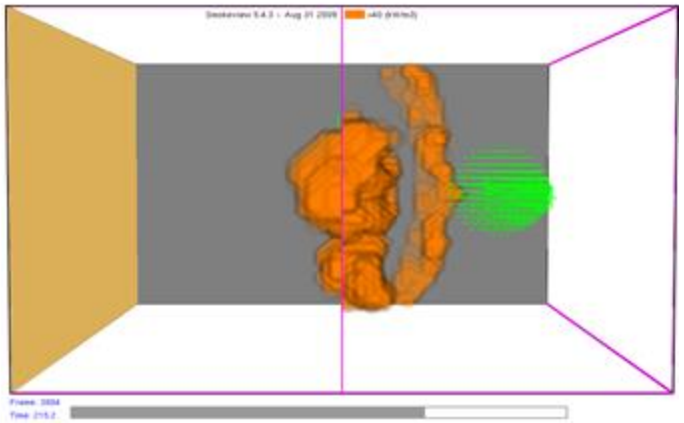
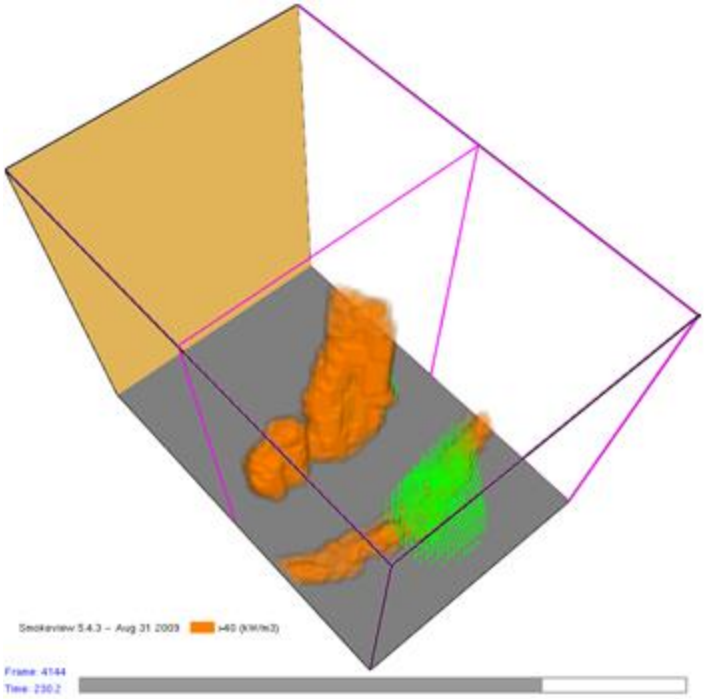
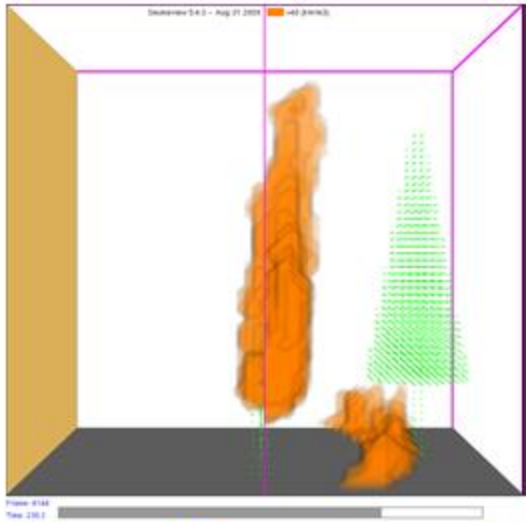
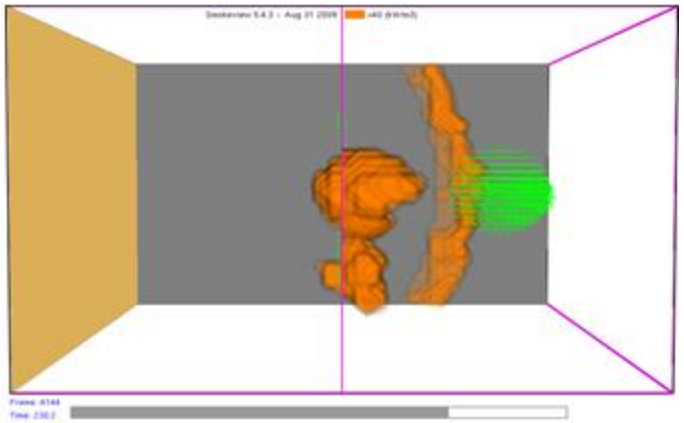
Time: 215.2

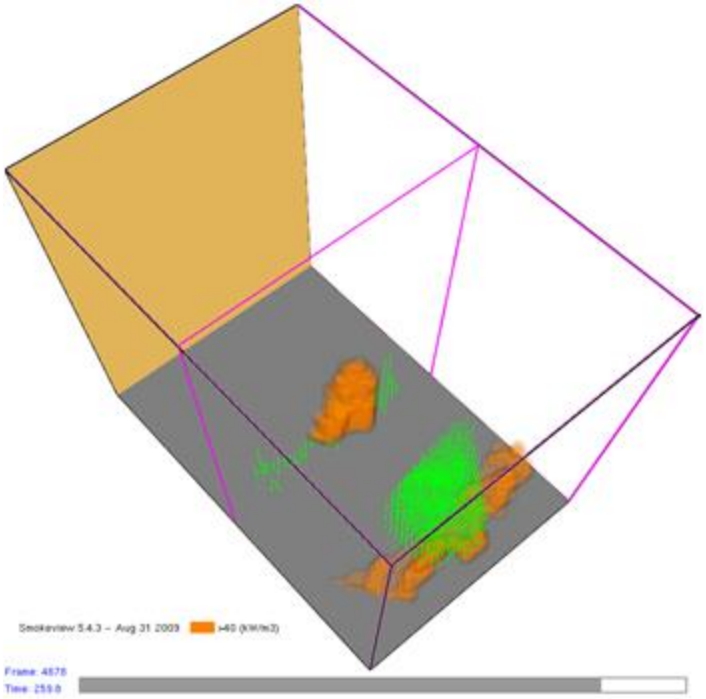


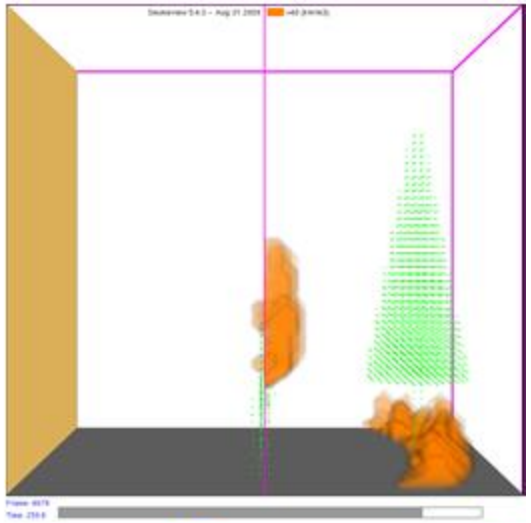


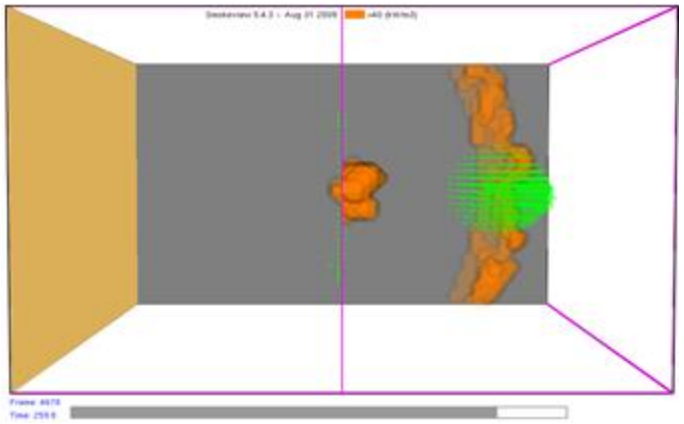

Smokeview 5.4.3 – Aug 31 2009
>40 (kW/m3)
Frame: 4144
Time: 230.2

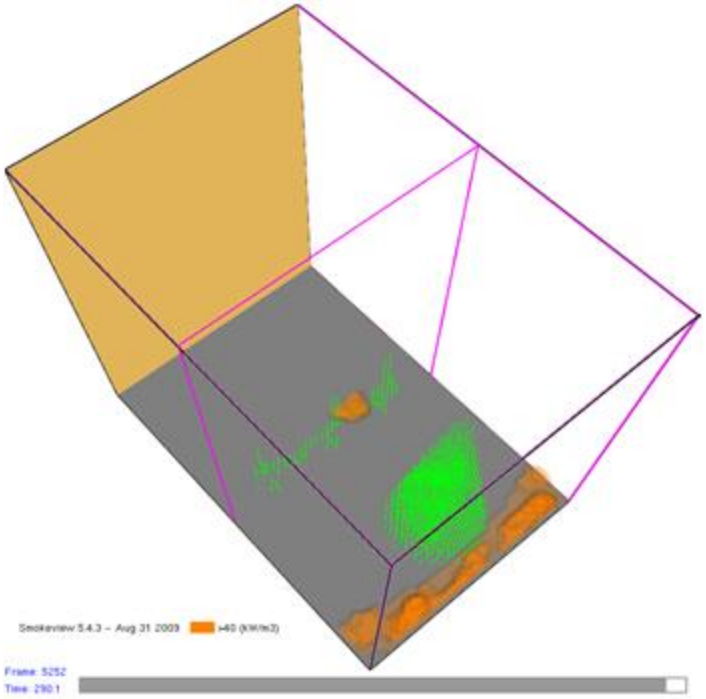


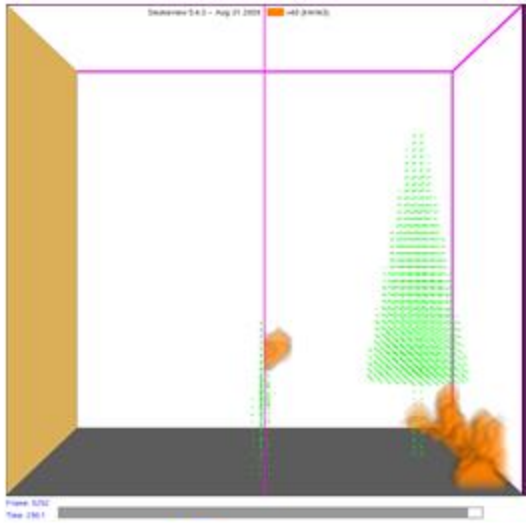


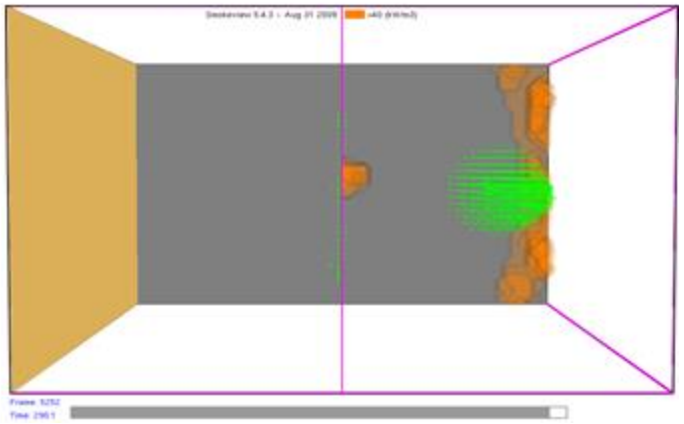

Smokeview 5.4.3 – Aug 31 2009
>40 (kW/m3)
Frame: 4678
Time: 259.8






Smokeview 5.4.3 – Aug 31 2009
>40 (kW/m3)
Frame: 5252
Time: 290.1





ÅCrown fire initiation model

$$P = \frac{e^{g(x)}}{1 - e^{g(x)}} \qquad g(x) = 10.93897 + (0.24285 \times HT) - (2.84814 \times CBH)$$

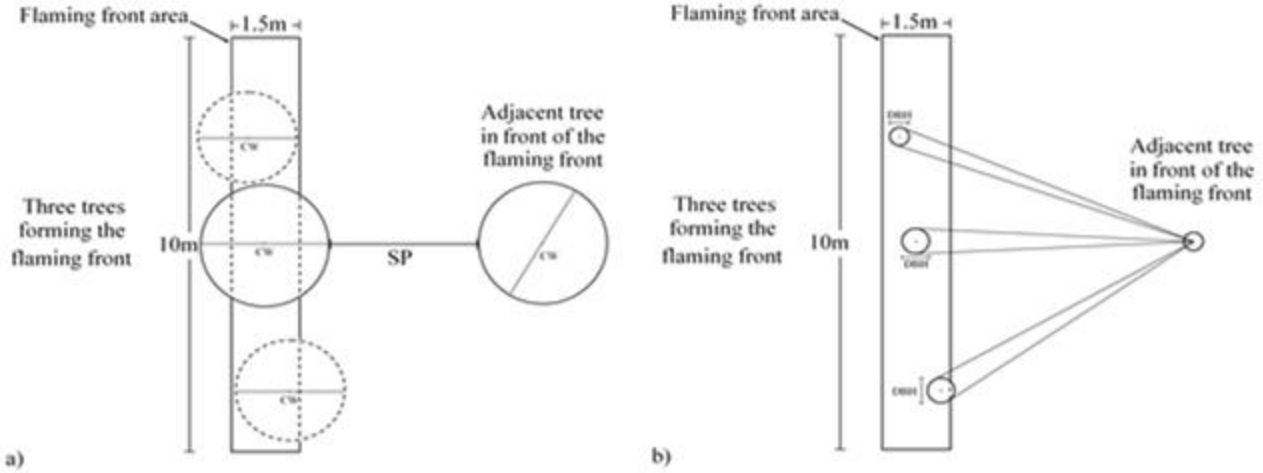
P = probability of crown fire initiation will occur

HT = tree height

CBH = crown base height

Crown fire propagation model

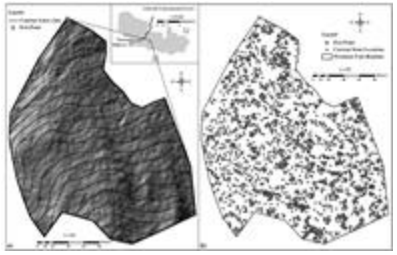
$$P = \frac{e^{g(x)}}{1 - e^{g(x)}} \qquad g(x) = -6.9064 + (0.3194 \times HT) - (3.2356 \times SP) + (69.4118 \times CI)$$



Wildfires – Opportunities

DEM and Stem Map

LiDAR-derived data



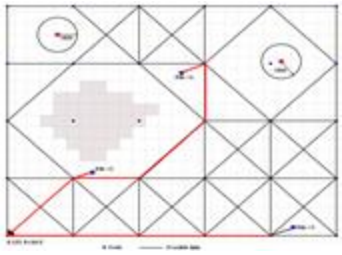
Crown Fire

Logistic regression models

$$P = \frac{e^{g(x)}}{1 - e^{g(x)}}$$

Skidding Cost

Tree-level skidding cost model

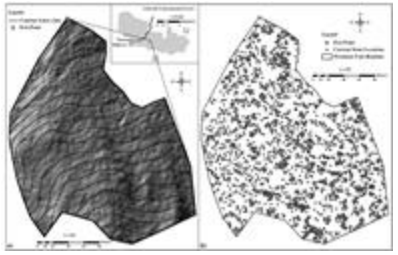


Optimization

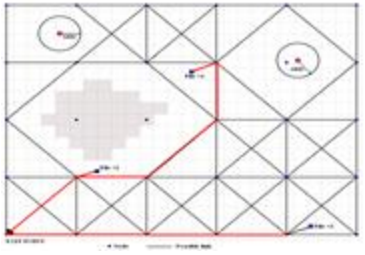
Minimize fuel connections and costs

Wildfires – Opportunities

DEM and Stem Map	Crown Fire	Skidding Cost	Optimization
LiDAR-derived data	Logistic regression models	Tree-level skidding cost model	Minimize fuel connections and costs



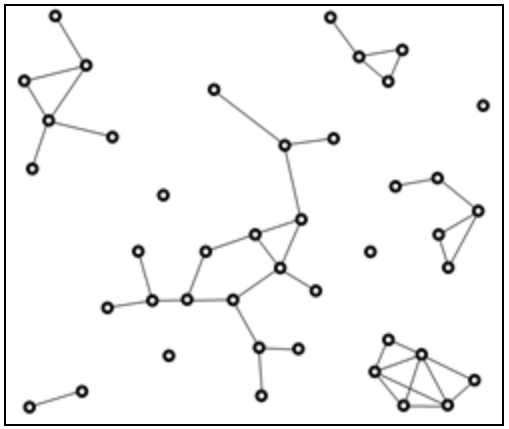
$$P = \frac{e^{g(x)}}{1 - e^{g(x)}}$$



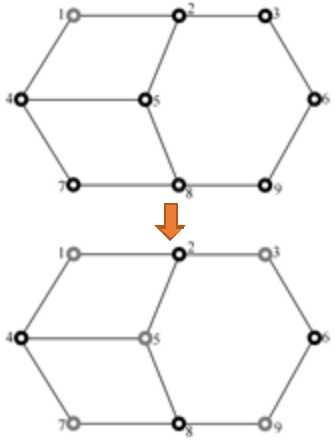
Wildfires – Opportunities

Å Minimum Vertex Cover (MVC) Algorithm

Clusters of connected trees



MVC



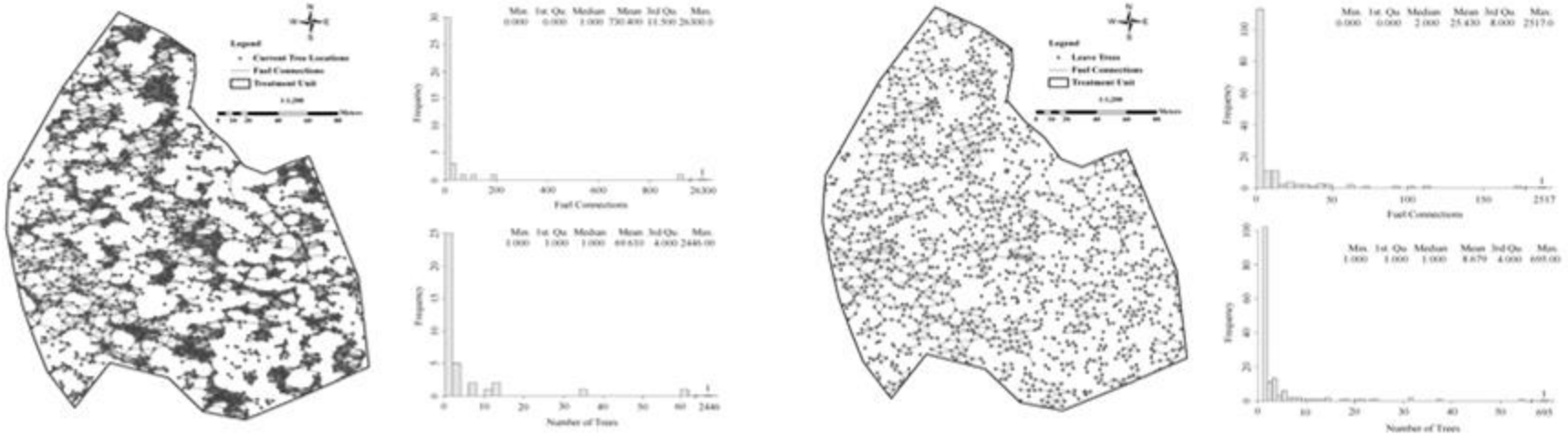
Cut Tree Selection

Fuel connections

Skidding costs

Wildfires – Opportunities

Stand Condition	Crown fire initiation	Crown fire propagation				
	Number of trees ignited	Total fuel connections	Number of connected clusters	Average connections per cluster	Average connection per tree	Average trees per cluster
Before	536	27755	38	730.39	10.49	69.60
After	313	4044	159	25.43	2.93	8.68
% Change	**- 41.6**	**- 85.4**	**+ 418**	**- 96.5**	**- 72**	**- 87.5**



Contreras, M. and W. Chung. 2013. Developing a computerized approach for optimizing individual tree removal to efficiently reduce crown fire potential. *Forest Ecology and Management* 289: 219-233.

Wildfires – Opportunities

- Strategic location of fuel treatments

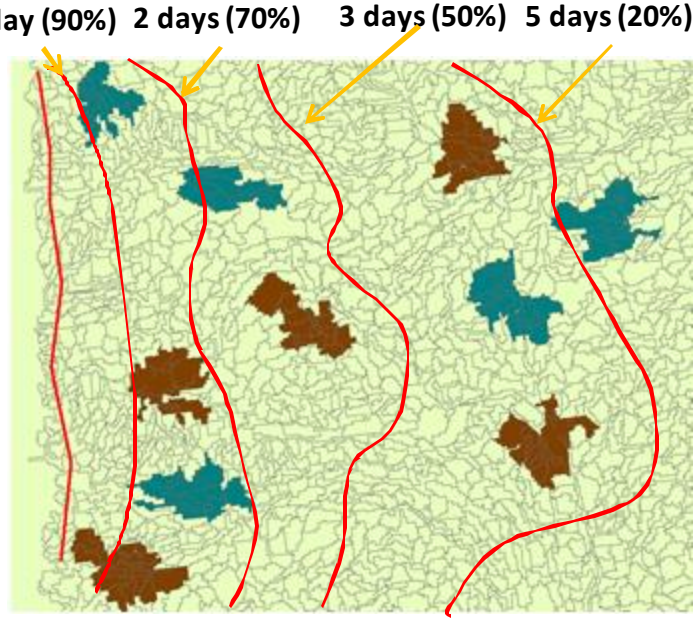
Wildfires – Opportunities

- Objective for driving treatment placement and scheduling
  - Minimize expected loss over time, subject to user-defined limited treatment acres by zones

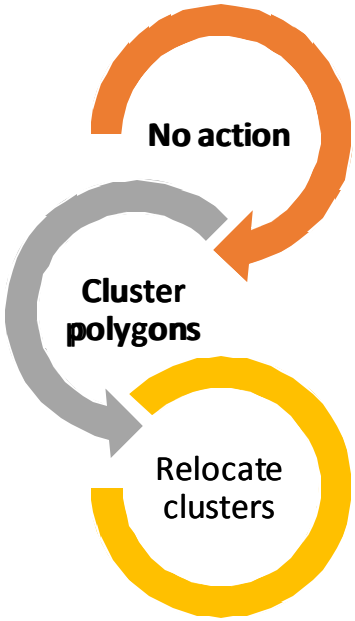
$$Minimize \quad Z = \sum_{t \in T} \sum_{c \in C} \sum_{f \in F} Loss_{f,c,t} \times Y_{f,c,t} \times P_{c,t}$$

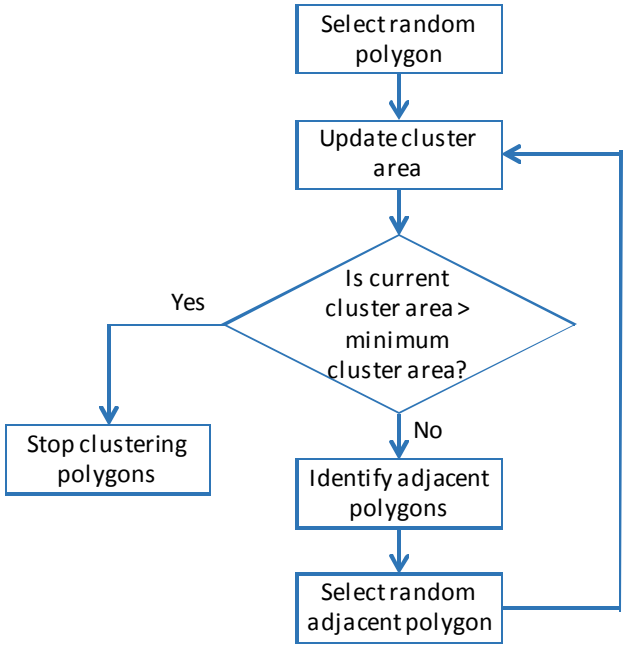
Relative Loss Values ($Loss_{f,c,t}$)

	Low	Med.	High	Very High
FS, roadless	0	10	20	30
FS, accessible	0	60	70	80
FS, WUI	50	150	250	480
Right-of-way	0	0	800	800
State and Private	10	30	50	80

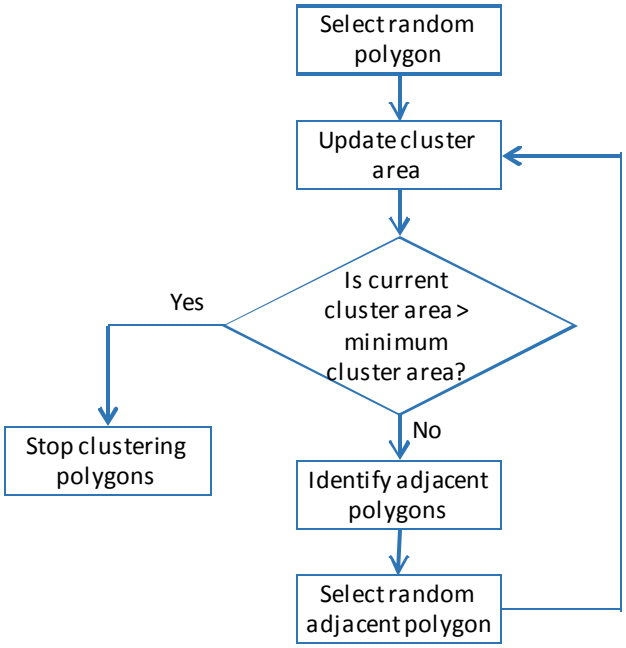


Wildfires – Opportunities





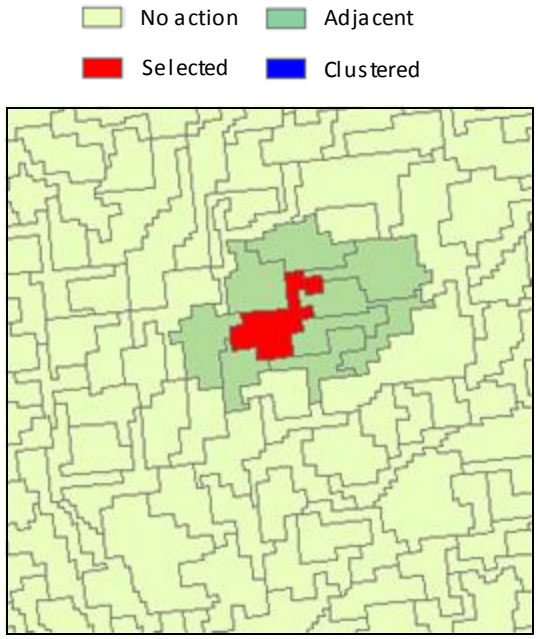
Wildfires – Opportunities



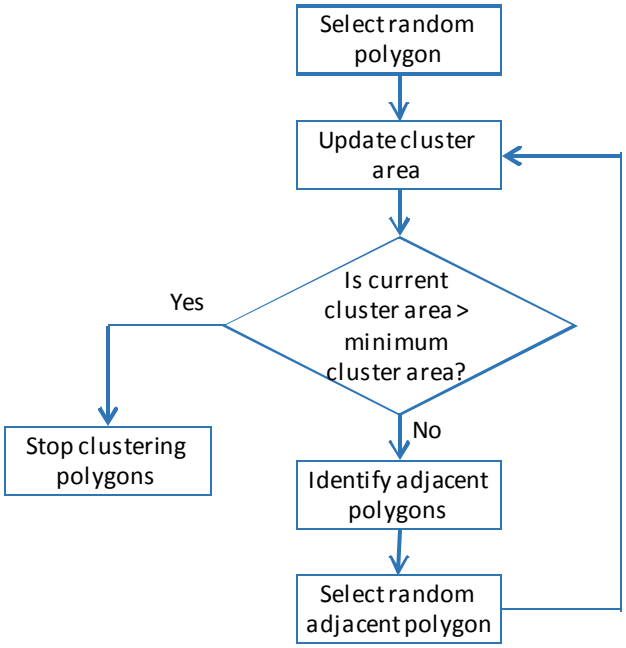
Minimum cluster
100.0 ac

Selected polygon
5.0 ac

Clustered area
5.0 ac



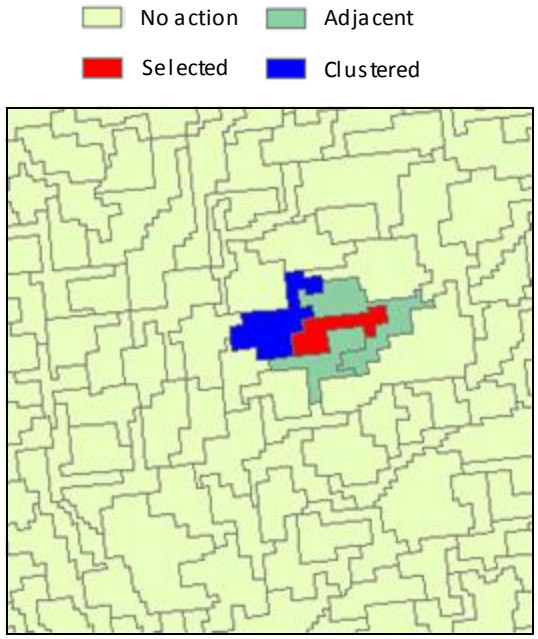
Wildfires – Opportunities



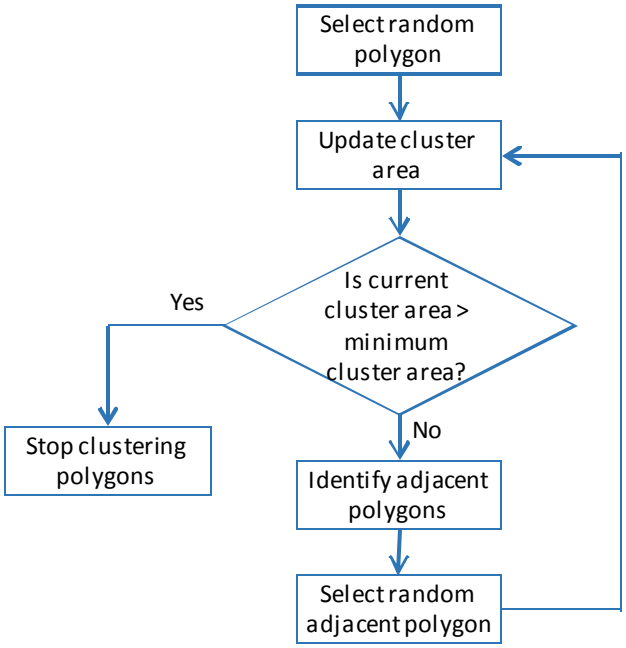
Minimum cluster
100.0 ac

Selected polygon
4.5 ac

Clustered area
9.5 ac



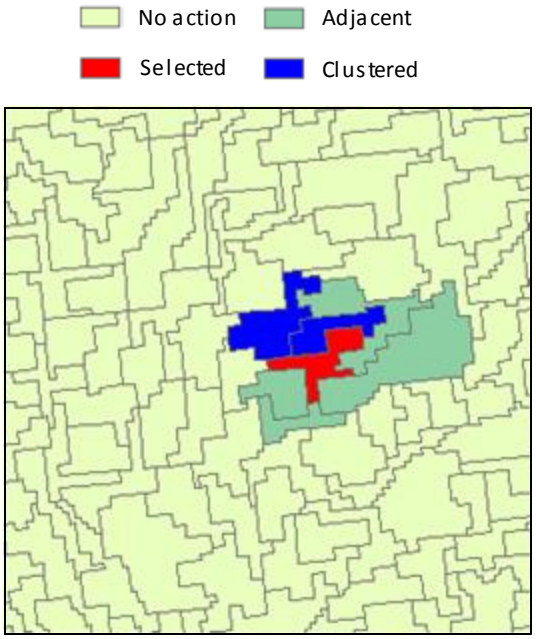
Wildfires – Opportunities



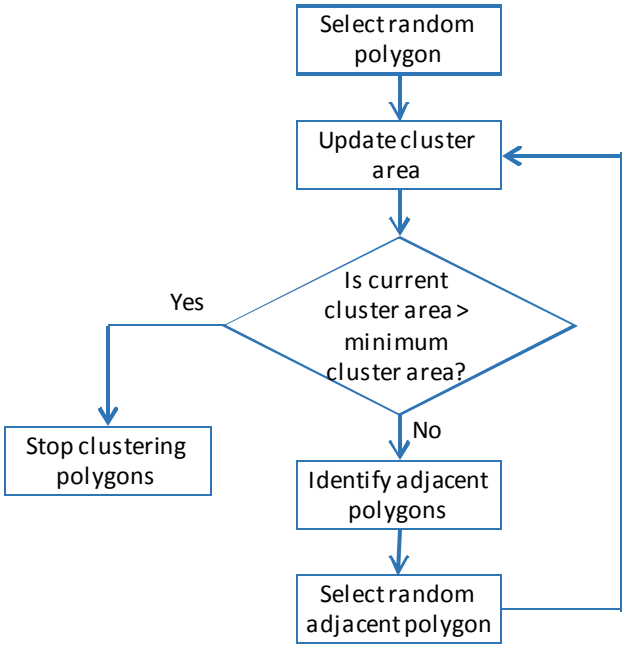
Minimum cluster
100.0 ac

Selected polygon
5.8 ac

Clustered area
15.3 ac



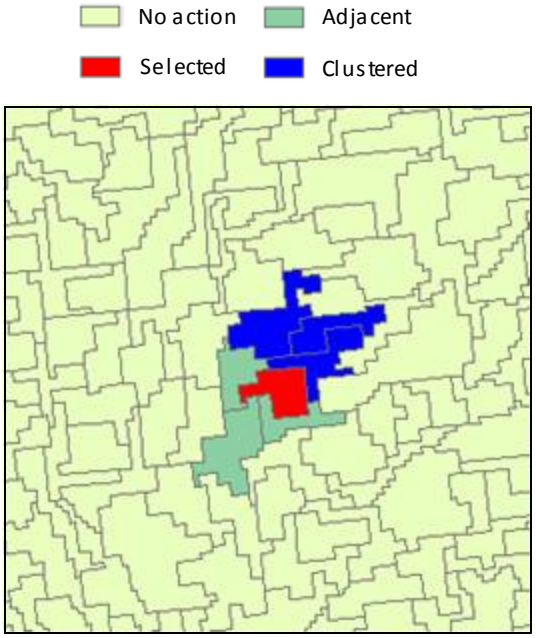
Wildfires – Opportunities



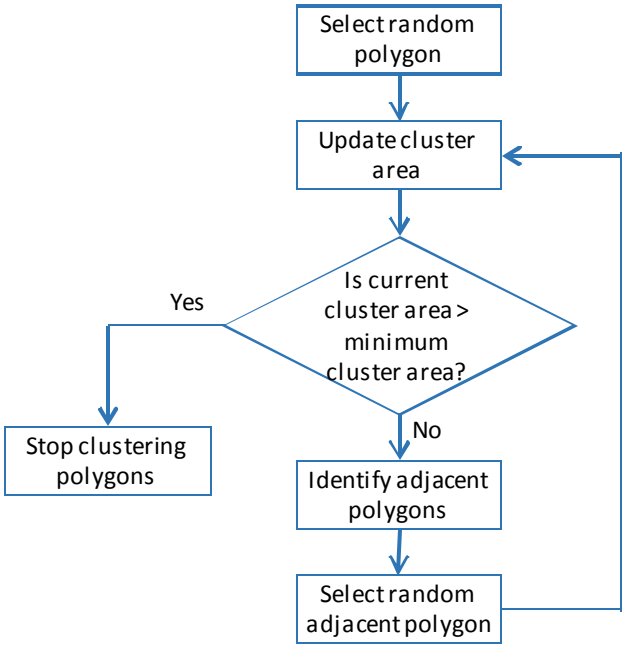
Minimum cluster 100.0 ac

Selected polygon 6.1 ac

Clustered area 21.4 ac



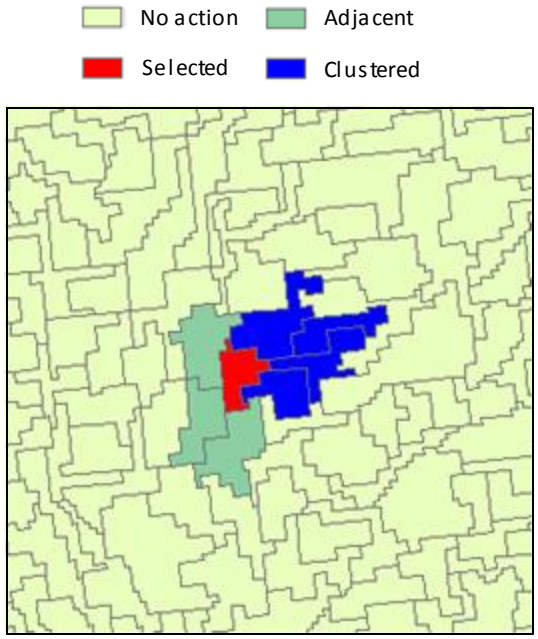
Wildfires – Opportunities



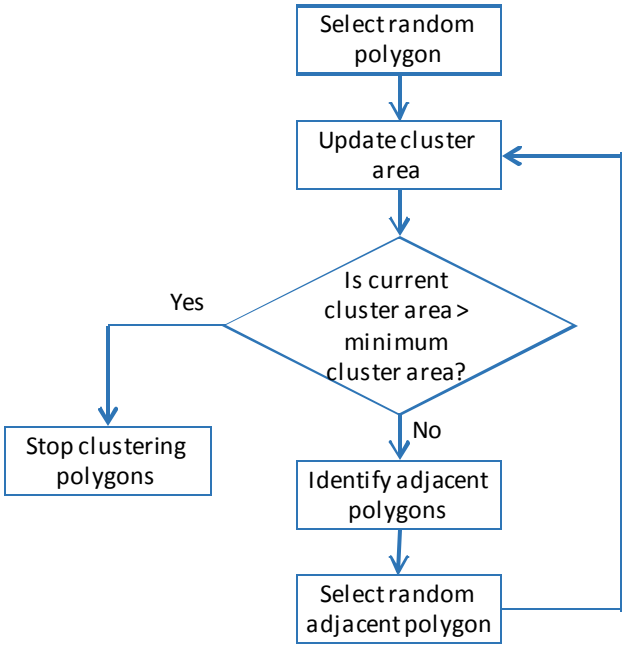
Minimum cluster
100.0 ac

Selected polygon
5.2 ac

Clustered area
26.6 ac



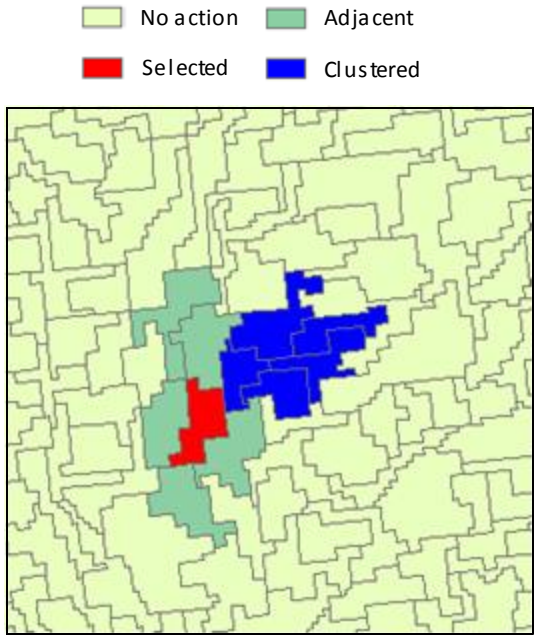
Wildfires – Opportunities



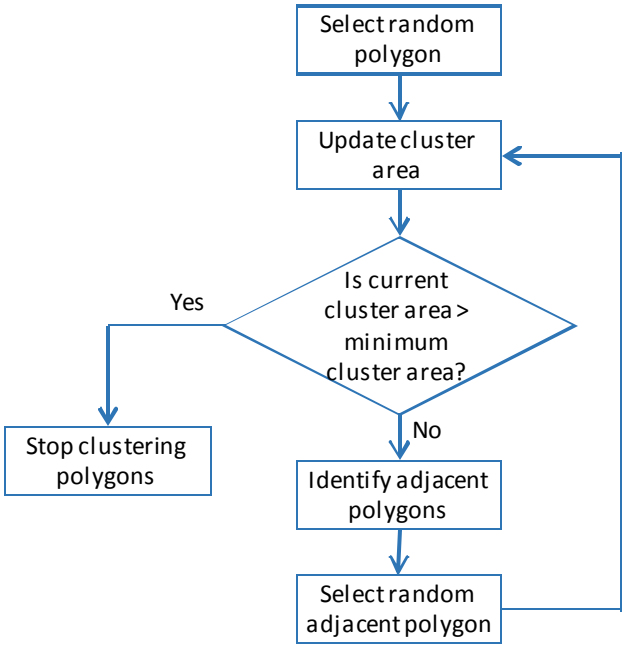
Minimum cluster
100.0 ac

Selected polygon
7.2 ac

Clustered area
33.8 ac



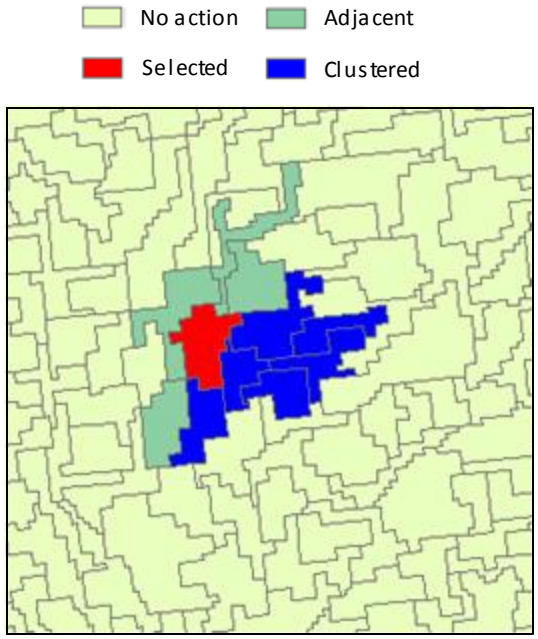
Wildfires – Opportunities



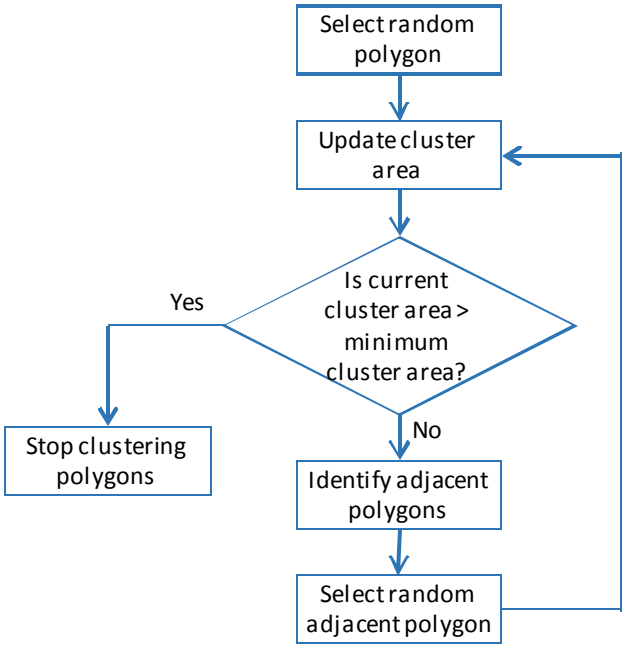
Minimum cluster
100.0 ac

Selected polygon
8.1 ac

Clustered area
41.9 ac



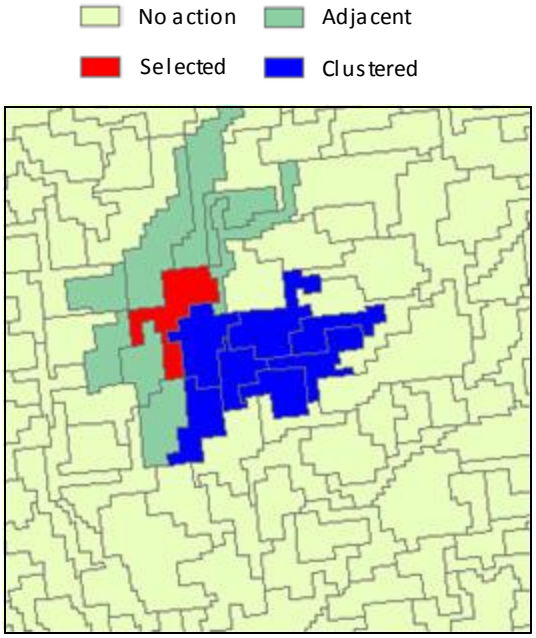
Wildfires – Opportunities



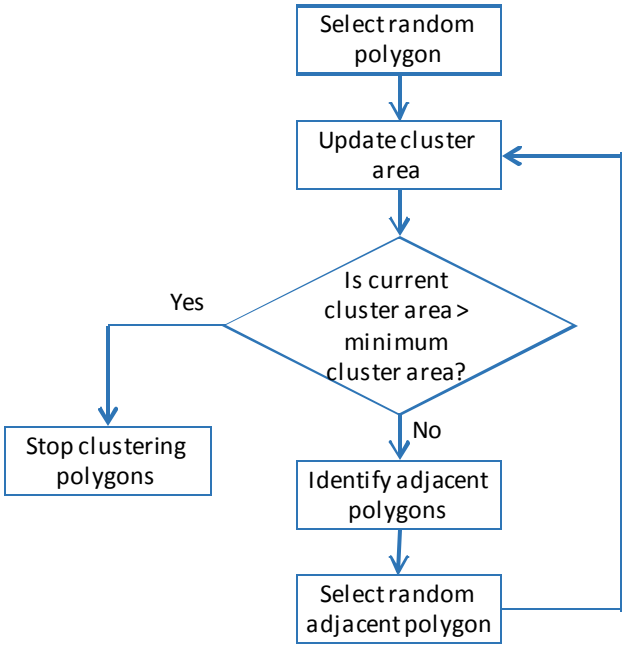
Minimum cluster 100.0 ac

Selected polygon 8.8 ac

Clustered area 50.7 ac



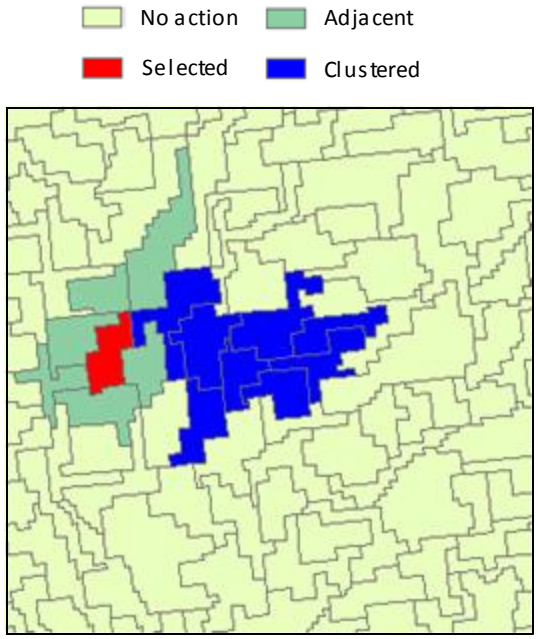
Wildfires – Opportunities



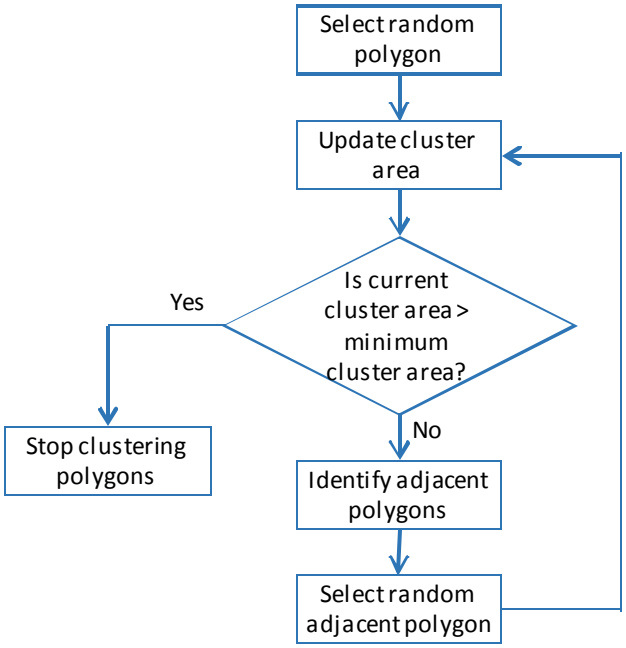
Minimum cluster
100.0 ac

Selected polygon
7.7 ac

Clustered area
58.4 ac



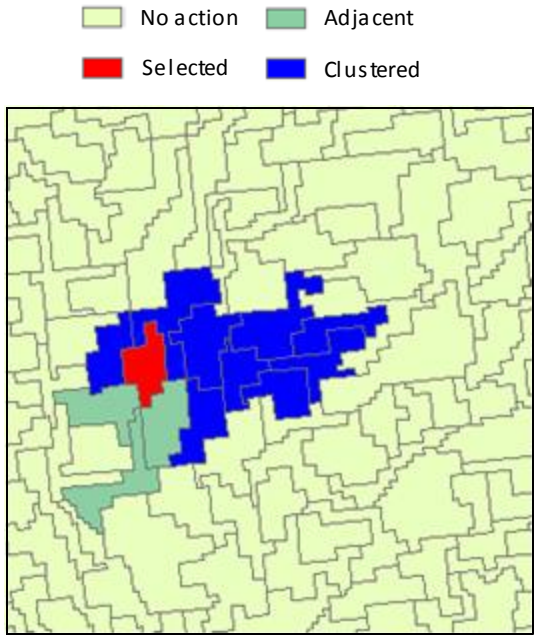
Wildfires – Opportunities



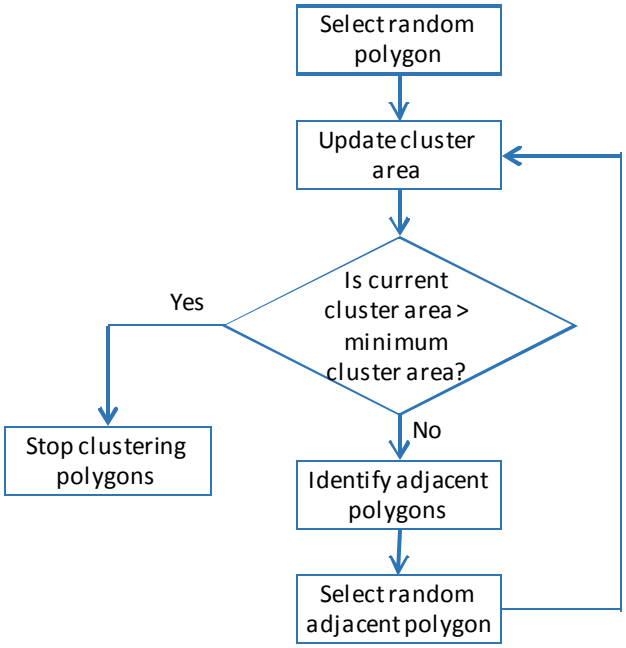
Minimum cluster
100.0 ac

Selected polygon
7.8 ac

Clustered area
74.0 ac



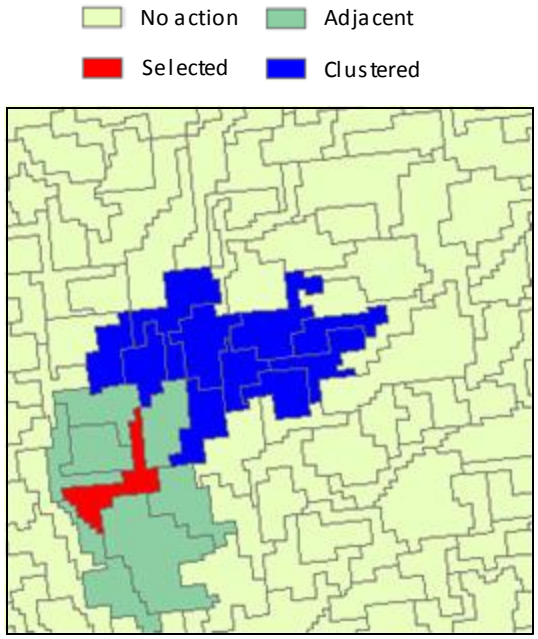
Wildfires – Opportunities



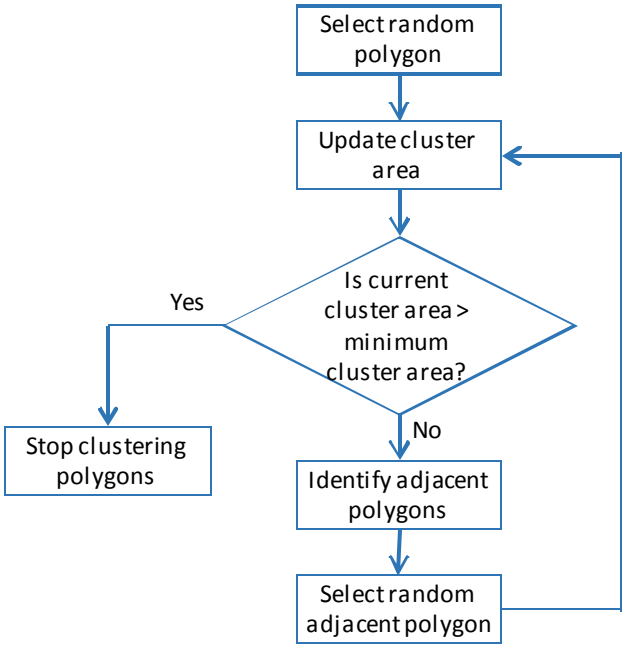
Minimum cluster 100.0 ac

Selected polygon 8.9 ac

Clustered area 82.9 ac



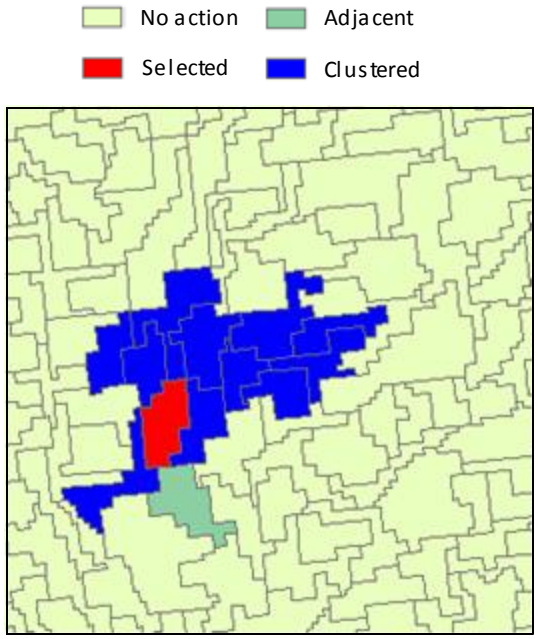
Wildfires – Opportunities



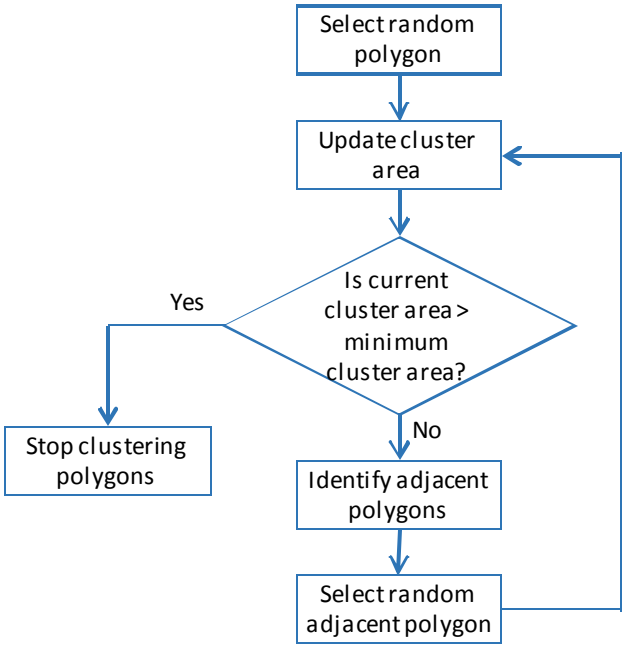
Minimum cluster
100.0 ac

Selected polygon
8.2 ac

Clustered area
91.1 ac



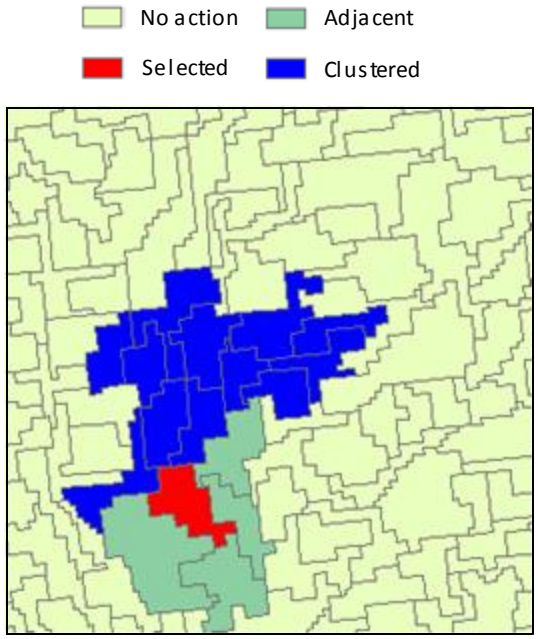
Wildfires – Opportunities



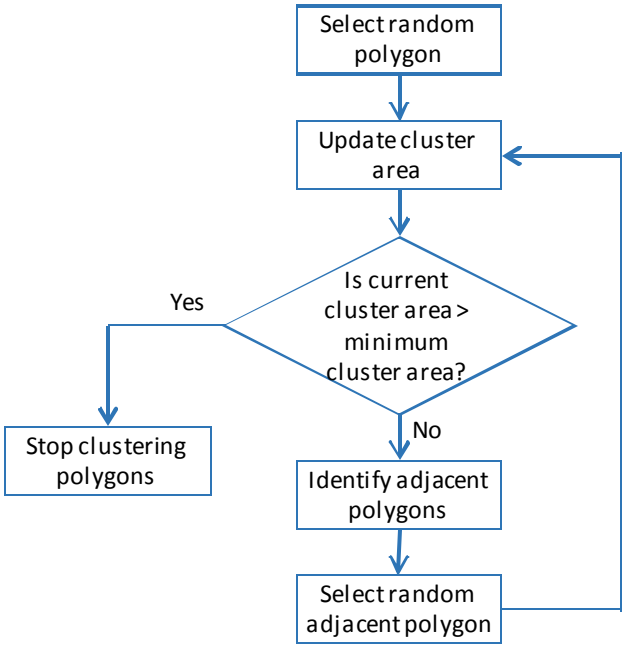
Minimum cluster
100.0 ac

Selected polygon
7.8 ac

Clustered area
98.9 ac



Wildfires – Opportunities



Minimum cluster
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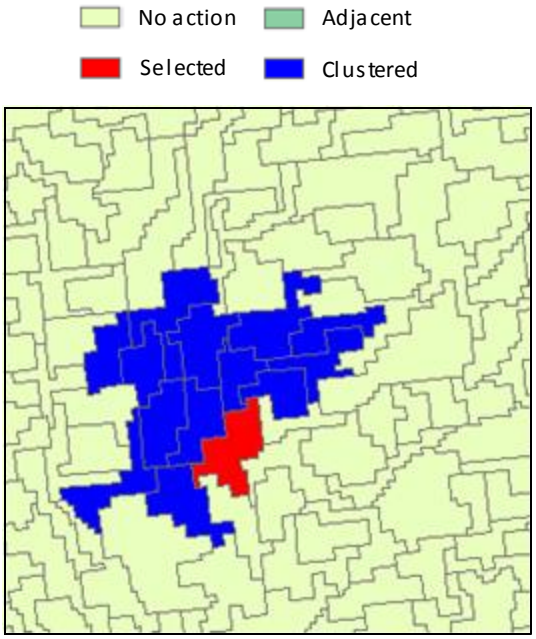
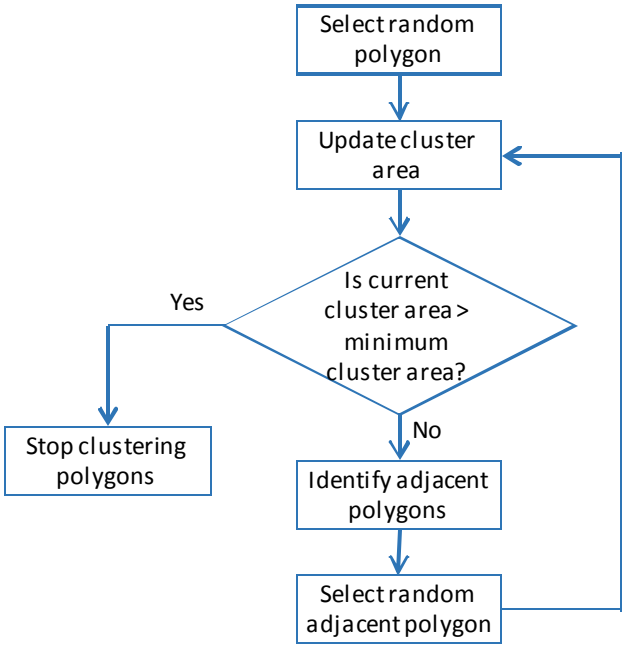
Selected polygon
7.8 ac

Clustered area
106.8 ac



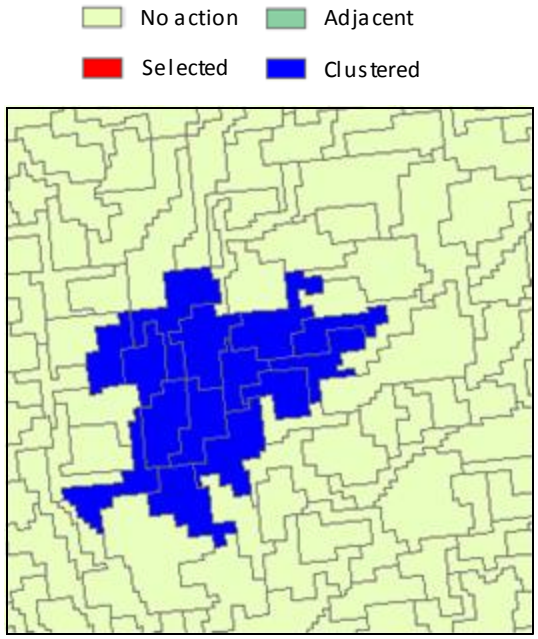
Wildfires – Opportunities



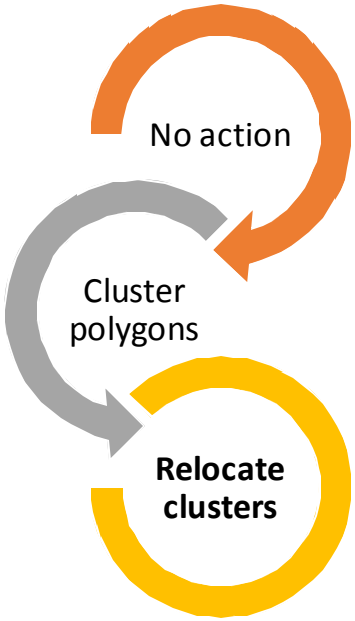
Minimum cluster
100.0 ac

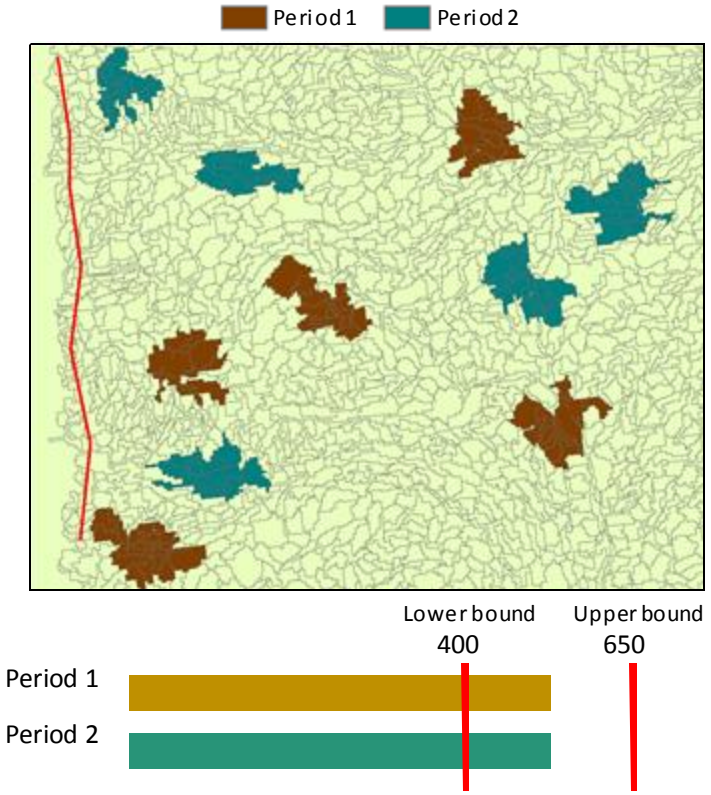
Selected polygon
7.8 ac

Clustered area
106.8 ac

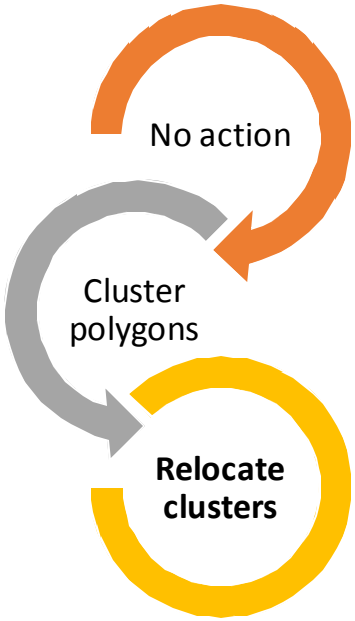


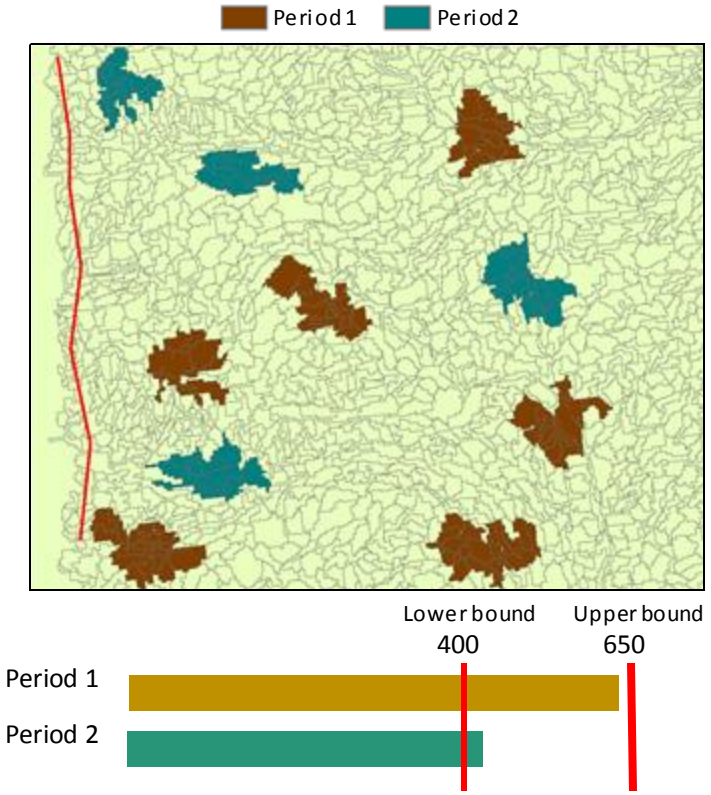
Wildfires – Opportunities



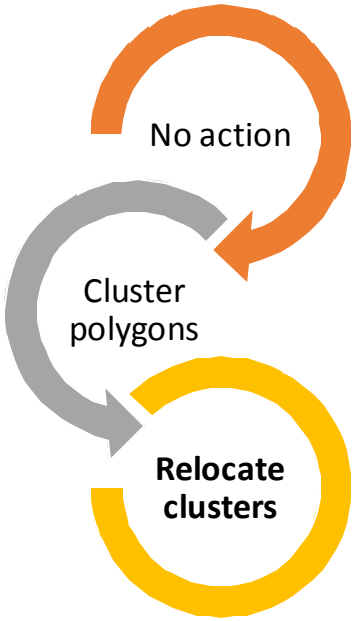


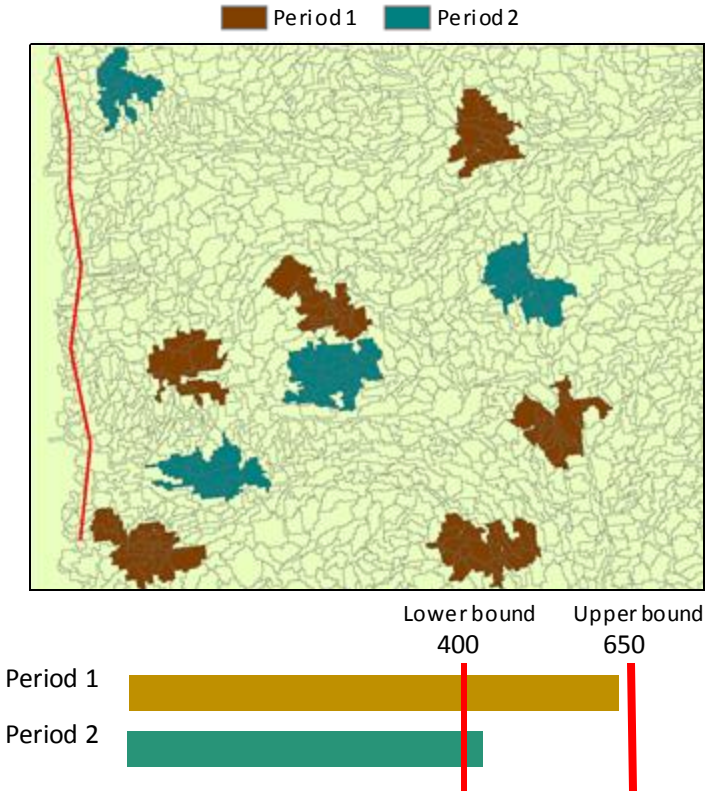
Wildfires – Opportunities



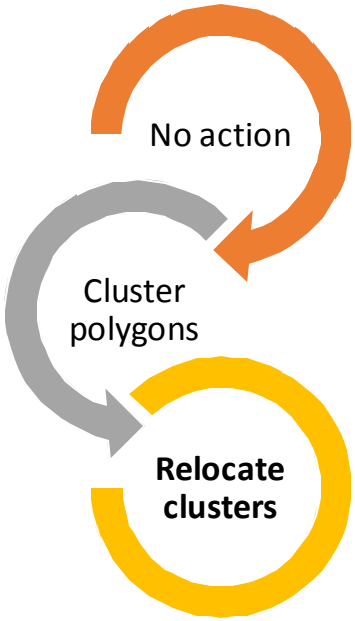


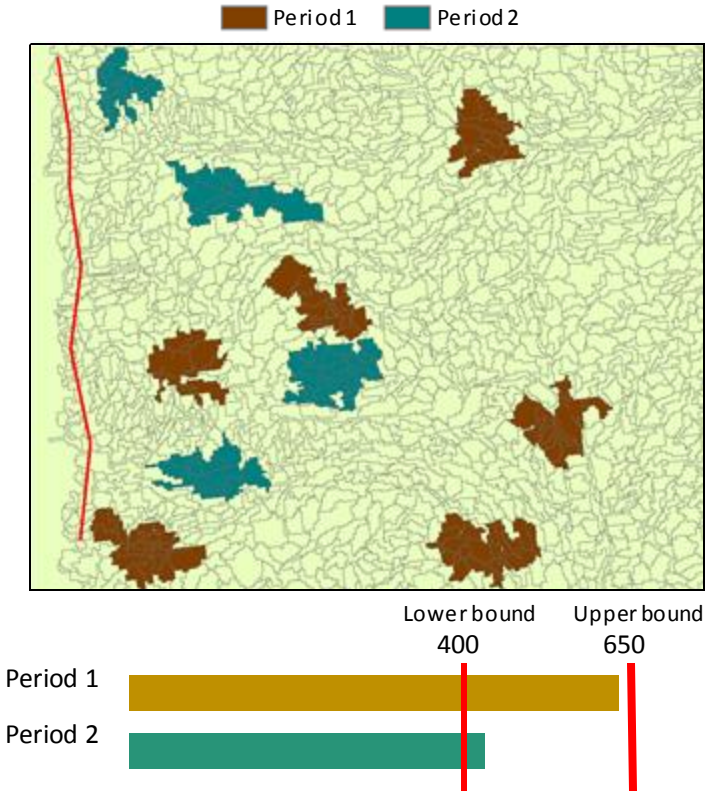
Wildfires – Opportunities



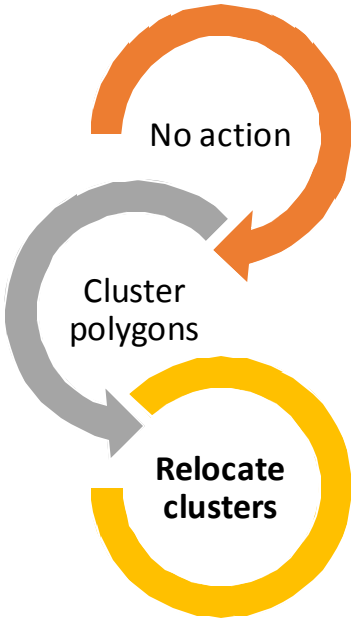


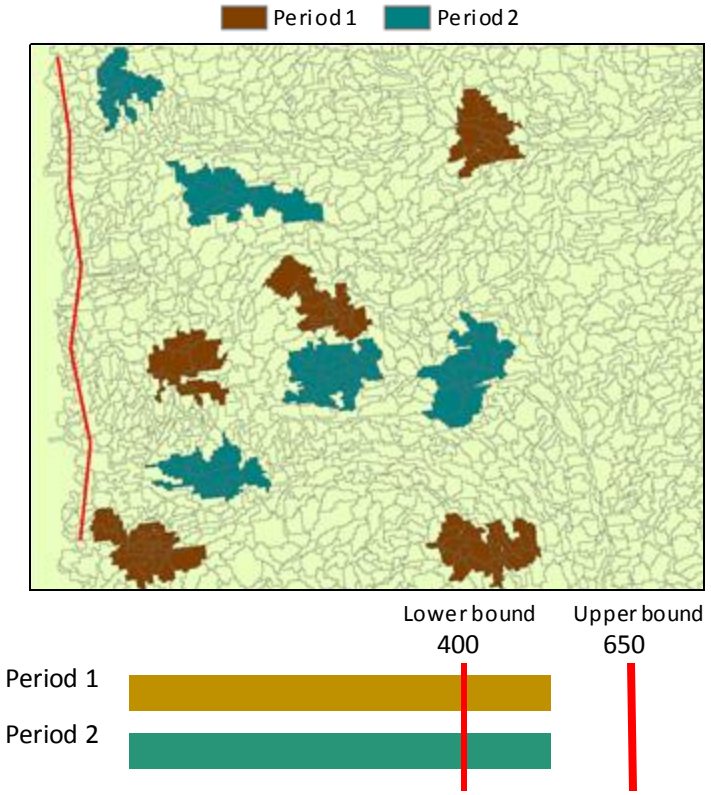
Wildfires – Opportunities



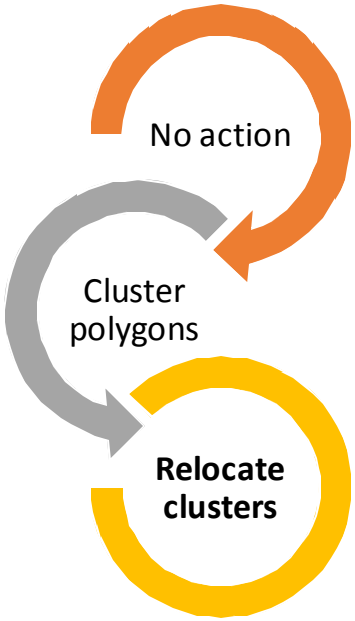


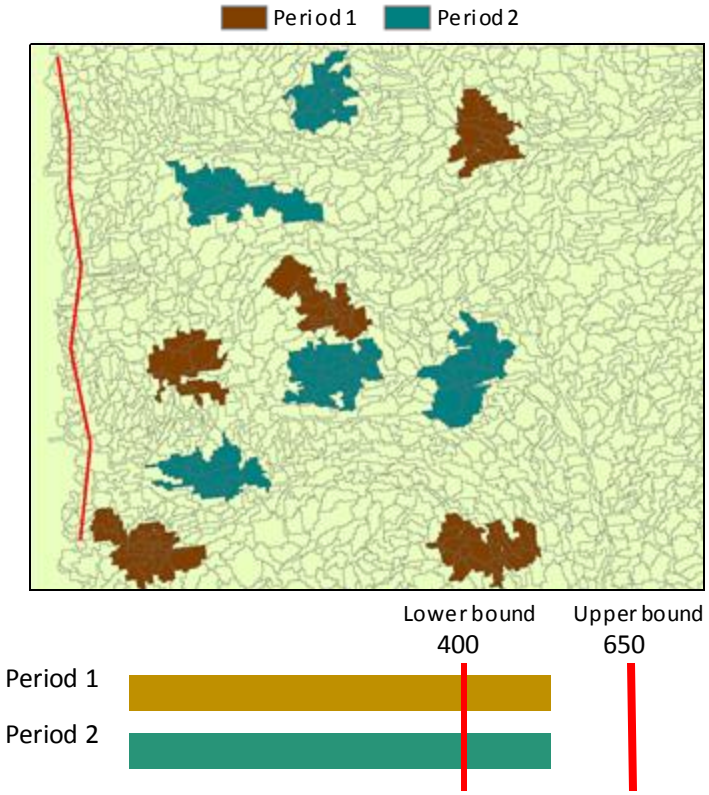
Wildfires – Opportunities



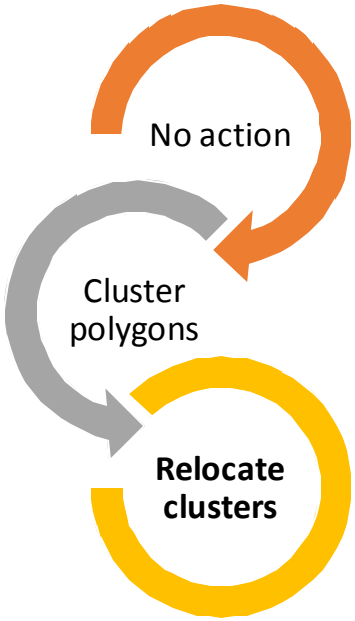


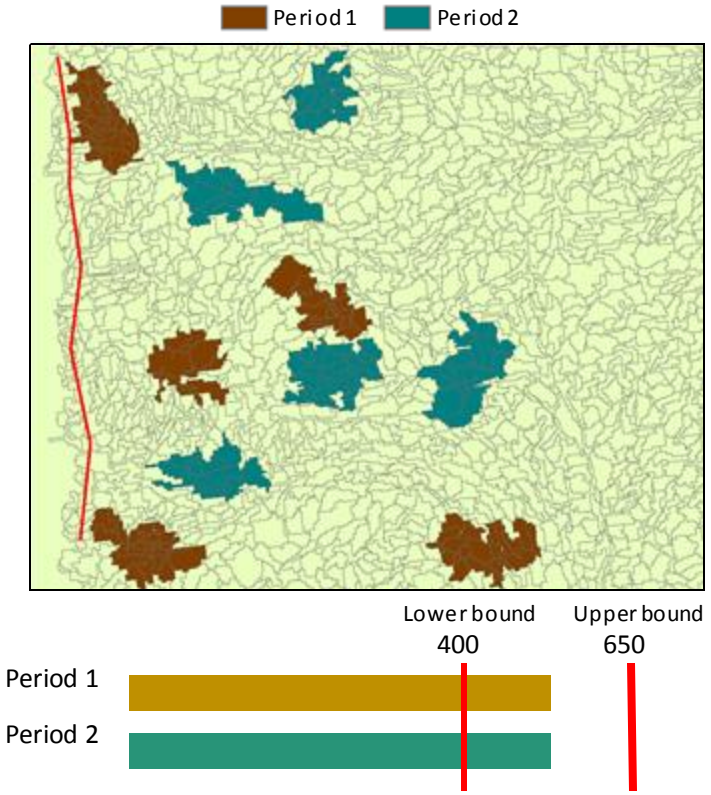
Wildfires – Opportunities



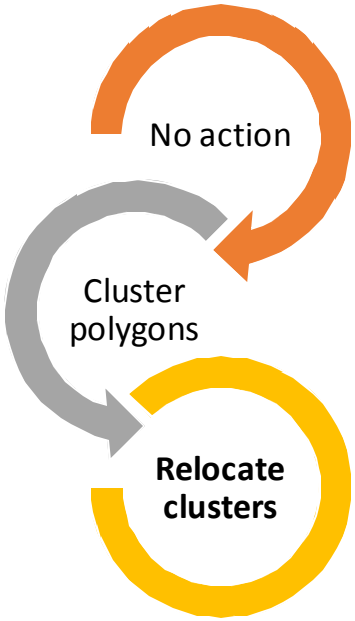


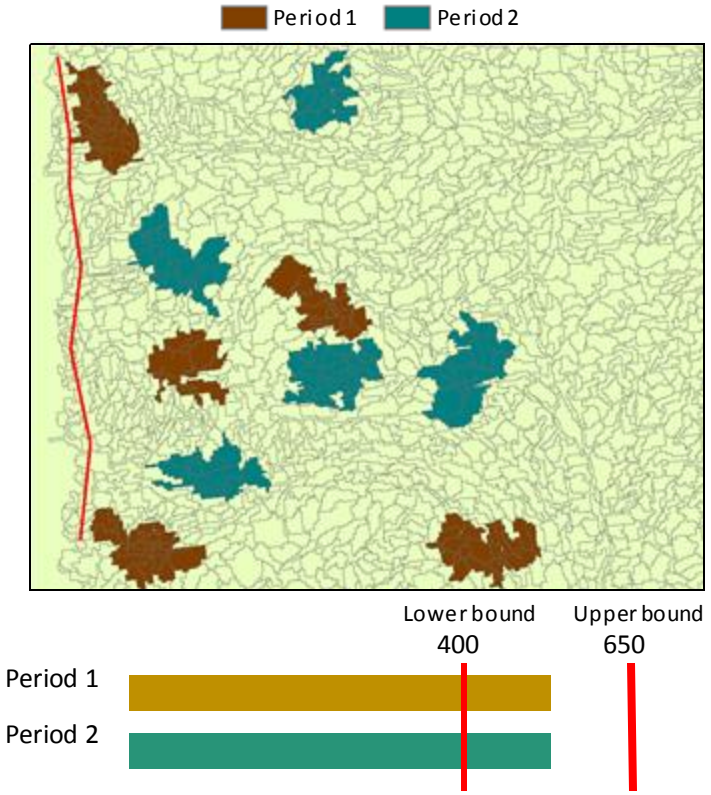
Wildfires – Opportunities



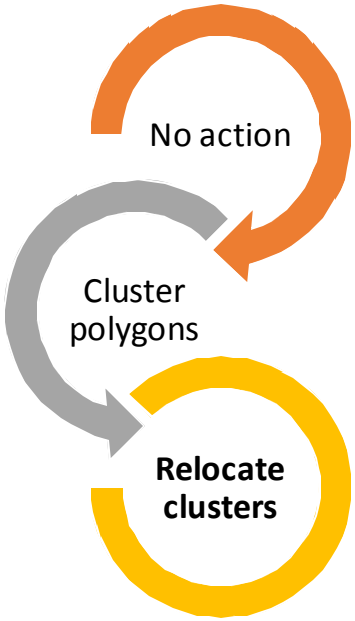


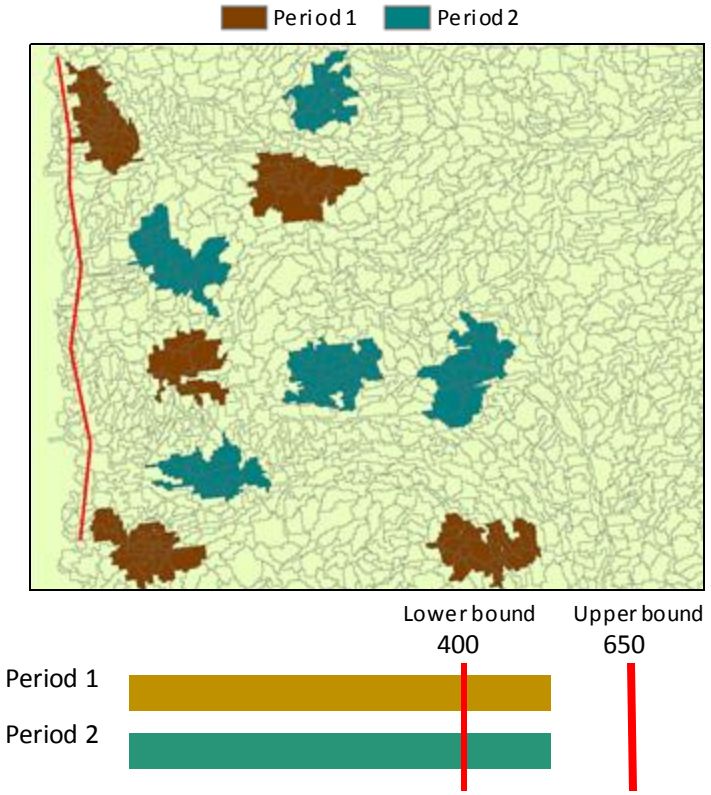
Wildfires – Opportunities



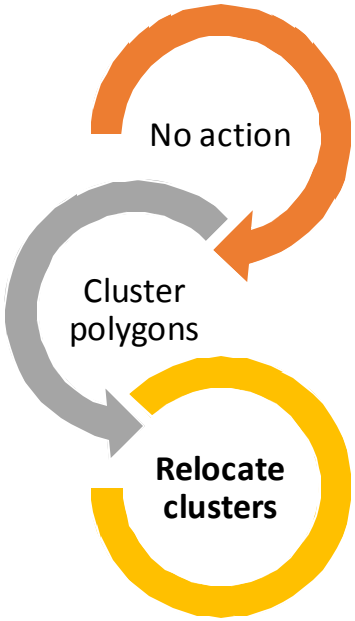


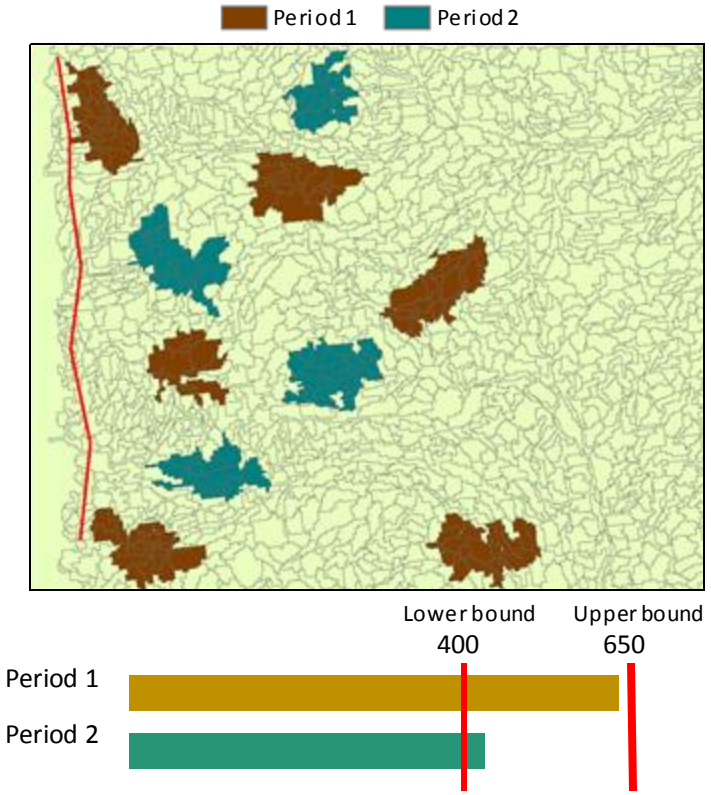
Wildfires – Opportunities



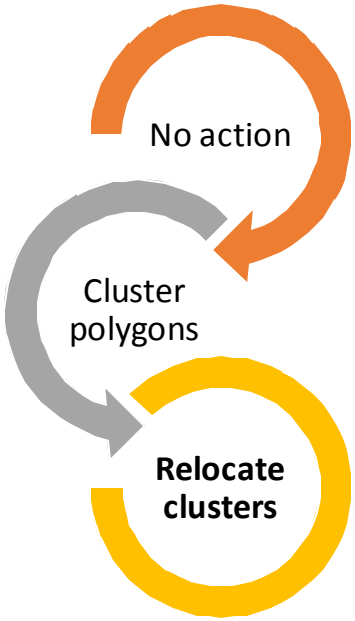


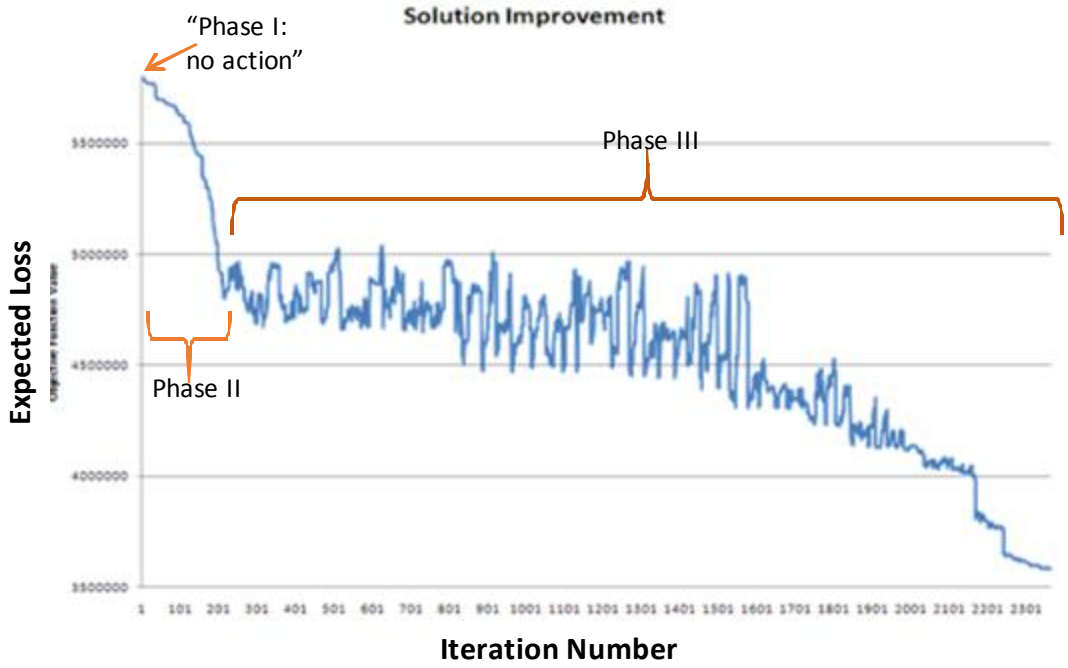
Wildfires – Opportunities



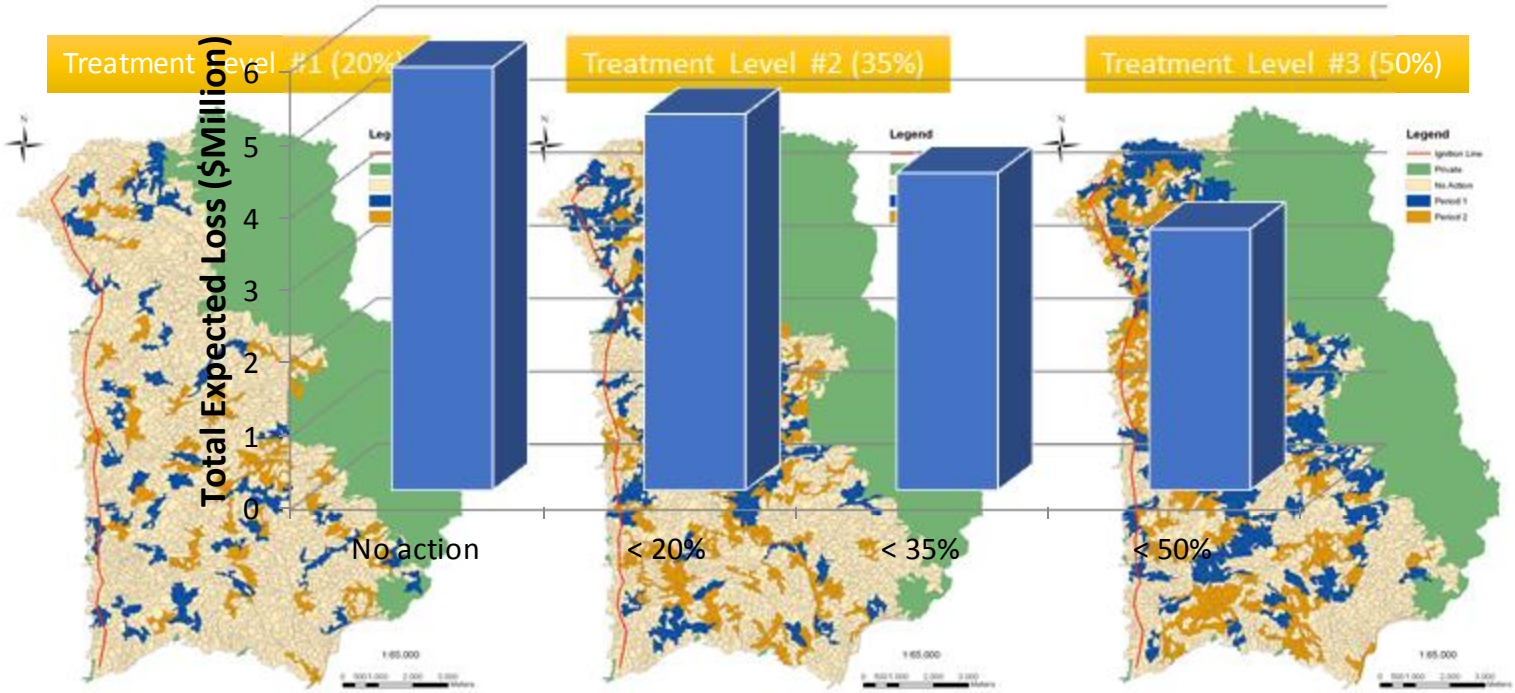


Wildfires – Opportunities





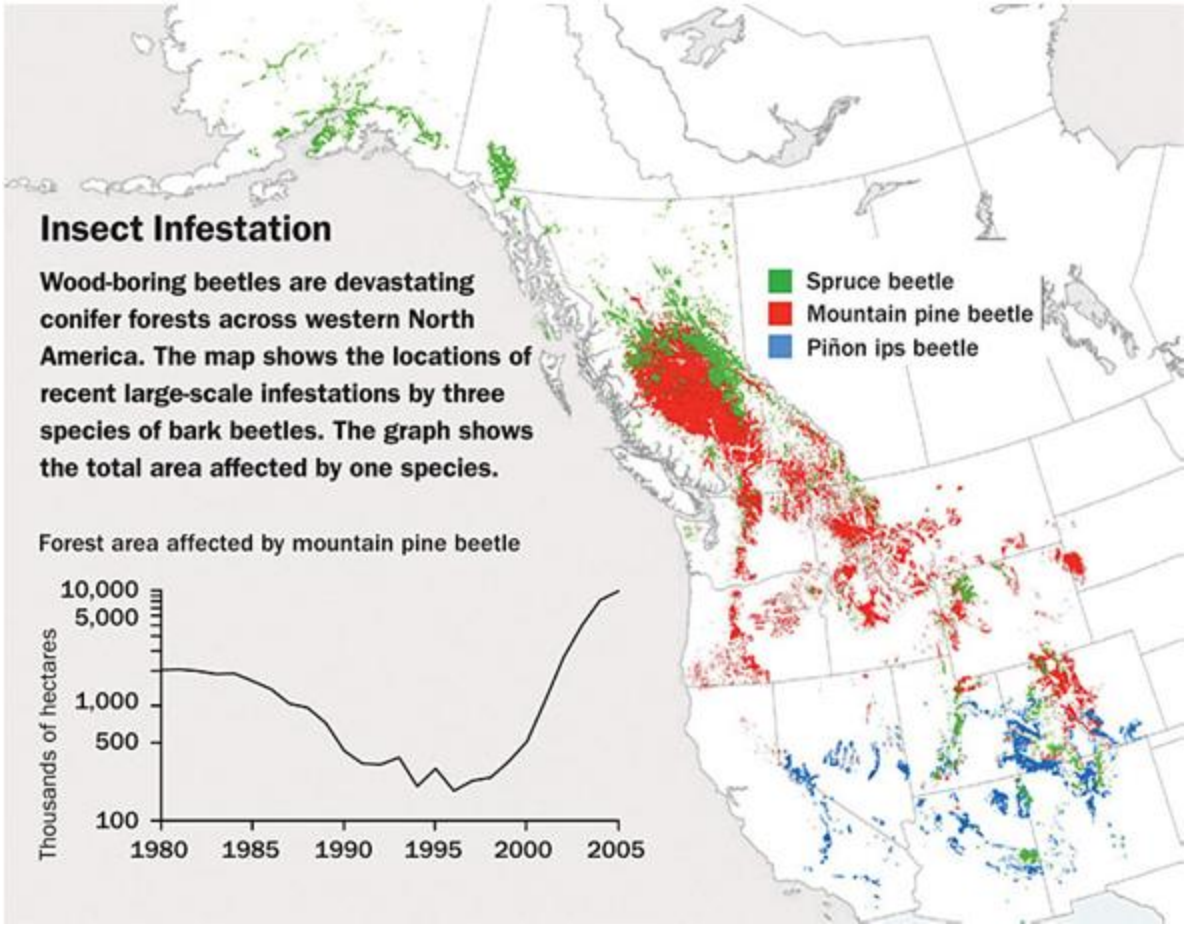
Wildfires – Opportunities



INSECT OUTBREAKS

Insect Outbreaks

Insect Outbreaks



Insect Outbreaks - Consequences

- Wildlife habitat
- Water quantity/quality
- Recreational values
- Loss of timber values
- Increase in fire risks
- Public safety
- Carbon source

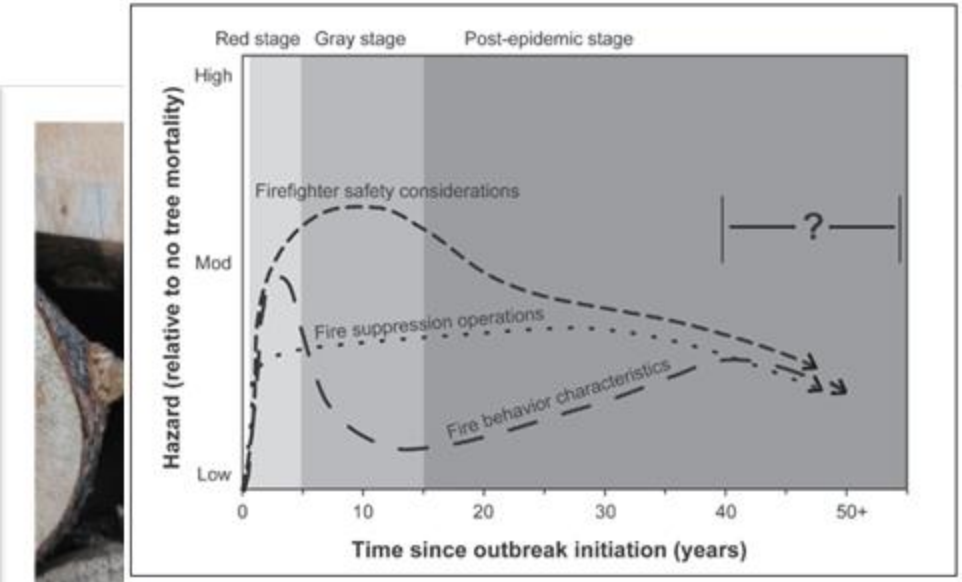


Fig. 4. Summary of the predicted hazard induced by severe tree morality from a mountain pine beetle outbreak in lodgepole pine forests, relative to the case of no tree mortality, for the three main elements of resistance to control, namely, fire behaviour characteristics (e.g., in relation to crowning and fireline intensity), firefighter safety considerations (e.g., in relation to snag conditions), and fire suppression operations (e.g., in relation to spotting and rate of fireline construction). Developed based on summaries by Hicke *et al.* (2012) and Jenkins *et al.* (2008, 2012, 2014). The long-term (50+ years) hazards are currently unknown, as indicated by a question mark.

(**Source**: Page, W.G., Alexander, M.E., and Jenkins, M.J. 2013. Wildfire's resistance to control in mountain pine beetle-attacked lodgepole pine forests. The Forestry Chronicle 89: 783-794.)

Insect Outbreaks – Current Efforts

- Salvage logging – recover values as much as possible

Insect Outbreaks – Opportunities

Innovative wood products: Construction materials , Concrete wood (Pasca et al. 2010), Nanoscale lignocellulose fibrils (Hoeger et al. 2014), ect.

Insect Outbreaks – Opportunities

ÅBioenergy production from beetle killed trees

Insect Outbreaks – Opportunities

ÅBioenergy production from beetle killed trees

Insect Outbreaks – Opportunities

ÅBiomass Supply Chain Logistics

1


load


grinding


short haul


load


long haul

2


load


short haul


load


grinding


long haul

Insect Outbreaks – Opportunities

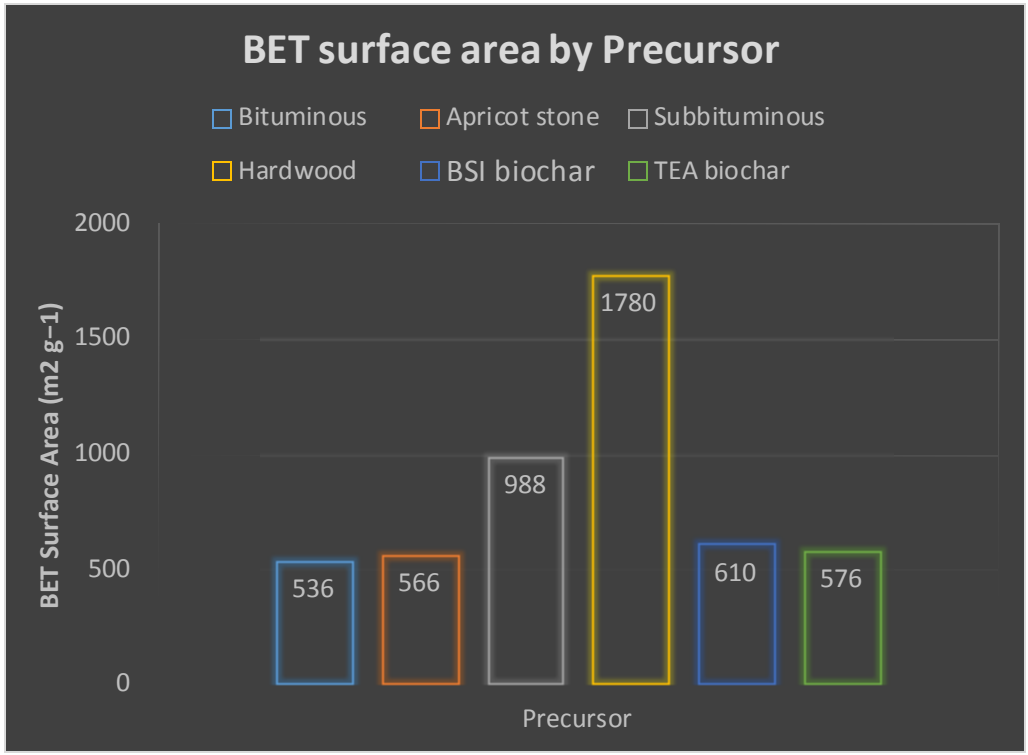
ÅIn-woods Biomass Conversion

Insect Outbreaks – Opportunities

ÅCarbon Activation

Lab steam:
950°C, 15psig

Industrial steam:
815-927°C, 15psig



Insect Outbreaks – Oppo

Åstanding D… …g (Safet…

(Source: Trinder Engineering, Ltd., New Zealand)

CONCLUDING REMARKS


Opportunities

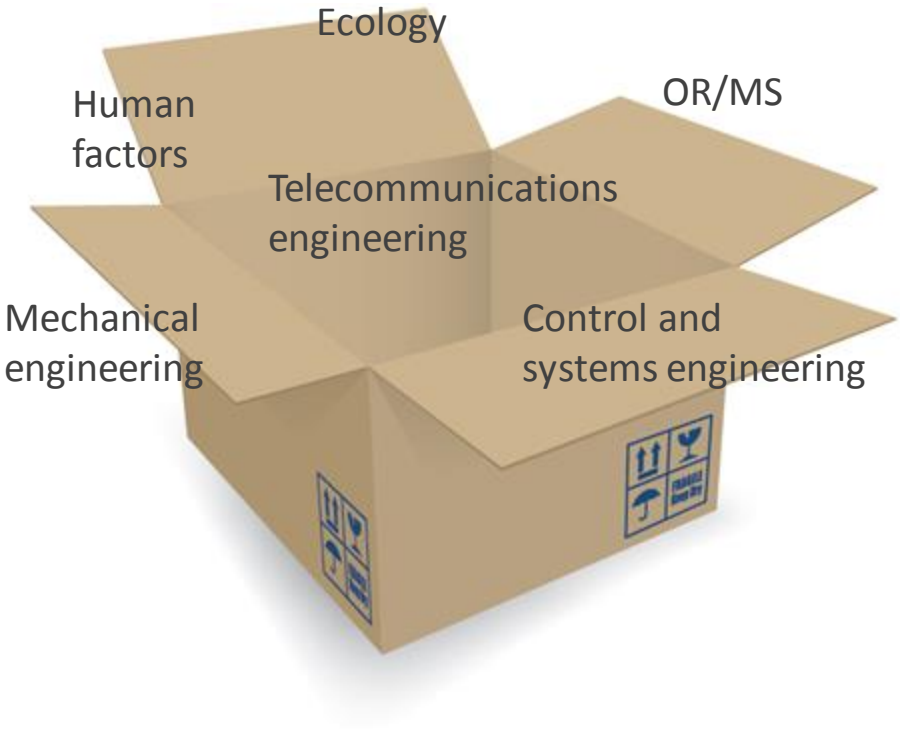
Our Roles

Thinking Inside the Box

Thinking Outside the Box

Our Roles

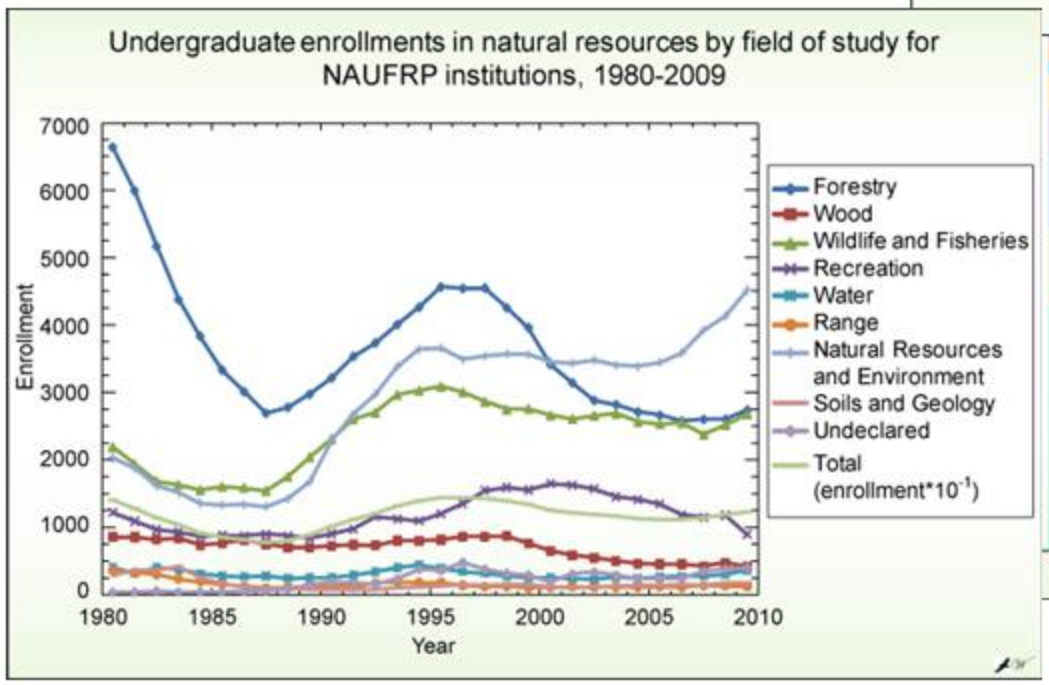
Problem -> Solution

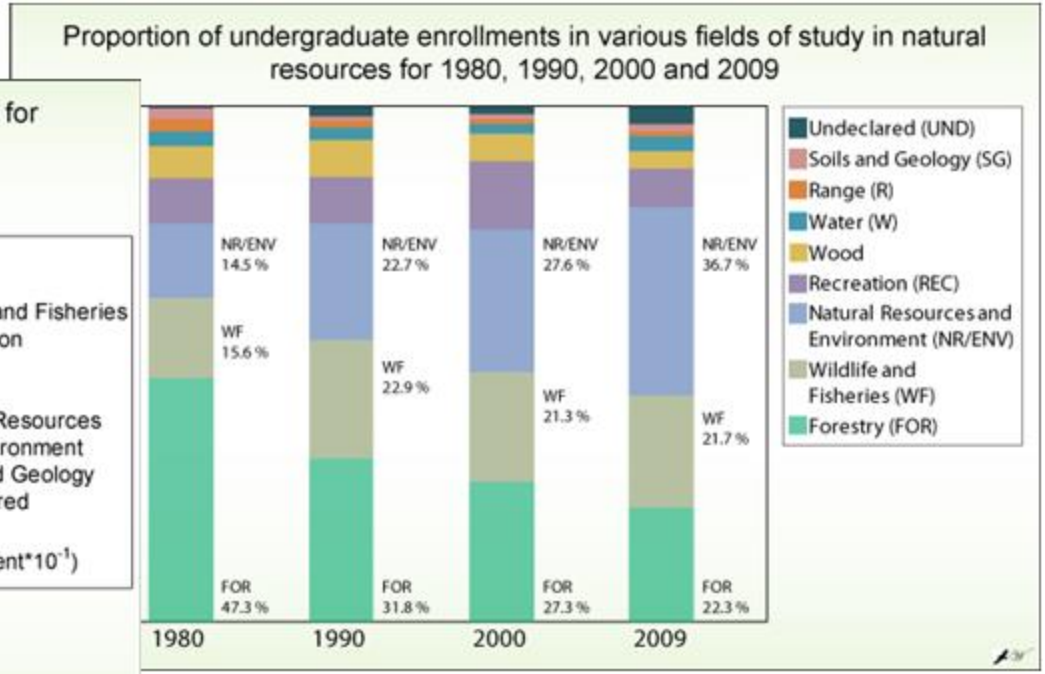


Solution -> Problem

Our Roles

Education





Source: Sharik, T.L., R.J. Lilieholm, W.W. Richardson. 2013. Trends in Undergraduate Enrollments in Forestry and Related Areas of Natural Resources in the U.S. with respect to gender and race/ethnicity. Presented at IUFROLAT 2013, San Jose, Costa Rica, June 14, 2013.

Our Roles


Forestry
SOLD
Ecosystem
Social Media
www.
ERP
Sustainability
Resilience
Relationship
Customer Benefit
CRM
Customers
Policy
Information
Service mind
Feed back

IUFRO Division 3 – Activities

- **Redefining Roles:** *Networking + ???*
- **Knowledge Sharing:** *Joint conferences with other divisions and disciplines*
- **Knowledge Development:** *Joint projects funded by local governments, NGOs, intergovernmental organizations*
- **Education & Training:** *Workshops, graduate student conferences, young scientist awards programs – grow the next generation of quality researchers*
- **Communication:** *Social media engagement – information broadcasting*


" ALL THE NEWS
YOU NEED TO KNOW "
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Acknowledgment
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Thank You