A Post-Fire Index for Describing Mixed severity Outcomes after Wildfire for Trees and Soils

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110+ Publications and Applications
The Past and Current Use of Severity Classification

Issues:

• Fire intensity, fire severity, and burn severity definitions are inconsistently used leading to confusion and misinterpretation
• No consistent way to communicate severity
• Past rationale for a severity classification: prescribed fire with activity fuels
• Lumpers, splitters, selectors
• No integrated severity classification
Environmental characteristics before the fire

Environmental characteristics during the fire

Environmental characteristics after the fire

The biological physical, social, economic response to the environment

“Fire Intensity” (Fire characteristics)

“Fire Severity” (Direct effects from combustion process) Consumption

“Burn Severity” What is left

“First-order fire effects” Disturbance

Post-fire Condition

Desired Condition

“Second-order fire effects” Response
Tree Burn Severity is a Continuum

Unburned Levels Levels Not much left

Classification can be Levels of this continuum

Measurement of Interest – Indicator Variables?
Where are the breaks (thresholds) between the levels?
Enough levels so they can be selected or grouped
“Low”, “Moderate”, or “High” are values placed on the levels which is a combination of the pre-fire condition, burn severity of other vegetation, and response
<table>
<thead>
<tr>
<th>Study</th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ryan and Noste 1989 (prescribed fire)</td>
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<td>Borchert et al. 2003 (plant regeneration)</td>
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<td>BAER: Parsons 2003 (erosion)</td>
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<td>Fire effects monitoring (all purpose)</td>
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<td>Sieg et al. 2006 (birds)</td>
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<td>Odion et al 2004 (fuel treatment eval.)</td>
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<tr>
<td>Verling and Lentile 2006 (vegetation)</td>
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</tbody>
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Revisiting and Revising Severity Definitions

To develop an integrated severity classification:
• Management application for multiple purposes and integration among disciplines
• Integrates scientific information
  – Fire Behavior and Effects
• Can be combined, split, or selected
• Simple to quantify and describe
• Visualize severity
• Provide a rationale
Two Views of Tree Burn Severity

Vertical (mortality prediction)

Plot or patch (wildlife, erosion)
# Tree Burn Severity (Individual Tree)

<table>
<thead>
<tr>
<th>Pre-Fire Environment</th>
<th>Fire Environment</th>
<th>Post-Fire Environment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flame Length</td>
<td>S, C, O, R, C, H</td>
<td>Harvest</td>
</tr>
<tr>
<td>Tree Species</td>
<td>Feet</td>
<td>0 - 2</td>
<td>Mortality</td>
</tr>
<tr>
<td>Canopy base height</td>
<td>2 - 4</td>
<td>Mixed Green ≥ 60%</td>
<td>Needle input</td>
</tr>
<tr>
<td>Surface fuels</td>
<td>4 - 8</td>
<td>Mixed Green 30-60% green</td>
<td>Habitat</td>
</tr>
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<td>Tree size</td>
<td>8 - 12</td>
<td>Mixed Brown &lt; 30% green</td>
<td>Hydrologic</td>
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<tr>
<td>Ladder fuels</td>
<td>&gt; 12</td>
<td>Crown Transition</td>
<td>Wood longevity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bole dead</td>
<td></td>
</tr>
<tr>
<td>Patch</td>
<td>Score</td>
<td></td>
<td></td>
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<td>------------------------------------</td>
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<td></td>
</tr>
<tr>
<td>1a. No evidence of fire</td>
<td>0</td>
<td></td>
<td></td>
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<tr>
<td>1b. Evidence of fire</td>
<td></td>
<td></td>
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<tr>
<td>2a. Presence of residual green crown “Alive”</td>
<td>100.0</td>
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<tr>
<td>3a. All trees have &gt; 60% (green)</td>
<td>100.1</td>
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<tr>
<td>3b. Plurality of trees contain green crowns, brown trees may be present, no black trees present (mixed green)</td>
<td>100.2</td>
<td></td>
<td></td>
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<tr>
<td>3c. Trees with green crowns present, brown trees maybe present, black trees present (mixed brown)</td>
<td>100.3</td>
<td></td>
<td></td>
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</tbody>
</table>
Tree Post-Fire Index Key
Patch

1a. No evidence of fire 0
1b. Evidence of fire
   2b. No evidence of residual green crown "dead" 200.0
       4a. All trees contain only brown needles/leaves (brown) 200.1
       4b. Mixture of trees with brown needles/leaves, trees with both brown and black, and trees with only black crowns (transition) 200.2
       4c. All trees contain only black crowns (black) 200.3
Relation Between Forest Structure and Burn Severity
Wildfires in Moist, Cold, and Dry Forests

Classification Tree
Conditional Probabilities
Random = 0.25

As a Function of Pre-Fire Forest Structure
Visited 73
2001-2003 Wildfires

Moist Forest (Hemlock/Cedar)

Dry Forests (PP/Mixed conifer)

Cold Forests (spruce/fir)
Low Overstory Tree Density
Mixed Conifer Forests
Tree Burn Severity

0.53 probability of brown trees (mixed brown, brown) from heat scorch
23 obs. – 10 mixed brown, 1 brown, 5 black

Conditions:
1) Dry forest
2) Low canopy base height
3) Low cover (20%)
4) Surface fuels – produce high heat?

May be good for wildlife browse and cover
Tree size > 50 cm diameter
  0.70 probability of green trees
Surface fuels < 7 Tonnes/ha
  0.57 probability of green trees

Conditions:
1) Dry forest
2) Canopy base height (high)
3) Low surface fuels
High Overstory Tree Density
PP/Mixed Conifer to Moist Conifer Forests

Tree Burn Severity

0.67 probability of green trees

Conditions: 13 observations
Top height:  Dry=18 m; Moist=19
Canopy cover: 60 to 70%
High canopy base heights:
Dry = 9 m; Moist = 4
Crown ratio: Dry=38; Moist=39

75 % cover 45 % cover
All forest types
Tree Burn Severity

Conditions:
High overstory density
Needle understory
Higher canopy base height

0.52 prob. of mixed green

Conditions:
Low overstory density
Grass understory
Low canopy base height

0.41 probability of brown trees
Application

- Describes the post-fire environment
- Integrates past and current science
- Placed within the context of the fire disturbance continuum – provides a rationale
- Relates to fire behavior and fire effects
- It is a hypothesis that can be changed, added to, and critically evaluated
- Elements can be combined and/or selected
- There is a soil burn severity developed using the same technique
Questions and Comments
Example on how response influences a value

Low or High Severity?