Climate Change: Implications for Forest Dynamics

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Climate Change

- species distributions
- tree mortality rates
- direct effects
- regeneration success
- indirect effects
- climate-mediated disturbances
- fire regimes
- insects pathogens
- forest dynamics
Interpreting Fire Regimes

- Fuel availability vs. fuel combustibility
- Fire severity vs. fire frequency

- Grasslands
- Woodlands
- Montane forest
- Interior rainforest
- Subalpine forest

Dry to wet transition
Historical Fire Regimes in Mountain Ecosystems

- Alpine tundra
- Subalpine forest
- Montane forests
- Interior rainforest
- Grassland-woodland
Montane Spruce Forests:
NDT3 – stand-replacing fire, 150 yrs
– even-aged, pine-dominated
- Wildfires in late 1800s
- Mining era 1858-1920
- Industrial logging 1950-present
Montane Forests
Montane Spruce Forests in the East Kootenays

Structurally complex stands = 25% of montane forests
Crossdated Fire Records

- Fire records
  - 30 sites
  - >250 trees
  - >400 scars

- Return Interval
  - Local scale
  - Regional scale
Site-Level Fire Chronologies

Start dates: 1449 to 1828
Median fire intervals: 10 to 26 yrs
Interval range: 2 to 123 yrs
Daniels et al. 2007, Cochrane 2007

1770-1857: pre-settlement
1858-1944: settlement
1945-2006: modern era

1509-1944
1 fire every 3 years

1945-2006
Expected c. 20 scars
Observed 6 scars

Contributing factors:
- fire exclusion/suppression
- cessation of burning by First Nations
- climate variation

10 Old Growth Sites

20 Representative Sites
Drought-Fire 1700-1970

- No fires (n = 196)
- All fires (n = 74)
- Regional fires (n = 18)

Years relative to fire

Departures (s.d.)
Global Climate and the Kootenays

“teleconnections”
Global Climate and Fire

- **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)
Effect of Climate Change

- Fire severity
- Fire frequency
- Fuel availability

Dry to wet conditions across different ecosystems:
- Grasslands
- Woodlands
- Montane forest
- Interior rainforest
- Subalpine forest

Graph shows changes in fuel combustibility and availability.
Effects of Climate and Fuels

- Fire severity
- Fire frequency

Fuel combustibility vs. fuel availability

- Dry to wet gradient
- Grasslands, woodlands, montane forest, interior rainforest, subalpine forest

Graph showing the impact of climate and fuels on fire severity and frequency.
The Fire Suppression Paradox

- mixed fire regime
- +
- fire exclusion
- fuels buildup
- unusually severe fires
- mitigation: prescribed burns thinning
- human costs economic losses
Fire Effects on Forest Dynamics

Survival of understory trees in absence of low severity fires + self thinning = departed from NRV
Stand establishment following severe fire in 1911
Evidence of mixed severity regime, within NRV
Climate-Fire-Mountain Pine Beetle Interactions?

increased fuels due to tree mortality
+ high fire risk during regional droughts
## Fire and Mountain Pine Beetle Operational Prescribed Burn Kootenay National Park

<table>
<thead>
<tr>
<th></th>
<th>No MPB</th>
<th>Red Attack</th>
<th>1980s MPB</th>
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</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>100%</td>
<td>98%</td>
<td>100%</td>
</tr>
<tr>
<td>Log Loss</td>
<td>22%</td>
<td>29%</td>
<td>51%</td>
</tr>
<tr>
<td>Snag Loss</td>
<td>24%</td>
<td>16%</td>
<td>44%</td>
</tr>
<tr>
<td>Fire Intensity</td>
<td>0.11 m/sec</td>
<td>0.13 m/sec</td>
<td>0.46 m/sec</td>
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<tr>
<td>FI</td>
<td>FI &lt; predicted</td>
<td>FI &lt; predicted</td>
<td>FI 2-10x predicted</td>
</tr>
</tbody>
</table>
Lessons learned ...

• Historical fires in mountains
  – low to high frequency + severity

• Climate influences on fire
  – global climate influences drought and fires

• Human influences on fire
  – fire free period = natural variation + fire suppression
Implications for Ecological Restoration

• Historical fires ranged from low to high severity
• Suppressed many stand-maintaining fires
• Current forest structures =
  natural processes + fire suppression effects

Should we thin the forest and prescribe fire...
  to mitigate to reduce fire hazard?
  to restore the ecosystem?
Conclusions

• Fire is natural and important for forests

• Increased risk of severe fires
  – humans impacts, droughts + global warming

• Solutions: mitigation and restoration

• BUT, fires will burn in future
  – with positive and negative effects
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