Letting wildfires burn
Modeling the change in future suppression costs as the result of a suppress versus a let-burn management choice

Western Forest Economists Conference 2011
Rachel M. Houtman
M.S. student
Oregon State University
Forest Resources
Acknowledgements

• Dr. Claire Montgomery, OSU, Major Professor
• Dave Calkin, Forest Service, Funding
• Carla Gomes, Institute for Computational Sustainability, Funding
• Alan Ager, Forest Service, Data and information
• Nicole Vaillant, Forest Service, Data support
• Aaron Gagnon, Research help/Moral support/Fire Team
• Sean McGregor and Roy Adams, Computer programming/Fire Team
• Dr. Tom Dietterich, OSU, Fire Team
• Mark Finney, Matt Thompson, and Krista Gebert at the RMRS for help with model parameters
History of Wildfire Policy in the United States

- Pre-1900’s.
- Post-1910 fires.
  - 1935: 10 am policy.
- Build-up of fuels.
  - Increased the intensity/severity of fire.
- Policy shift in the 1970’s.
  - Decrease fuel loads.
  - Reintroduce fire to fire-dependent ecosystems, where possible.

“...it was desired to ascertain if some scientific method could be found by means of which it would be possible to determine how much money can justifiably be spent for fire protection on the national forests” (Sparhawk 1925).
Cost plus Net Value Change

- Defined originally as the “cost of protection plus losses incurred in spite of protection” (Sparhawk 1925).

\[ C + NVC = \text{Presuppression costs} + \text{Suppression costs} + \text{Loss to fire} - \text{Benefit from fire} \]

The focus of my thesis was to estimate the Benefit from fire.
Analytical Framework

Define:  
\( s_t \) state of the landscape at time \( t \) – vegetation, topography.

\( w_t \) information becomes available at time \( t \) – ignition location(s), weather.

\( x_0 \) is 0 for let-burn and 1 for suppress. All future fires are treated with full suppression.

The present value of a landscape:

\[
v(s, w, x_0) = r(s_0, w_0, x_0) - c(s_0, w_0, x_0) + \sum_{t=1}^{T-1} \{ \beta_t^t R(s_t, w_t) - C(s_t, w_t) \} + \beta^T \nu_T(s_T)
\]

Where:

\( r(s_0, w_0, x_0) \) is the revenue collected in time 0.

\( c(s_0, w_0, x_0) \) is the suppression cost incurred in time 0.

\( R(s_t, w_t) \) is the revenue collected in time \( t \).

\( C(s_t, w_t) \) is the suppression cost incurred in time \( t \).

\( \beta^T \nu_T(s_T) \) is the ending value of the landscape.
Analytical Framework (cont.)

The net value change of the landscape as a result of letting a current fire burn:

\[ \Delta v(s, w, x_0) = v(s, w, x_0 = 0) - v(s, w, x_0 = 1) \]

The Let-Burn choice is optimal when \( \Delta v(s, w, x_0) > 0 \).

I estimated the future avoided suppression costs resulting from the Let-Burn choice for the current fire:

\[ B = \sum_{t=1}^{T-1} \beta^t \{ C_t(s_t, w_t | x_0 = 0) - C_t(s_t, w_t | x_0 = 1) \} \]
Analytical Framework (cont.)

The future is unknown, Expected Benefit:

\[ E[B] = \frac{\sum_{r=0}^{N} B^r}{N} \]

Using \( N \) Monte Carlo simulations to study a range of future conditions.

Data sets for Monte Carlo realizations:

- Wind and Weather
- Ignition information
Study Area

Southeast Deschutes National Forest

72,164 hectares
5104 stands

31,003 hectares dry ponderosa pine
32,901 hectares dry lodgepole pine
171 hectares mountain hemlock
5,524 hectares dry mixed conifer
Historical Data

- Weather/Wind data
  - 24 years of data from the Cabin Lake RAWS station.

- Ignition data
  - 24 years of data from the FS.
  - Kernel Density Map.

- Fire Duration
  - 2% of ignitions escape initial attack.
  - Regression equation for IA escape fires (Finney et al. 2009).
  - Weather criteria for Let-Burn fires.

Image of RAWS Cabin Lake weather station. Available at: http://www.raws.dri.edu/cgi-bin/rawMAIN.pl?orOCAB

Image of kernel density map based on historical ignitions for the study area
Oregon Centennial Wildfire Simulator

Landscape File
Wind/Weather/Ignition Information

→

FARSITE

→

Total Area Burned

Crown Fire Map

→

Suppression Cost Equation

↓

Cost Outputs Compiled (E(B))

→

Look-up Table

←

Update Icp File
Oregon Centennial Wildfire Simulator: Fire Spread Model

- **FARSITE (Finney 1998)**
  - Freeware available through the Forest Service.
  - The program is temporal and spatial.
  - Inputs include weather/wind, fire duration, and landscape file.
  - Outputs include a crown fire map and total area burned.
Oregon Centennial Wildfire Simulator: Updating the Vegetation

- FFE-FVS informed transitions.
- States defined by:
  - Surface fuels
  - Crown fuels
  - Cover type
  - Time-in-State
- Three transition types:
  - Grow
  - Surface fire
  - Crown fire

<table>
<thead>
<tr>
<th>State 1</th>
<th>Canopy Base Height</th>
<th>Canopy</th>
<th>Canopy Height</th>
<th>Canopy Bulk Density</th>
<th>Fuel Model</th>
<th>Cover Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>25</td>
<td>24</td>
<td>3</td>
<td>5</td>
<td>46</td>
</tr>
</tbody>
</table>

Maximum Time in State = 28
Current Time in State = 27

<table>
<thead>
<tr>
<th>State 2</th>
<th>Canopy Base Height</th>
<th>Canopy</th>
<th>Canopy Height</th>
<th>Canopy Bulk Density</th>
<th>Fuel Model</th>
<th>Cover Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>55</td>
<td>24</td>
<td>3</td>
<td>5</td>
<td>46</td>
</tr>
</tbody>
</table>

Maximum Time in State = 24
Current Time in State = 0
Results: \( E[B] \)

- For a sample set where \( N=500, E[B] = $2,287,214, \) or $31.70/ha.
- The range was negative $721,051 to positive $17,918,341.
Results: Positive Pathway

Common characteristics of positive sample pathways:
- Future ignitions that escape initial attack occur in areas burned in the let-burn scenario, and result in spreading fires in the suppress scenario.
Results: High Positive Pathway

Common characteristics of high positive sample pathways:

- Future ignitions tend to occur early in the sample pathway.
- They tend to result in large fires in the full suppression scenario, and small, or no, fires in the let-burn scenario.
Results: Negative Pathway

Common characteristics of negative sample pathways:

- At least one future ignition occurs in fuel models with a higher spread rate in the let-burn scenarios than in the suppression scenario.

Fuel Model Key
Fuel Model: Spread Rate
5: Moderate
8: Slow
10: Moderate
13: High
98: Non-burnable
Results: Average Future Area Burned

Average area burned by year in a suppress and a let-burn scenario for the current fire

Suppress Scenario

Let-Burn Scenario
Results: Current fire and $B^r$

As the size of the current fire increases, the value of $B^r$ increases.
Timber Loss

Define estimated losses to fire as $\Delta LTV$.

Assume:

Lodgepole Pine:
- Even-aged management, 80-year rotation on a regulated forest.
- Surface fire = 50% loss. Crown fire = 100% loss.

Ponderosa Pine:
- Selective harvest schedule, thin at age 80, and every 20 years.
- Surface fire = 0% loss. Crown fire = 100% loss.

Ignore future fires.

Values for timber using 2004 prices (ODF [1]).

Timber harvesting costs (ODF [2]).
Results: Timber Losses

- Expected value of timber losses = $24,097,083.
  - Biggest current fire -> biggest losses.
- The average net value change from allowing a current fire to burn = -$21,801,171.

However: 3.2% of sample pathways had a positive net value change.
- Small current fires.
- Mostly in ponderosa pine as surface fire ($\Delta LTV=0$).
Conclusions

- Land managers may be able to decrease current and future suppression costs by allowing current fires to spread.

- Given the assumptions made here, few current fires result in a net positive change.

- The difficulty is in determining which ignitions have a high probability of resulting in a positive net value change on the landscape.
What’s Next?

- Expand the look-up table to include timber harvest transitions, and increase the variation in starting stand conditions.
- Include the value of losses to future fires, and value from salvage logging.
- Include non-market losses, such as recreation, habitat loss, etc.
- Fire size vs. fire intensity.
Citations


Thank you! Questions?