FUELS TREATMENT PLANNING: A WORKSHOP ON THE APPLICATIONS OF THE TAHOE BASIN-SPECIFIC OPTFUELS MODELING SYSTEM

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Project Timeline:

- April 2009: Project Start
- April 2009 – March 2011:
  - Develop a Tahoe Basin-Specific application of OptFuels
- May 2011: Workshop
  - Present Tahoe Basin-Specific OptFuels model
  - Get feedback on system and data inputs
- May 2011 – November 2011:
  - Finalize the Tahoe Basin-Specific OptFuels model and documentation
  - Finalize the OptFuels data base for the Tahoe Basin
- November 2011: Workshop:
  - Teach the Tahoe Basin-Specific OptFuels model
  - Finalize the OptFuels data base for the Tahoe Basin
- December 2011: Final Project Report
WORKSHOP OBJECTIVES

- **Present our demo OptFuels model for the Tahoe Basin**
  - Work in progress

- **Get participant feedback**
  - OptFuels system
  - Data to include in the default models for Lake Tahoe areas.
  - How these areas should be defined
WORKSHOP AGENDA

Morning:
- Overview of OptFuels system
- Demonstration of use of OptFuels for wildfire risk assessment and fuel treatment scheduling capabilities

Afternoon:
- Vegetation and fuels inputs
- Erosion modeling for OptFuels using WEPP
- Overview of the heuristic algorithm for scheduling fuel treatments
- Discussion on data to include in default Lake Tahoe models, comments, and questions
Overview of the Tahoe Basin-Specific OptFuels Modeling System

Greg Jones, Jody Bramel, and Kurt Krueger, USDA Forest Service RMRS
Woodam Chung, Edward Butler, Marco Contreras-Salgado,
The University of Montana
Different tools are available to help managers plan where, when, and how to apply new and maintenance fuel treatments on a forested landscape:

- FARSITE (Finney 1998) and FlamMap (Finney 2006)
- Treatment Optimization Model (Finney 2007)
- FVS-FFE (Reinhardt and Crookston 2003)
- FCCS (Ottmar et al. 2007)
- MAGIS (Zuuring et al. 1995, Chung et al. 2005)
- Etc.

Each tool addresses only specific aspects of planning fuel treatments spatially over time.
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.
SYSTEM COMPONENTS

GIS and Spatial Data

Vegetation and Fuels

Management Options and Objectives

Step 1

FVS-FFE
FCCS

Step 2

OptFuels Interface

Step 3

Optimizer for Scheduling Treatments

OptFuels

FlamMap
Objective for driving placement and scheduling of fuel treatments

Minimize expected loss from wildland fire over time

\[
\text{Minimize } \sum_{t \in T} \sum_{c \in C} \text{Loss}_{c,t} \times P_{c,t}
\]

where:
- \(c\) : Index of grid cells (pixels)
- \(t\) : Index of time period
- \(\text{Loss}_{f,c,t}\) : Expected loss value for grid cell \(c\) for period \(t\), based on the flame length predicted by MTT
- \(P_{c,t}\) : Probability of cell \(c\) being burned in period \(t\), based on the fire arrival time predicted by MTT.
OptFuels Objective Function

\[
\text{Minimize } \sum_{t \in T} \sum_{c \in C} \text{Loss}_{c,t} \times P_{c,t}
\]

Example of Relative Loss Values

<table>
<thead>
<tr>
<th>Values at Risk</th>
<th>0-2 ft</th>
<th>2-6 ft</th>
<th>6-12 ft</th>
<th>12+ ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>FS, roadless</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>FS, accessible</td>
<td>0</td>
<td>60</td>
<td>70</td>
<td>80</td>
</tr>
<tr>
<td>FS, WUI</td>
<td>10</td>
<td>30</td>
<td>50</td>
<td>80</td>
</tr>
<tr>
<td>Right-of-way</td>
<td>0</td>
<td>0</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>State and Private</td>
<td>10</td>
<td>30</td>
<td>50</td>
<td>80</td>
</tr>
</tbody>
</table>

OptFuels Objective Function

\[
\text{Minimize} \quad \sum_{t \in T} \sum_{c \in C} \text{Loss}_{c,t} \times P_{c,t}
\]

Burn Probability

<table>
<thead>
<tr>
<th>Fire Duration</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 day</td>
<td>0.9</td>
</tr>
<tr>
<td>2 days</td>
<td>0.7</td>
</tr>
<tr>
<td>3 days</td>
<td>0.5</td>
</tr>
<tr>
<td>4 days</td>
<td>0.3</td>
</tr>
<tr>
<td>5 days</td>
<td>0.2</td>
</tr>
<tr>
<td>6 days</td>
<td>0.1</td>
</tr>
<tr>
<td>7 days</td>
<td>0.1</td>
</tr>
<tr>
<td>8+ days</td>
<td>0.0</td>
</tr>
</tbody>
</table>
Management Objectives Component

- Constraints that can be used
  - Limit budget
  - Limit treatment options by zones (treatment exclusion, treatment priority, treatment type)
  - Quantity and value of products produced by treatments
  - Sediment delivered to stream channels from fuel treatments (estimated using WEPP)
Trapper-Bunkhouse analysis area
Minimize $\sum_{t \in T} \sum_{c \in C} Loss_{c,t} \times P_{c,t}$

**Study area**

<table>
<thead>
<tr>
<th>Land Use Type</th>
<th>Acres</th>
<th>Polygons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest Service</td>
<td>23,538</td>
<td>2,938</td>
</tr>
<tr>
<td>WUI, Residential</td>
<td>11,063</td>
<td>1,957</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>34,601</td>
<td>4,895</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Flame Length Categories (meters)</th>
<th>0-0.3</th>
<th>0.3-1</th>
<th>1-1.5</th>
<th>1.5-3</th>
<th>3.0+</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Values at Risk</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>WUI</td>
<td>60</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>FS Managed</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>
APPLICATION

Treatment Options

No action

Prescribed Fire (National Forest only)

Thinning from below followed with broadcast burn (National Forest only)

Time Period

Two time periods with a 10 year interval

Cluster Size

50-acre target

Treatment Level

#1  ~ 20% of total treatable area (4,800 acres)
#2  ~ 35% of total treatable area (8,300 acres)
#3  ~ 50% of total treatable area (11,800 acres)
The application of the equation:

\[
\min \sum_{t \in T} \sum_{c \in C} \text{Loss}_{c,t} \times P_{c,t}
\]

Fire Scenario:
- Wind speed: 20 MPH
- Wind direction: 270°

Burn Probability \( P_{c,t} \):
- Time step | Probability
- 0.6 day   | 0.9
- 1.2 days  | 0.7
- 1.8 days  | 0.5
- 2.3 days  | 0.3
- 2.9 days  | 0.2
- 3.5 days  | 0.1
- 4.1 days  | 0.1
- > 4.7 days| 0.0
APPLICATION RESULTS

Treatment Level #1 (20%)

Treatment Level #2 (35%)

Treatment Level #3 (50%)
APPLICATION RESULTS

<table>
<thead>
<tr>
<th>Treatment Level</th>
<th>Total Treated Area (ac)</th>
<th>Period 1</th>
<th>Period 2</th>
<th>Total Iterations</th>
<th>Computation Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>No action</td>
<td>4,711</td>
<td>2,394</td>
<td>2,317</td>
<td>3,066</td>
<td>approximately 30 sec. per iteration</td>
</tr>
<tr>
<td>~ 20%</td>
<td>8,235</td>
<td>4,102</td>
<td>4,133</td>
<td>3,130</td>
<td></td>
</tr>
<tr>
<td>~ 35%</td>
<td>11,767</td>
<td>5,872</td>
<td>5,895</td>
<td>3,193</td>
<td></td>
</tr>
<tr>
<td>~ 50%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Expected Loss ($Million)

- No action
- ~ 20%
- ~ 35%
- ~ 50%
APPLICATION RESULTS

- Fire Arrival Time (1st Period)

- No action
- Treatment level #1 (20%)
- Treatment level #2 (35%)
- Treatment level #3 (50%)
APPLICATION RESULTS

- Fire Arrival Time (2nd Period)

- No action
- Treatment level #1 (20%)
- Treatment level #2 (35%)
- Treatment level #3 (50%)
APPLICATION RESULTS

- Flame Length (1st Period)

- No action
- Treatment level #1 (20%)
- Treatment level #2 (35%)
- Treatment level #3 (50%)
APPLICATION RESULTS

- Flame Length (2\textsuperscript{nd} Period)

- No action
- Treatment level #1 (20%)
- Treatment level #2 (35%)
- Treatment level #3 (50%)
APPLICATION RESULTS

- Expected Loss Value (1st Period)

No action

- Treatment level #1 (20%)
- Treatment level #2 (35%)
- Treatment level #3 (50%)
APPLICATION RESULTS

- **Expected Loss Value (2nd Period)**

- No action
- Treatment level #1 (20%)
- Treatment level #2 (35%)
- Treatment level #3 (50%)
CONCLUDING REMARKS

- **Highlights of OptFuels**
  - Management objective: minimize expected loss value across a landscape
  - Temporal – FVS-FFE
  - Spatial – GIS
  - Constraints – budget, acres, treatment zones
  - Work with management units
  - Risk assessment
  - Enhances ability for trade-off analyses

- OptFuels can assist land managers to develop fuel treatment schedules that are cost-efficient and practically feasible
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  - SNPLMA – Round 9
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- **Project Team**
  - Woodam Chung, PI, The University of Montana
  - Greg Jones, Co-PI, RMRS
  - Solomon Dobrowski, Co-PI, The University of Montana
  - William Elliot, Co-PI, RMRS
  - Jody Bramel, RMRS
  - Edward Butler, The University of Montana
  - Marco Contreras-Salgado, The University of Montana
  - Kurt Krueger, RMRS
  - David Schmidt, The University of Montana

- **Collaborators**
  - Mark Finney, USDA Forest Service
  - Elizabeth Reinhardt, USDA Forest Service
  - Carl Seielstad, The University of Montana
  - Janet Sullivan, formerly RMRS
Questions?