Wildfires: The Intersection of changes in climate, policy, and culture in Alaska’s Boreal Forest

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University of Alaska Fairbanks

LTER Mini-symposium at NSF
March 8, 2007
Social-ecological framework is essential for understanding change
Q1: How do long-term trends in climate and fire regime interact to alter the boreal forest of Interior Alaska and to feedback to the climate system?

Q2: How are feedbacks between landscape and stand structure (biotic composition, permafrost, and soils) and functioning (ecosystem budgets, demographic processes, and permafrost dynamics) affected by climate warming and changing fire regime?

Q3: How do ecological changes caused by altered climate and fire regime affect climate and fire regulation by landscapes and the supply of subsistence and cultural resources to local residents?

Q4: How will the human population of Interior Alaska respond to recent and projected changes in fire regime and subsistence and cultural services?

Q5: How do humans decisions and actions affect the fire regime of Interior Alaska?
Permafrost thaw:
The land is getting drier in places
Ice-rich wetlands become wetter
Kenai bark beetle outbreak
Area burned in W. North America has doubled in last 40 years
Total Annual Area Burned in Alaska 1950-2006

15 Fire Seasons > 1,000,000 ac - 7 (47%) have occurred since 1990

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Number of hot summer days in the future

![Barrow](chart)

- **60°F**
- **85°F**

![Fairbanks](chart)

- **1980-1999**
- **2010-2029**
- **2040-2059**
- **2070-2089**

![Juneau](chart)

- **1980-1999**
- **2010-2029**
- **2040-2059**
- **2070-2089**

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Fire alters energy exchange
Negative feedback to climate warming

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Close connection between ecology and culture
Rural communities have locations fixed by infrastructure
People’s fine-scale relationship with fire has changed over time

- Pre-contact: Mobile family groups
  - People adjust to fire regime
- Gold rush & settlement: Influx of population and fire
  - People alter fire regime
- 1950s: Consolidation in permanent settlements
  - Fire affects communities
- 1980s: Zonation for suppression
  - Policy influences fire and communities
Population density (% of maximum)

Time after a fire (years) [log scale]

Blueberries
Moose/marten
Lynx/hares
Caribou
Communities differ in moose/caribou dependence

annual harvests

pounds/capita (for moose, pounds/10)

mOOSE  CARIBOU

commuNIty
Caribou Habitat

Caribou Habitat (Spruce Stand Age > 80)

--- Initial Spruce > 80 Yrs Old = 230392 km²

- Spr > 80.a2hdcm3
- Spr > 80.a2pcm
- Spr > 80.b2hdcm3
- Spr > 80.b2pcm

Year

Black & White Spruce > 80 Yrs Old (km²)
Moose Habitat

Moose Habitat (10 < Decid Stand Age < 31)

- 10<Decid<31.a2hadcm3
- 10<Decid<31.a2pcm
- 10<Decid<31.b2hadcm3
- 10<Decid<31.b2pcm

10 Yrs Old < Initial Decid < 31 Yrs Old = 29000.5 km^2
Community engagement

• We hate fire!
  – Cultural kinship with animals
  – Risk to life and property
  – Economic benefits of fire-fighting

• Fuel costs > $6/gallon
  – Drives rural-urban migration

• Biofuel harvest to reduce fire risk
  – Ecologically sustainable (90% of communities)
  – Economically viable (>80% of communities
  – 90% of costs retained locally as wages
  – Improved moose habitat near villages
Human ignitions strongly influence local *patterns* of fire distribution

Lightning Fires Human-Caused Fires

- **Human-caused**
- **Lightning-caused**

<table>
<thead>
<tr>
<th>Final Fire Size (ha)</th>
<th>Frequency (% of all fires)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0.4</td>
<td></td>
</tr>
<tr>
<td>0.4-4</td>
<td></td>
</tr>
<tr>
<td>4-40</td>
<td></td>
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<tr>
<td>400-4000</td>
<td></td>
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<tr>
<td>&gt;4000</td>
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<td>400-4000</td>
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<td>&gt;4000</td>
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DeWilde
Total number of fires per unit area from 1950-2000.
Area burned

a. 1990-1999

DeWilde

b. 1950-2000

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Small Fires and Management Options within Interior Alaska

- Lightning Fires Smaller than 4 Ha
- Human Caused Fires Smaller than 4 Ha

- Full and Critical Protection
- Modified Protection
- Limited Protection
- Alaska
Large Fires and Management Options within Interior Alaska

- Lightning Caused Fires Larger than 400 Ha
- Human Caused Fires Larger than 400 Ha

- Full and Critical Protection
- Modified Protection
- Limited Protection
- Alaska

Human Caused Fires Larger than 400 Ha

Lightning Caused Fires Larger than 400 Ha

Large Fires and Management Options within Interior Alaska
Total Federal and State Suppression Costs

Up 6.8 million per year

Cost in Millions $

Year

Key Factors Driving Fire Costs

- Rising human population (30 year doubling time)
  - Driven by migration from lower 48
    - More human ignitions
    - More demand for suppression

- Climate Change
  - Longer Season
  - Bigger fires
  - Greater overlap with lower 48 fire season

- Increased aircraft use

- Training/Safety Costs
  - Driven by fire events in lower 48

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Percent of Families Below the Poverty Level in 1999: 2000

U.S. Census, TM-P069.

U.S. Census TM-P049.
In 86% of villages with crews, EFF wages are <5% of total village income.

EFF is an Important Source of Income for Entry Level Workers

• On individual scale, EFF income is very important
  – Only income source for ~50% of crew members
  – Entry-level job experience
  – Self-esteem
  – Cross-generational mentorship
  – Equipment and supplies for subsistence activities
Top 10 EFF Earners – Average, 1986-2004

<table>
<thead>
<tr>
<th>Rank</th>
<th>Location</th>
<th>Earnings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fairbanks</td>
<td>$1,586,842</td>
</tr>
<tr>
<td>2</td>
<td>Delta</td>
<td>$502,363</td>
</tr>
<tr>
<td>3</td>
<td>Tok</td>
<td>$333,823</td>
</tr>
<tr>
<td>4</td>
<td>Fort Yukon</td>
<td>$301,870</td>
</tr>
<tr>
<td>5</td>
<td>Hooper Bay</td>
<td>$249,265</td>
</tr>
<tr>
<td>6</td>
<td>Palmer</td>
<td>$220,229</td>
</tr>
<tr>
<td>7</td>
<td>Northway</td>
<td>$212,442</td>
</tr>
<tr>
<td>8</td>
<td>Nulato</td>
<td>$202,629</td>
</tr>
<tr>
<td>9</td>
<td>Allakaket</td>
<td>$180,886</td>
</tr>
<tr>
<td>10</td>
<td>Glennallen</td>
<td>$168,550</td>
</tr>
</tbody>
</table>

Red = On Road
Black = Off Road
Boreal Summary

• Climate warming increases fire extent
• Impacts global society through climate feedbacks
  – Positive feedback to warming through CO$_2$ release
  – Negative feedback to warming through change in albedo
• Impacts society locally through landscape pattern and policy
  – Fire reduces local subsistence options
  – Fire suppression provides wage opportunities
• Policy can modify fire regime
  – Tradeoffs between short-term protection and long-term increases in flammable fuels
  – Increasing economic constraints require new approaches
  – New opportunities: Wildland fire use to “design” global and local patterns of ecosystem services
What disturbances are most important in LTER sites?

<table>
<thead>
<tr>
<th>Disturbance type</th>
<th>#1</th>
<th>#2</th>
<th>#3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate (e.g., floods, drought)</td>
<td>33</td>
<td>28</td>
<td>53 (mostly xeric climates)</td>
</tr>
<tr>
<td>Physical (e.g., fire, sedimentation)</td>
<td>39</td>
<td>22</td>
<td>7</td>
</tr>
<tr>
<td>Biotic (pests, grazing, invasives)</td>
<td>11</td>
<td>28</td>
<td>20 (mostly mesic climates)</td>
</tr>
<tr>
<td>Human (includes eutrophication)</td>
<td>17</td>
<td>22</td>
<td>20</td>
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Most important changes in disturbance regime

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<td>39</td>
<td>20 (intermediate sites)</td>
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<tr>
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<td>33</td>
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Presumed cause of change in disturbance (% of sites)

- Climate: 39 28 43
- Human activities: 61 61 43
- Unknown: 0 11 14

- Sites generally know the causes of change
- Direct human impacts on disturbance regime are important
Interior Athabascan culture is tied to salmon
Subsistence now uses modern technology
Kodiak Archeology

Karluk (salmon)
Akalura (salmon)
Frazer (control)

Early Kachemak
Late Kachemak
Koniag

Finney et al. (2002)
Alaska surface air temperature anomaly
Summer (JJA) : 1930 - 2004

Chapin et al. 2005
Today’s Tanana Floodplain

Tomorrow’s Tanana Floodplain?
Chapin LTER Mini-symposium
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Ecological Institutions: Their response to warming

Chapin et al. 2006
Ecosystem services define societal impacts of climate warming

Adapted from Millennium Ecosystem Assessment
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