Historic Fire Regime Reconstructions in the Western Canadian Cordillera

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Wildland Fire Canada
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Classification of Mountain Ecosystems in British Columbia

- Lower montane forests
- Montane forests
- Subalpine forest
- Interior rainforest
- Alpine tundra
Fire Regimes in the Mountains of BC

- **Alpine tundra**: Low severity, intervals: <50 years (Infrequent high severity)
- **Subalpine forest**
- **Interior rainforest**
- **Montane forests**
- **Lower montane forests**: High severity, intervals: ≥100 years

**Fire Regimes:**

- Low severity, intervals: <50 years (Infrequent high severity)
- High severity, intervals: ≥100 years
“Ecosystem-Based Management” in BC

Stand-Replacing Fire Regime:

- Even-aged silviculture
- Rotations of 100+ yrs
- Old-growth forests
- Fire suppression

Forest Types:
- Alpine tundra
- Subalpine forest
- Interior rainforest
- Montane forests
- Lower montane forests
Mid-Elevation Forests:

• Complex, mixed-species
• Large, old veteran trees
• Abundant fire scars
“Ecosystem-Based Management” in BC

Stand-Replacing Fire Regime:

Even-aged silviculture
Rotations of 100+ yrs
Old-growth forests
Fire suppression

What if we have misinterpreted the fire regime?
Research Questions

• How do fire regimes vary in the mountain ecosystems of British Columbia?
• Have humans altered fire regimes?
• How does climate affect fire regimes?
Study Areas

- Lower montane forests
- Alpine tundra
- Subalpine forest
- Montane forests
- Interior rainforest

Pervasive Low-Moderate Severity Fires
Montane Forests, East Kootenays

Daniels and Cochrane in review

Site location: south to north

Composite
Pervasive Low-Moderate Severity Fires
Montane Forests, East Kootenays

Highlights (18 of 20 sites):
76 fire years from 1509 to 2003
Fire intervals: 4 to 178 years
Site-level MFI: 17 to 68 years
Low-Moderate Severity Fire Across Elevations
Cranbrook, East Kootenays

DaSilva et al. in revision
Low-Moderate Severity Fire Across Elevations
Cranbrook, East Kootenays

Highlights (16 of 33 plots):
31 fire years from 1484 to 1953
Fire intervals: 4 to 148 years
Site-level MFI: 7 to 57 years
Low-Moderate Severity Fire Across Elevations
Darkwoods near Creston, West Kootenays
(Greene 2011, Greene and Daniels in prep.)
Low-Moderate Severity Fire Across Elevations
Darkwoods near Creston, West Kootenays
(Greene 2011, Greene and Daniels *in prep.*)

Highlights (25 of 40 plots):
41 fire years from 1440 to 1963
Fire intervals: 3 to 128 years
Site-level MFI: 17 to 67 years
Fire Regimes in the Mountains of BC

- Alpine tundra
- Subalpine forest
- Interior rainforest
- Montane forests
- Lower montane forests

Fire regimes:
Low-moderate severity
Intervals: 5-70 yrs

Marcoux, Gergel and Daniels 2013, Canadian Journal of Forest Research
Fire Regimes in the Mountains of BC

West Kootenays (n=18)

East Kootenays (n=20)
Fire Regimes in the Mountains of BC

West Kootenays (n=18)

- Mixed-severity = fire scars + cohorts
- 55% 55%

East Kootenays (n = 20)
Fire Regimes in the Mountains of BC

West Kootenays (n=18)
- TSLF = 150yrs
- Mixed-severity = fire scars + cohorts
  - 55% 55%

East Kootenays (n = 20)
- TSLF = 111yrs
- High-severity = post-fire cohort
  - 28% 20%
Fire Regimes in the Mountains of BC

West Kootenays (n=18)

- TSLF = 306 yrs
- TSLF = 150 yrs

High-severity = post-fire cohort
- 28% 20%

Mixed-severity = fire scars + cohorts
- 55% 55%

Undetermined time since fire
- 17% 25%

East Kootenays (n = 20)

- TSLF = 314 yrs
- TSLF = 111 yrs
Macroscopic Charcoal in Lake Sediments
Mustaphi and Pisaric 2013, *Journal of Biogeography*

MFI = **190 yrs** (139-250), n = 26

MFI = **135 yrs** (110-164), n = 34

MFI = **180 yrs** (132-236), n = 26

MFI = **226 yrs** (174-280), n = 21

MFI = **241 yrs** (192-295), n = 26
Fire Regimes in the Mountains of BC

Fire Regimes:
- High severity
  - Intervals: 100-250yrs
- Low-moderate severity
  - Intervals: 5-70yrs

Lower montane forests
Montane forests
Interior rainforest
Subalpine forest
Alpine tundra

Marcoux, Gergel and Daniels 2013, Canadian Journal of Forest Research
Mustaphi and Pisaric 2013, Journal of Biogeography
Fire Regimes in the Mountains of BC

Mixed-Severity Fire Regime:
- High severity
  Intervals: 100-250yrs
- Low-moderate severity
  Intervals: 5-70yrs

Marcoux, Gergel and Daniels 2013, Canadian Journal of Forest Research
Mustaphi and Pisaric 2013, Journal of Biogeography
20th Century Changes to Fire Regimes
Darkwoods, West Kootenays (Greene 2011)
20\textsuperscript{th} Century Changes to Fire Regimes

Causal factors:

1. Human impacts
   - Fire exclusion
   - Land use change
   - First Nations
   - Fire suppression

2. Climatic variation
   - PDO + AMO
   - El Niño + La Niña
Global Climate and 20th Century Fires

<table>
<thead>
<tr>
<th>PDO</th>
<th>+ AMO</th>
<th>- AMO</th>
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</thead>
<tbody>
<tr>
<td>+ PDO</td>
<td>El Niño</td>
<td>El Niño - La Niña</td>
</tr>
<tr>
<td>- PDO</td>
<td>Few fires</td>
<td>La Niña</td>
</tr>
</tbody>
</table>

- 1900-22 – highly susceptible to fire
- 1923-43 – more fires during El Niños
- 1944-66 – less conducive to fire
- Since 1981 – more fires during El Niños (e.g. 2003)

Daniels et al. 2011  Canadian Journal of Plant Pathology
20th Century Changes to Fire Regimes

Causal factors:

1. Human impacts
   - Fire exclusion
   - Land use change
   - First Nations
   - Fire suppression

2. Climatic variation
   - PDO + AMO
   - El Niño + La Niña

Consequences?
Consequences of Fire Exclusion

Veterans
- low density
- uneven-aged
- fire tolerant

Post-fire cohort
- dense
- even-aged
- persistent
- fire-intolerant
- ladder fuels

(Nesbitt 2010, Marcoux et al. in review)
20th Century Changes to Fire Regimes
Consequences of Fire Exclusion

- Mixed fire regime
- "Fire suppression paradox"
- Fire exclusion
- Fuels buildup
- Persistent understory
- Severe fires
“Ecosystem-Based Management” in BC

Stand-Replacing Fire Regimes:
- Even-aged silviculture
- Rotations of 100+ yrs
- Old-growth forests
- Fire suppression
“Ecosystem-Based Management” in BC

Mixed-Severity Fire Regime:

- Alternative silviculture + old-growth strategy
- Proactive fire management

Diagram showing different ecosystems and fire regimes:
- Alpine tundra
- Subalpine forest
- Interior rainforest
- Montane forests
- Lower montane forests
New Wildfire Management Strategy

Use of wildfire management, prescribed fire, and silvicultural treatments to...

mitigate fuel hazards,
restore ecosystem structures, and
increase forest resilience to climate change.
Thanks to many people and organizations...