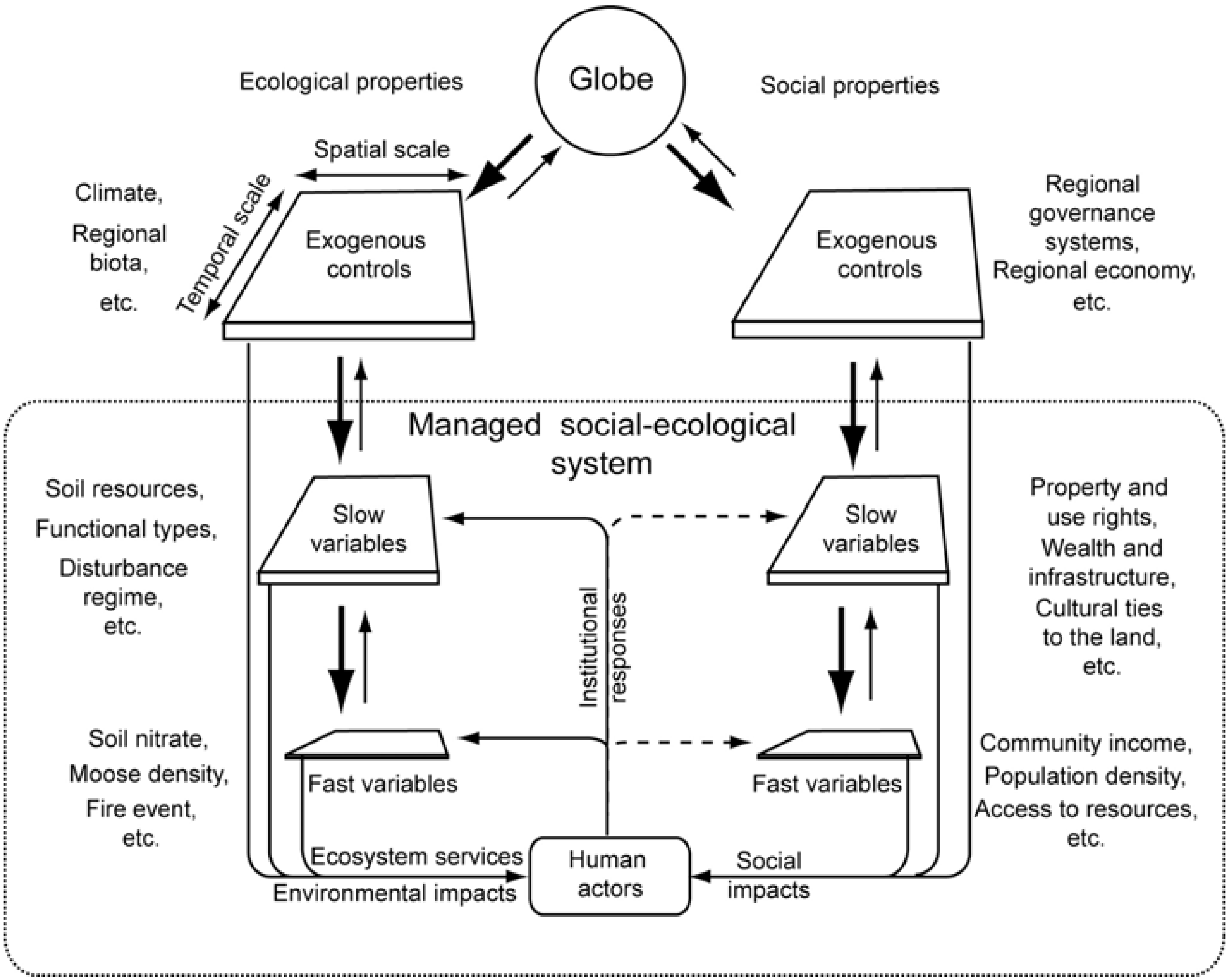
Wildfires: The Intersection of changes in climate, policy, and culture in Alaska’s Boreal Forest

Terry Chapin
University of Alaska Fairbanks

LTER Mini-symposium at NSF
March 8, 2007

Social-ecological framework is essential for understanding change



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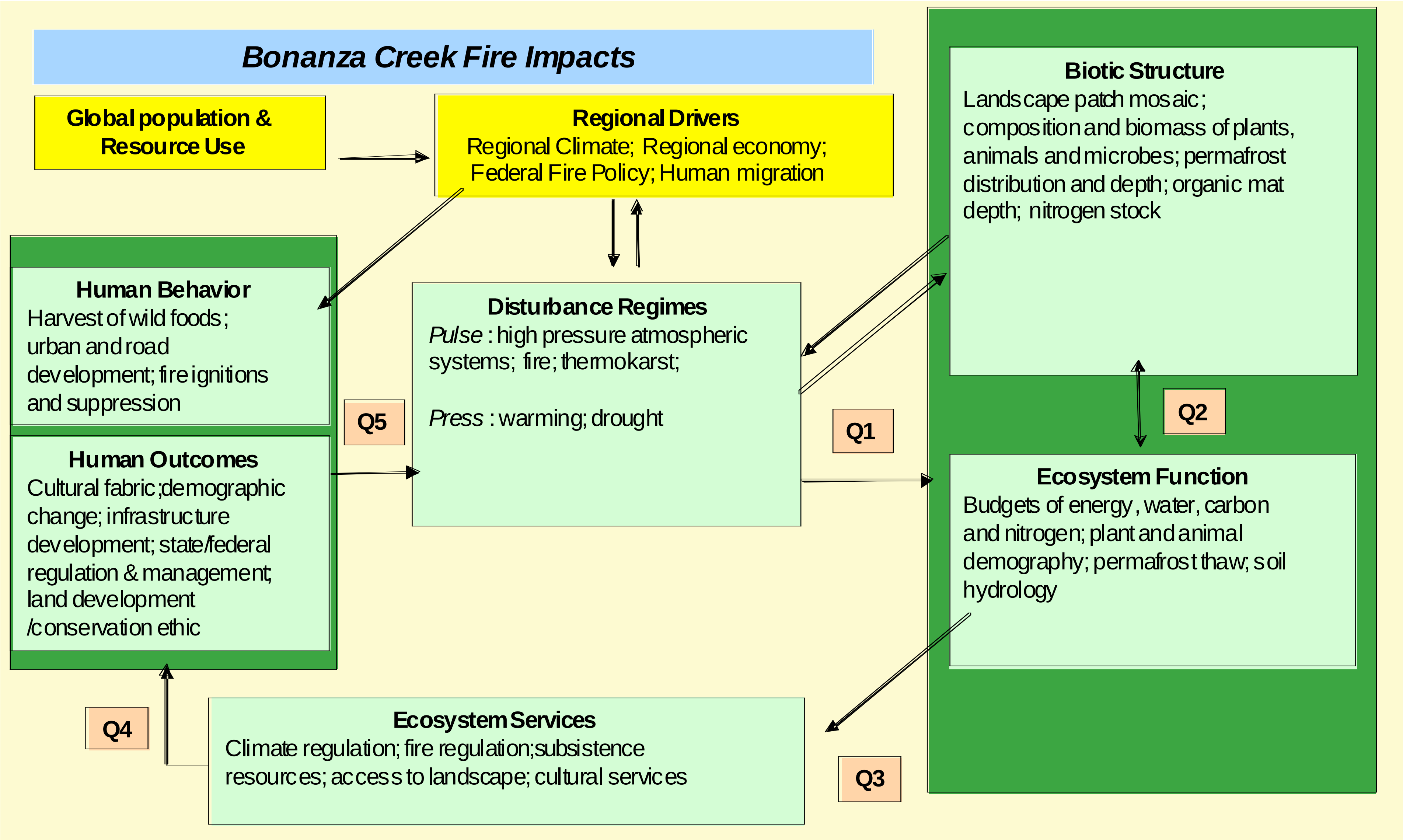
Chapin et al. 2006



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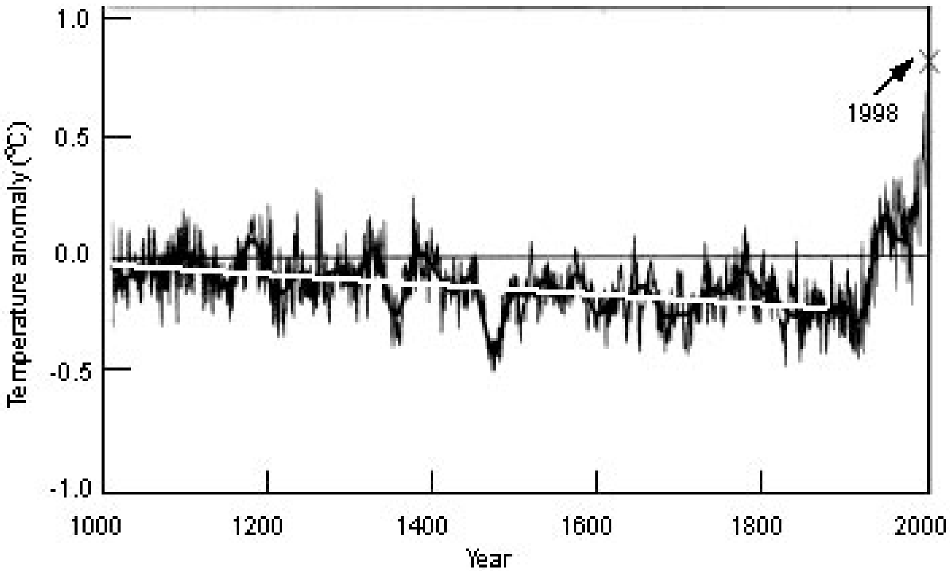
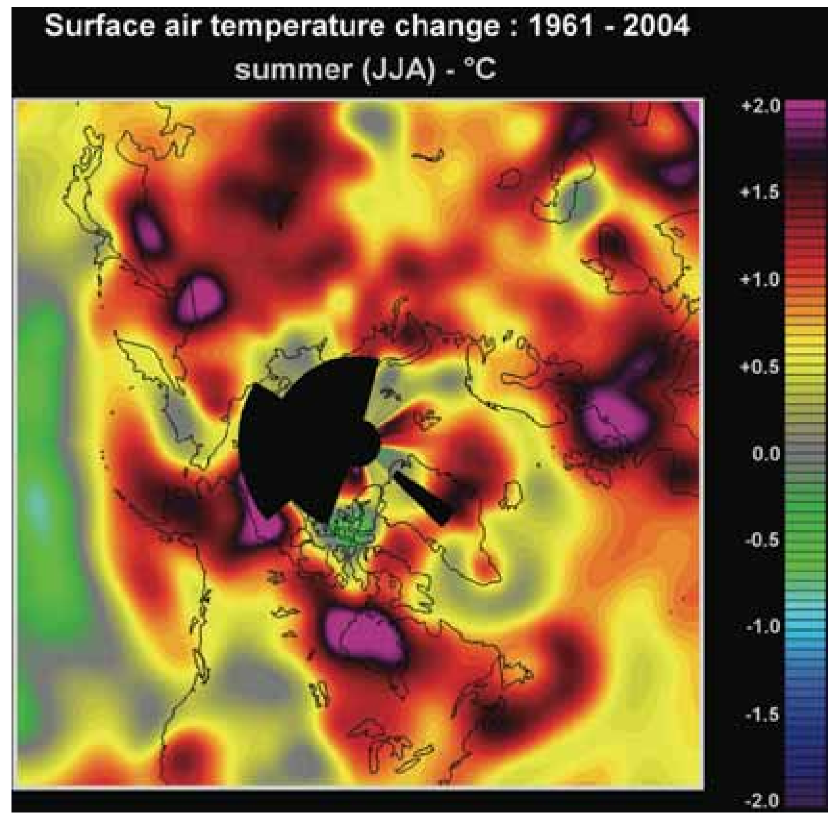


Mann et al.

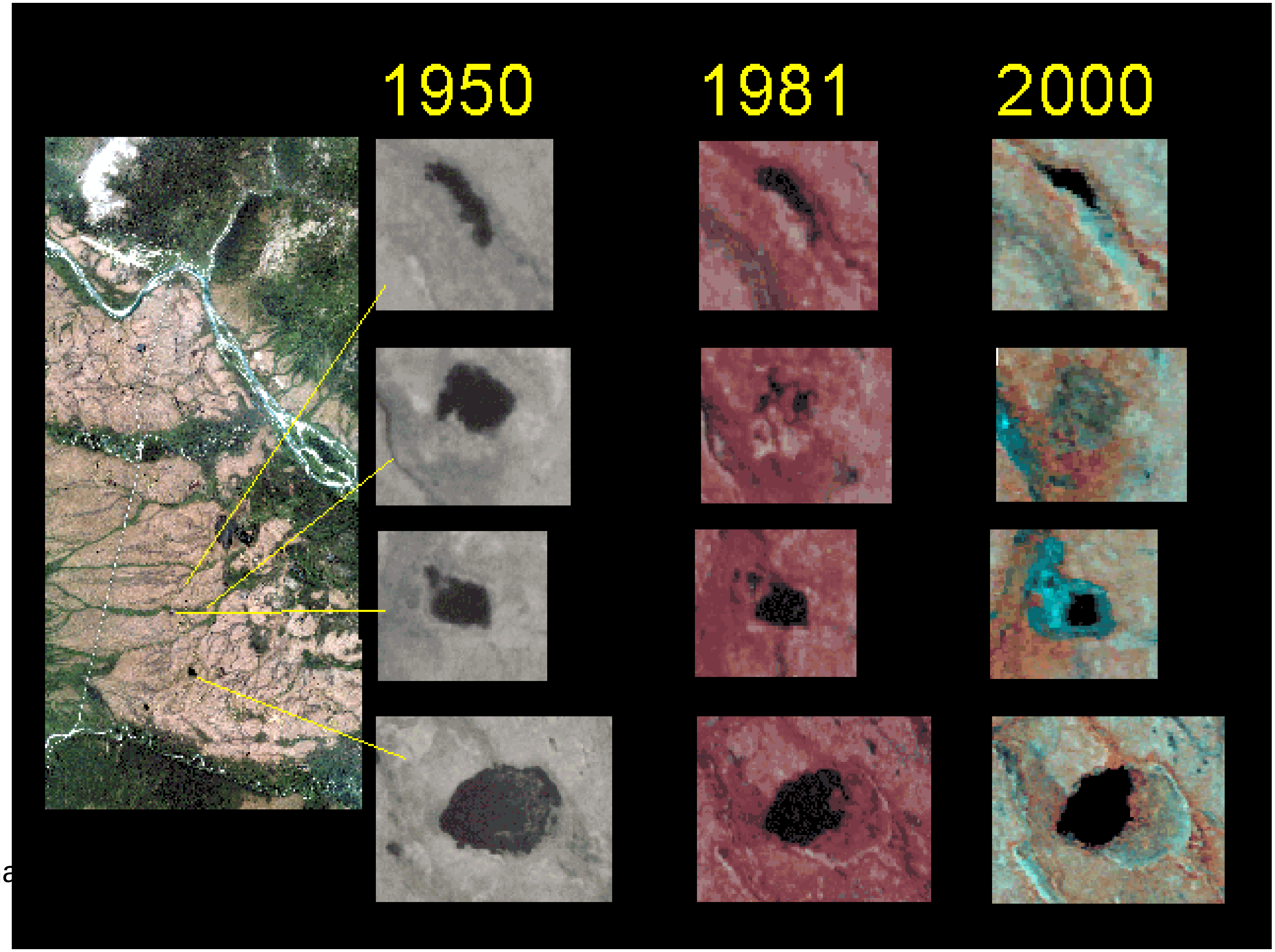
Global to boreal



Polar amplification

Chapin et al. 2005

Permafrost thaw:
The land is getting drier in places



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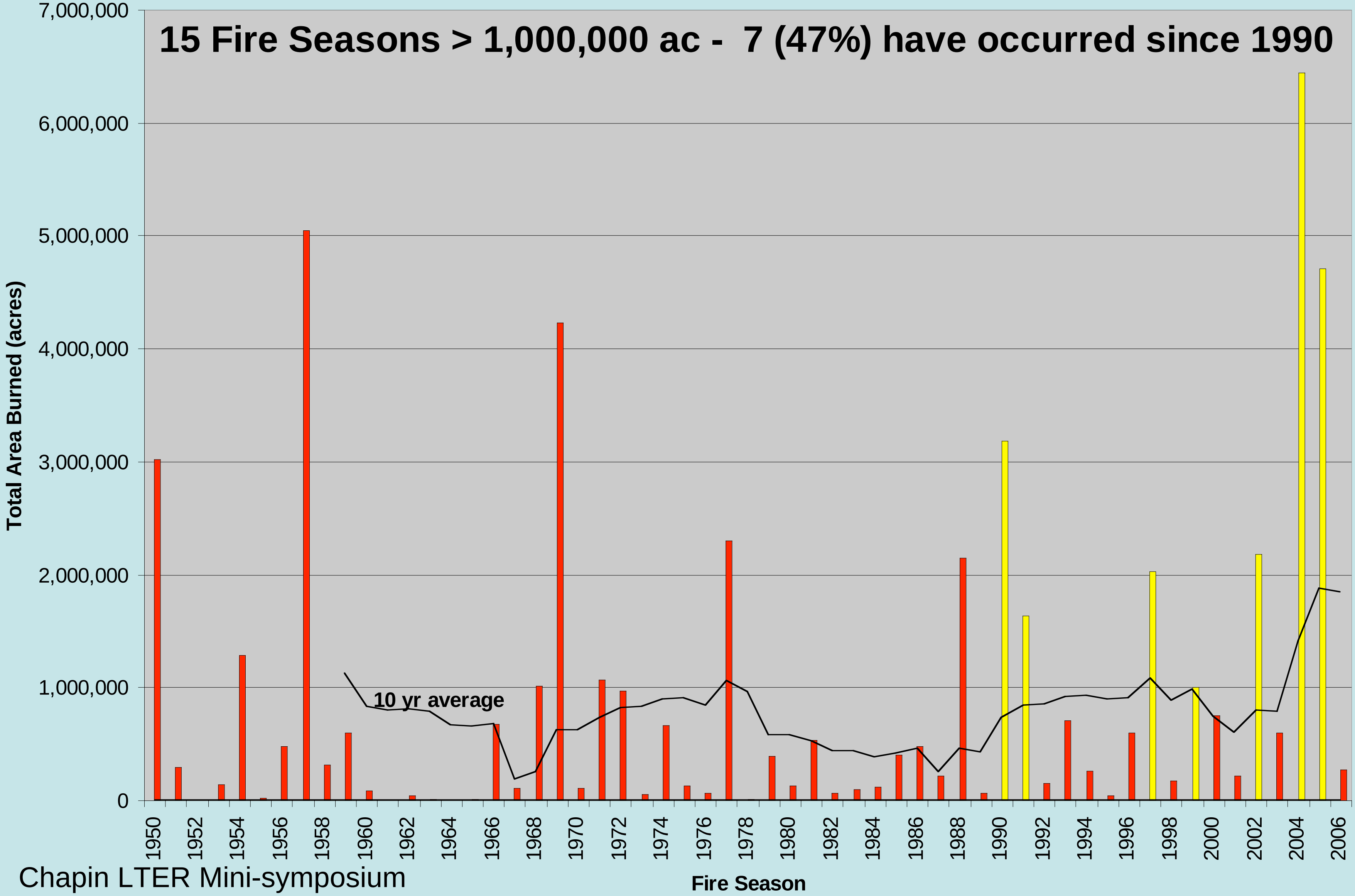
Hinzman et al. 2005

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



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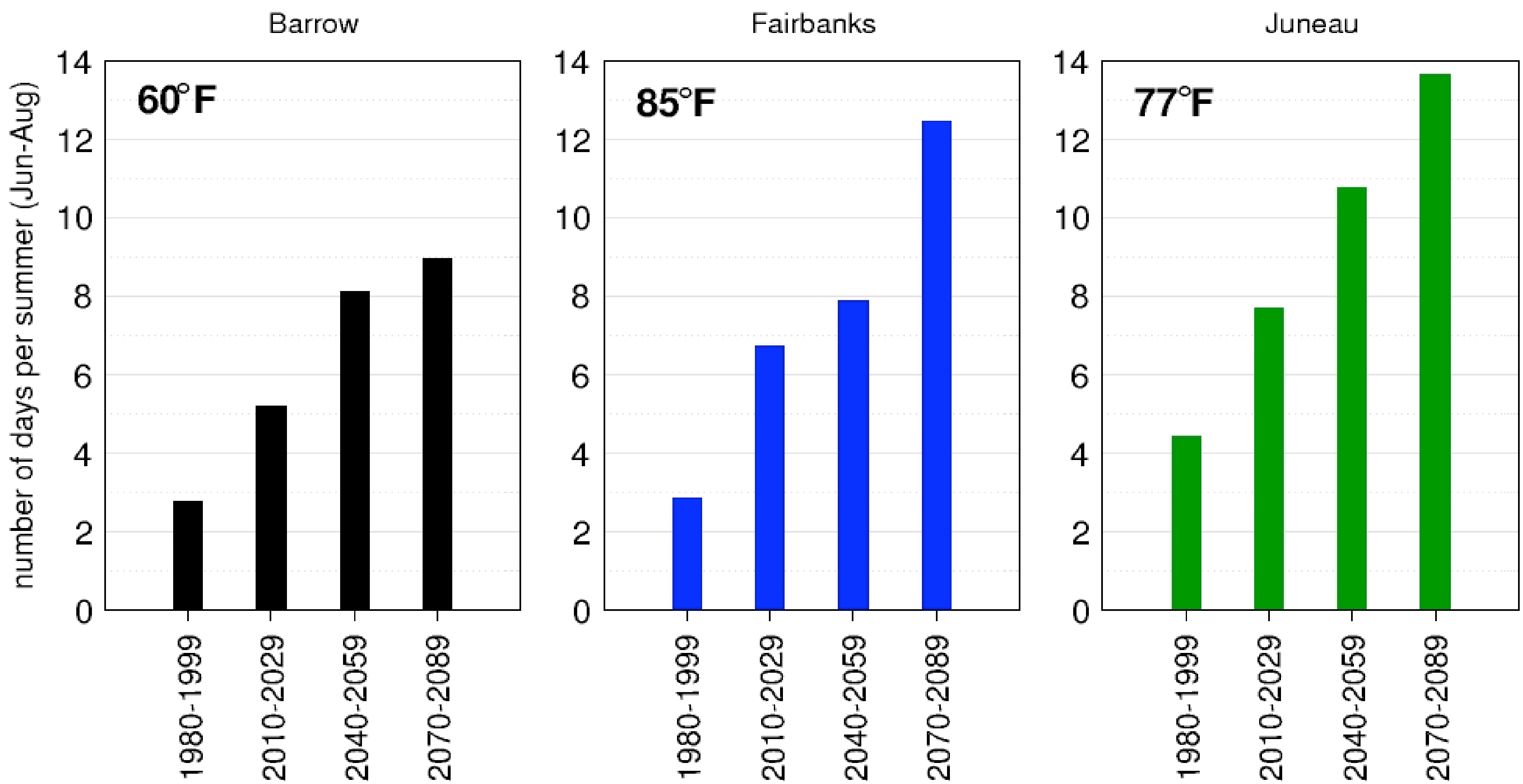
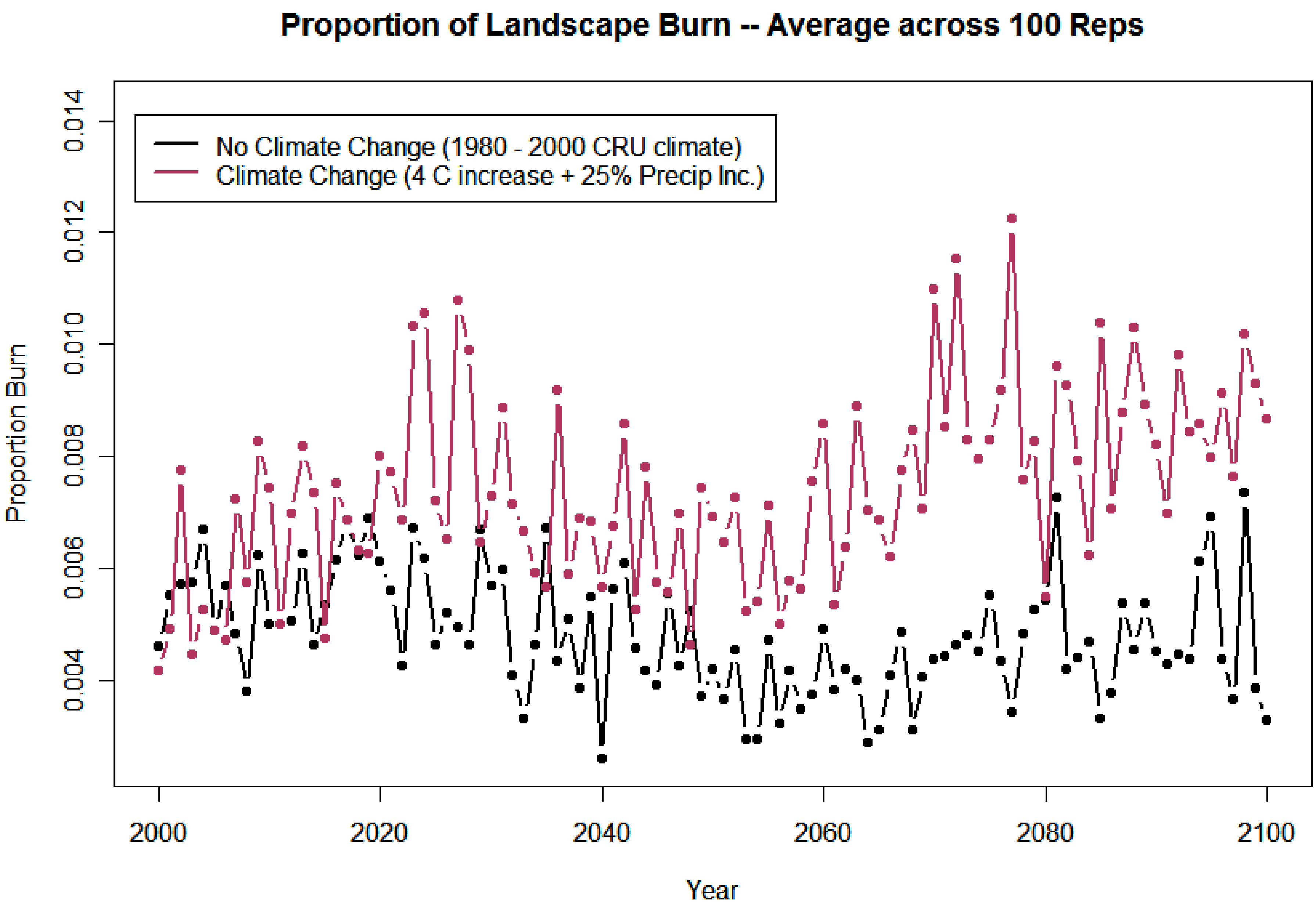
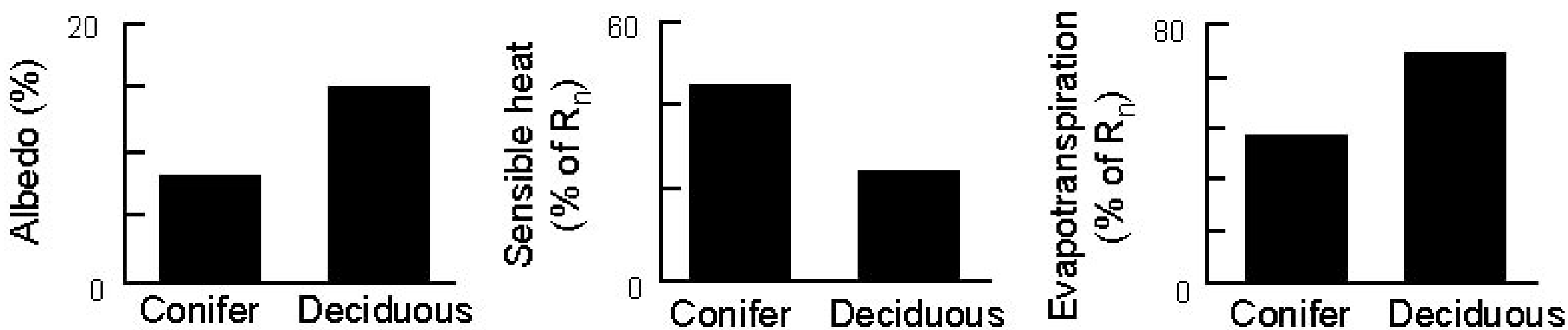
Number of hot summer days in the future



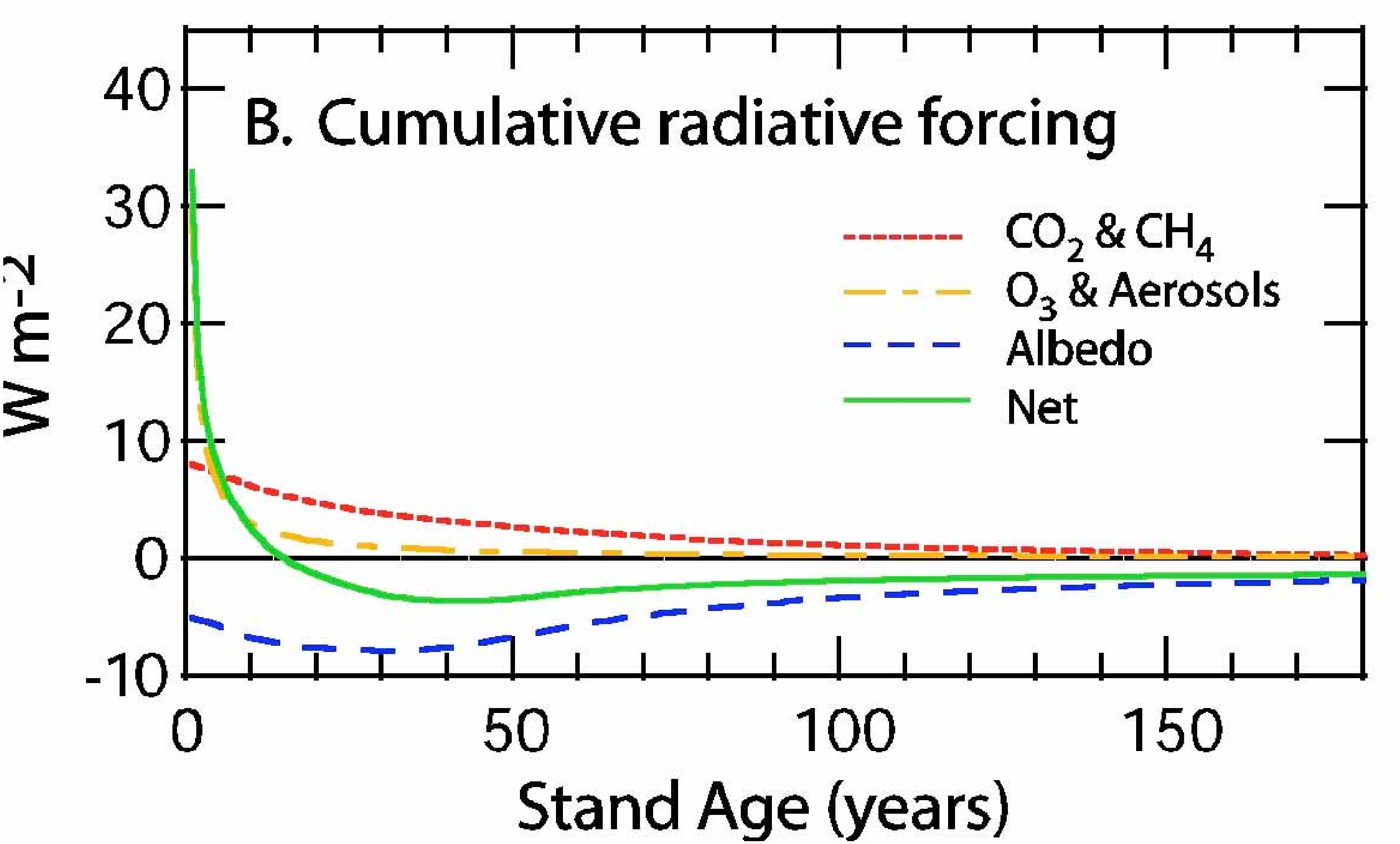

Proportion of Landscape Burn -- Average across 100 Reps
No Climate Change (1980 - 2000 CRU climate)
Climate Change (4 C increase + 25% Precip Inc.)
Proportion Burn
0.004
0.006
0.008
0.010
0.012
0.014
2000
2020
2040
2060
2080
2100
Year

Rupp

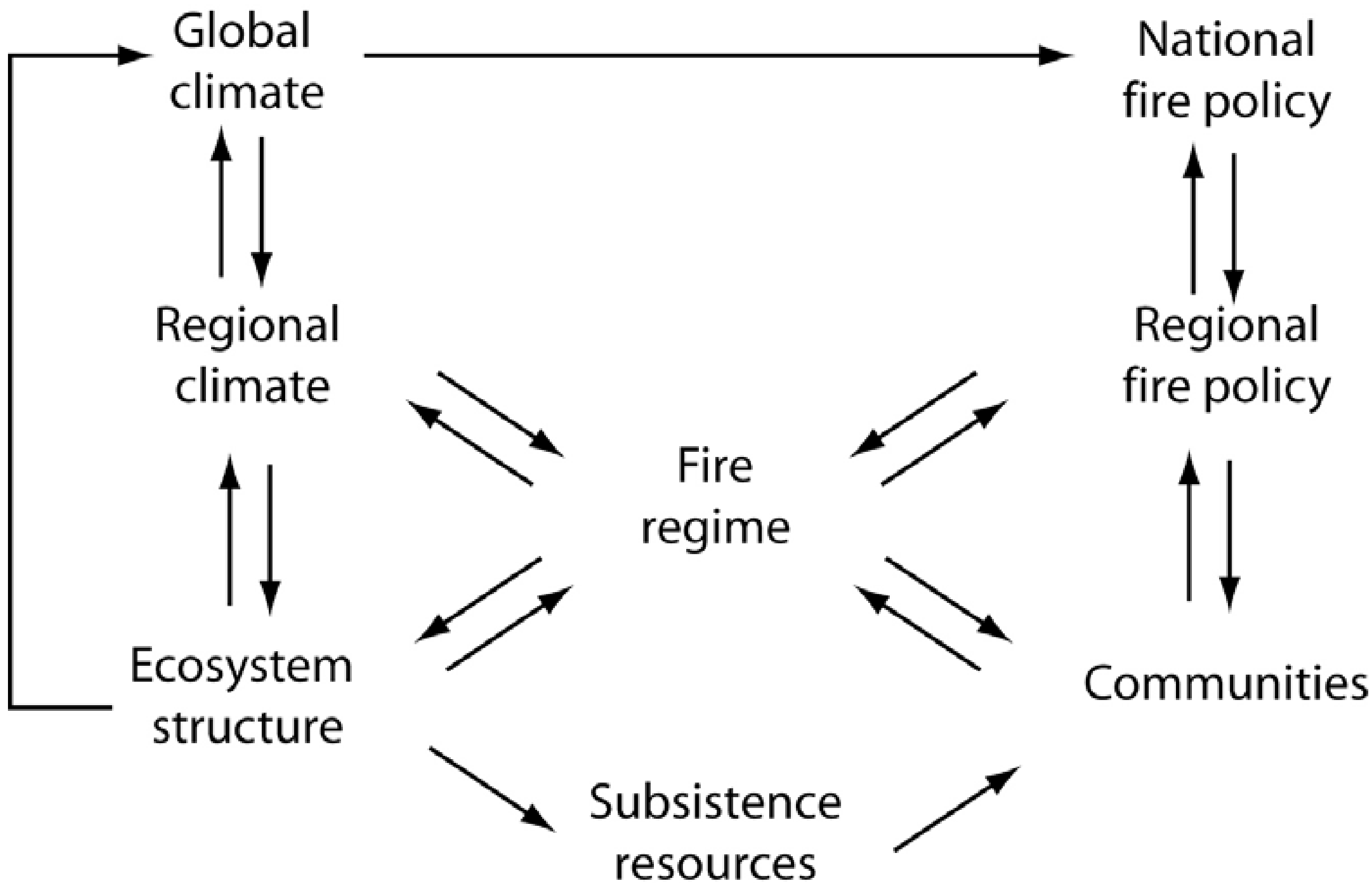
Fire alters energy exchange
Negative feedback to climate warming



Baldochi

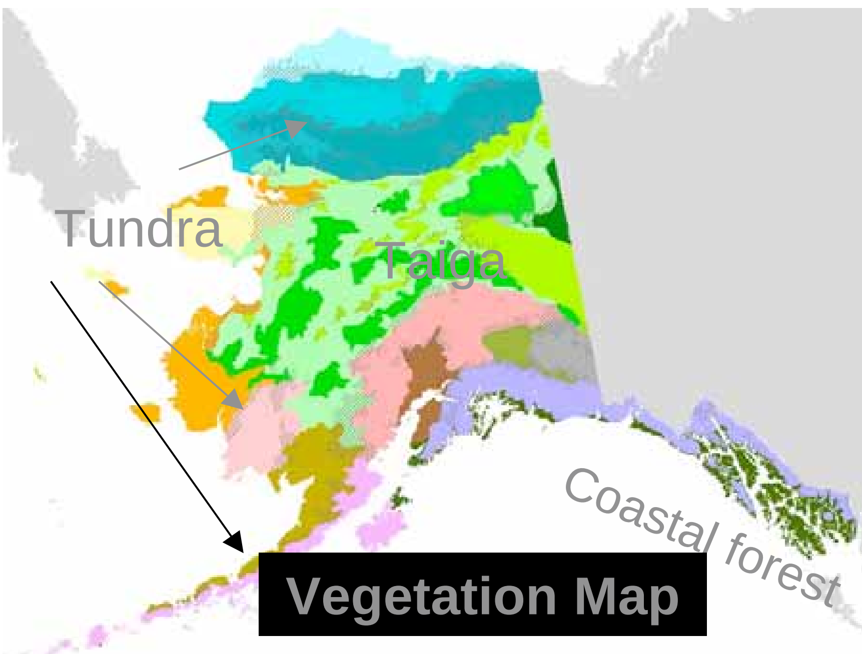


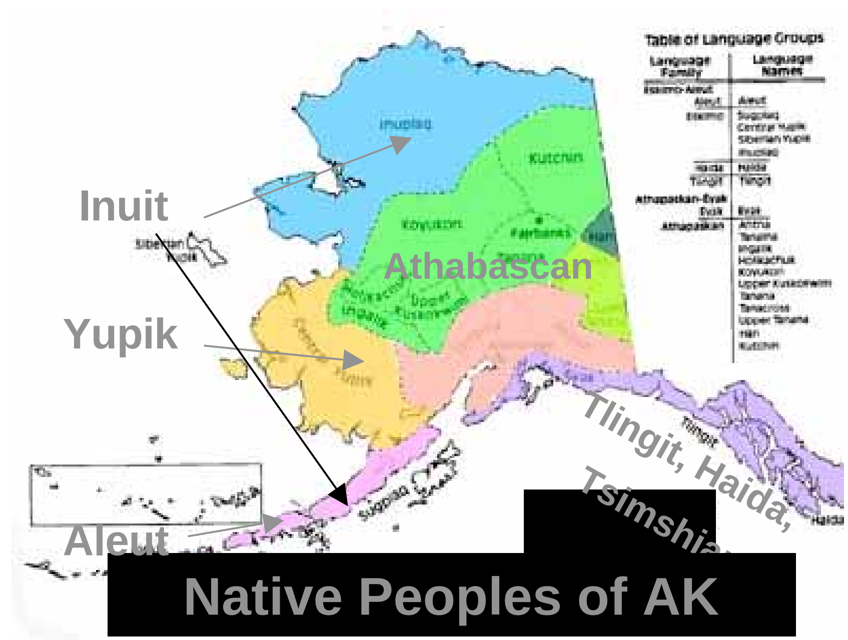
Randerson et al. 2006



Global
climate
National
fire policy
Regional
climate
Regional
fire policy
Fire
regime
Ecosystem
structure
Communities
Subsistence
resources

Close connection between ecology and culture

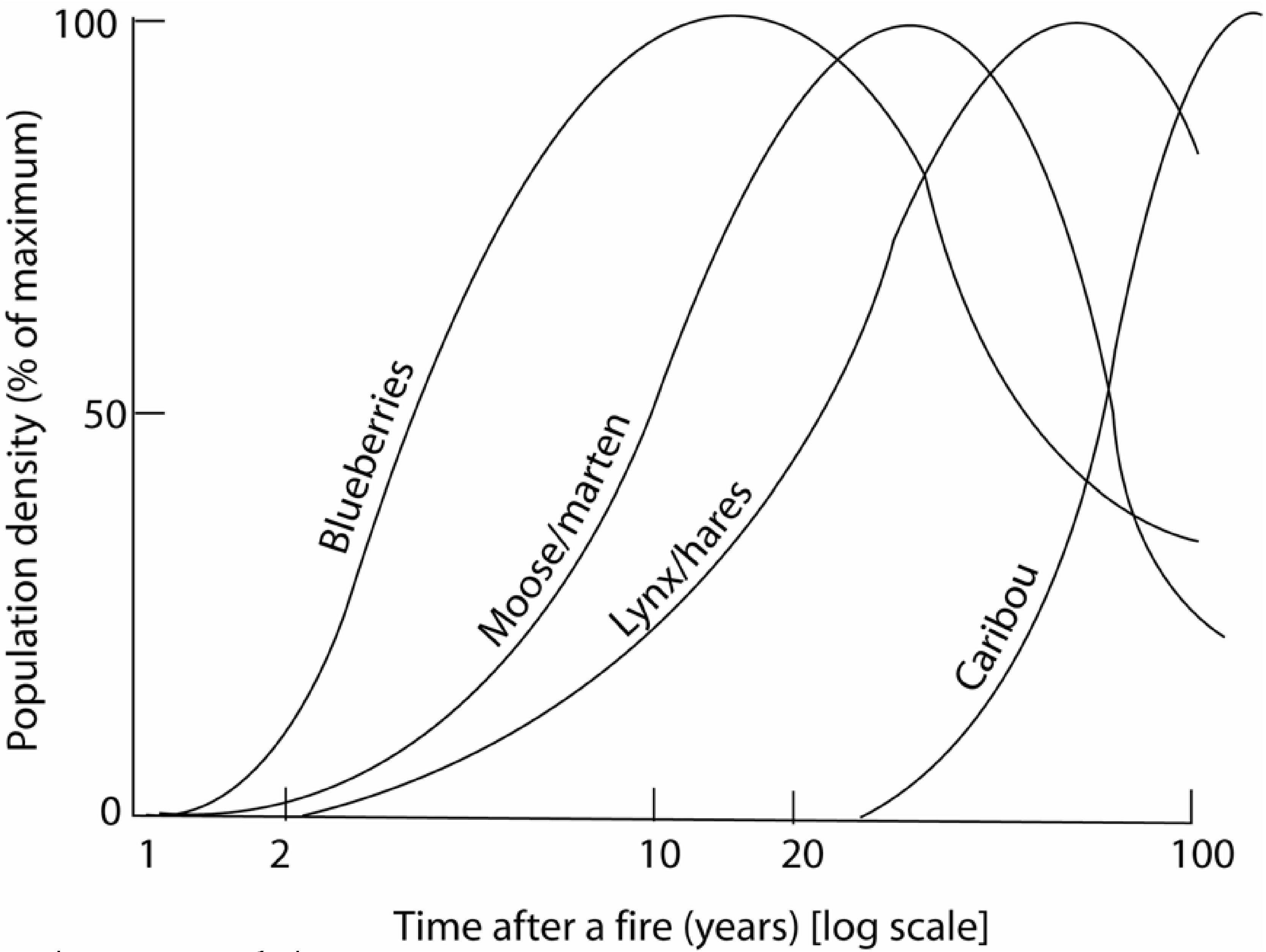




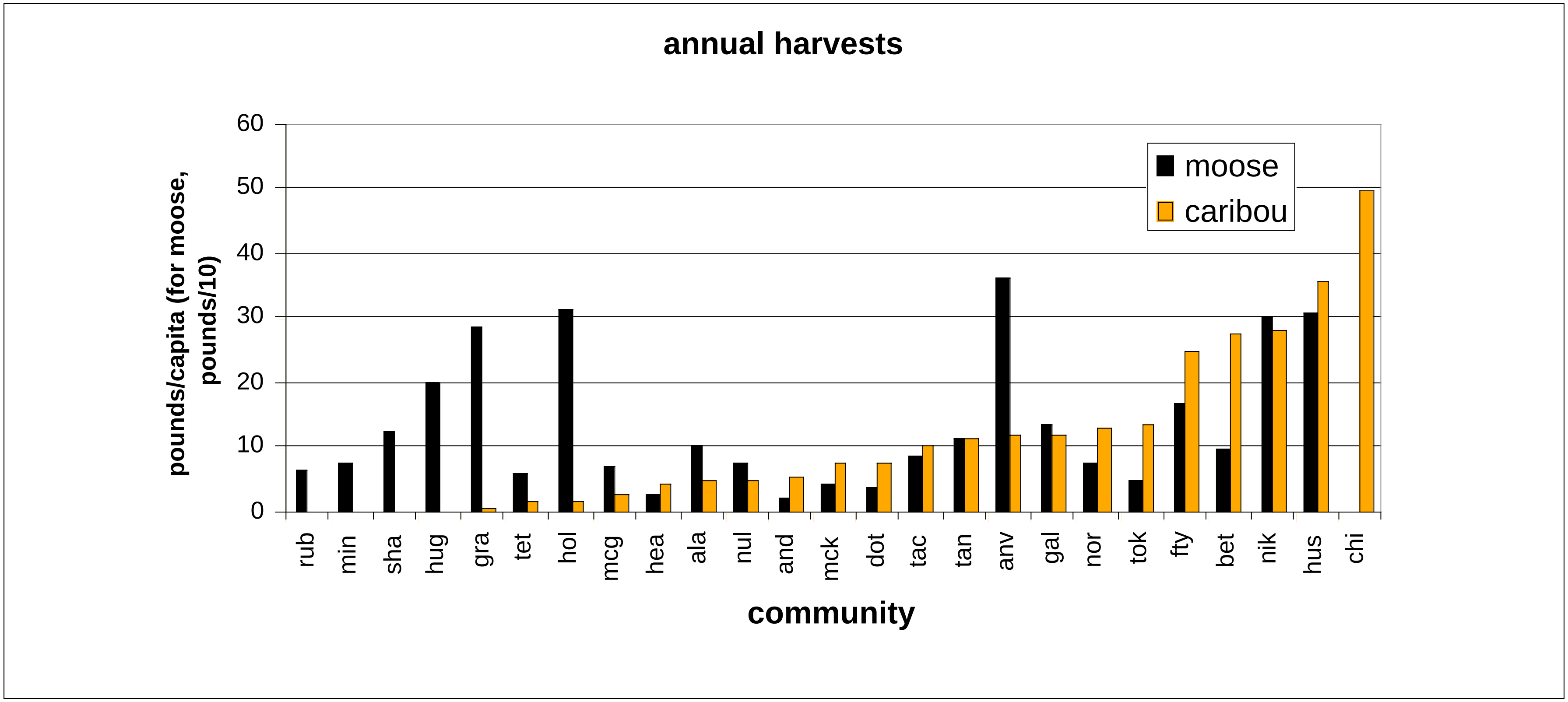
Rural communities have locations fixed by infrastructure

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)
100
50
0
Blueberries
Moose/marten
Lynx/hares
Caribou
1
2
10
20
100
Time after a fire (years) [log scale]

Communities differ in moose/caribou dependence



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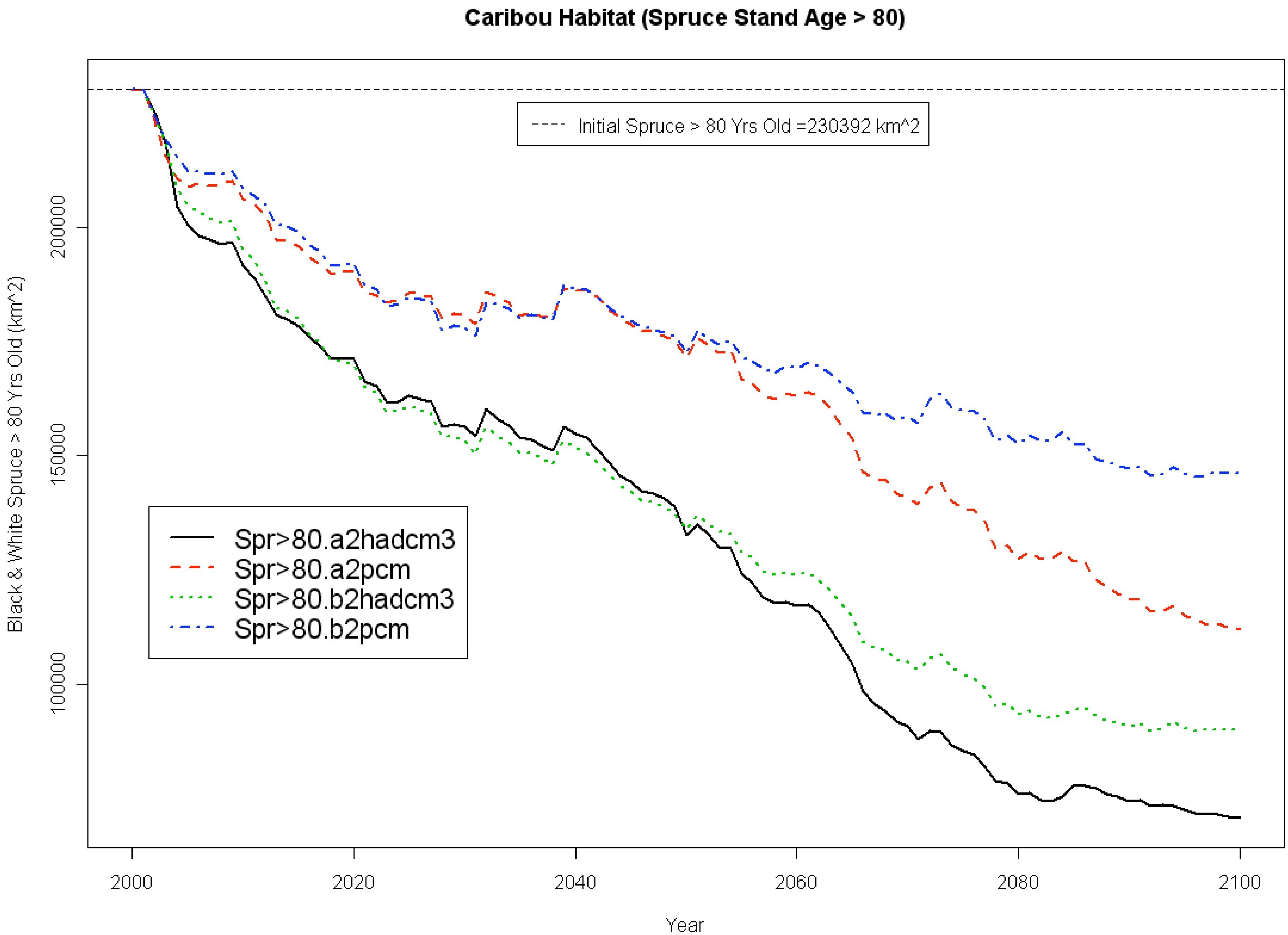
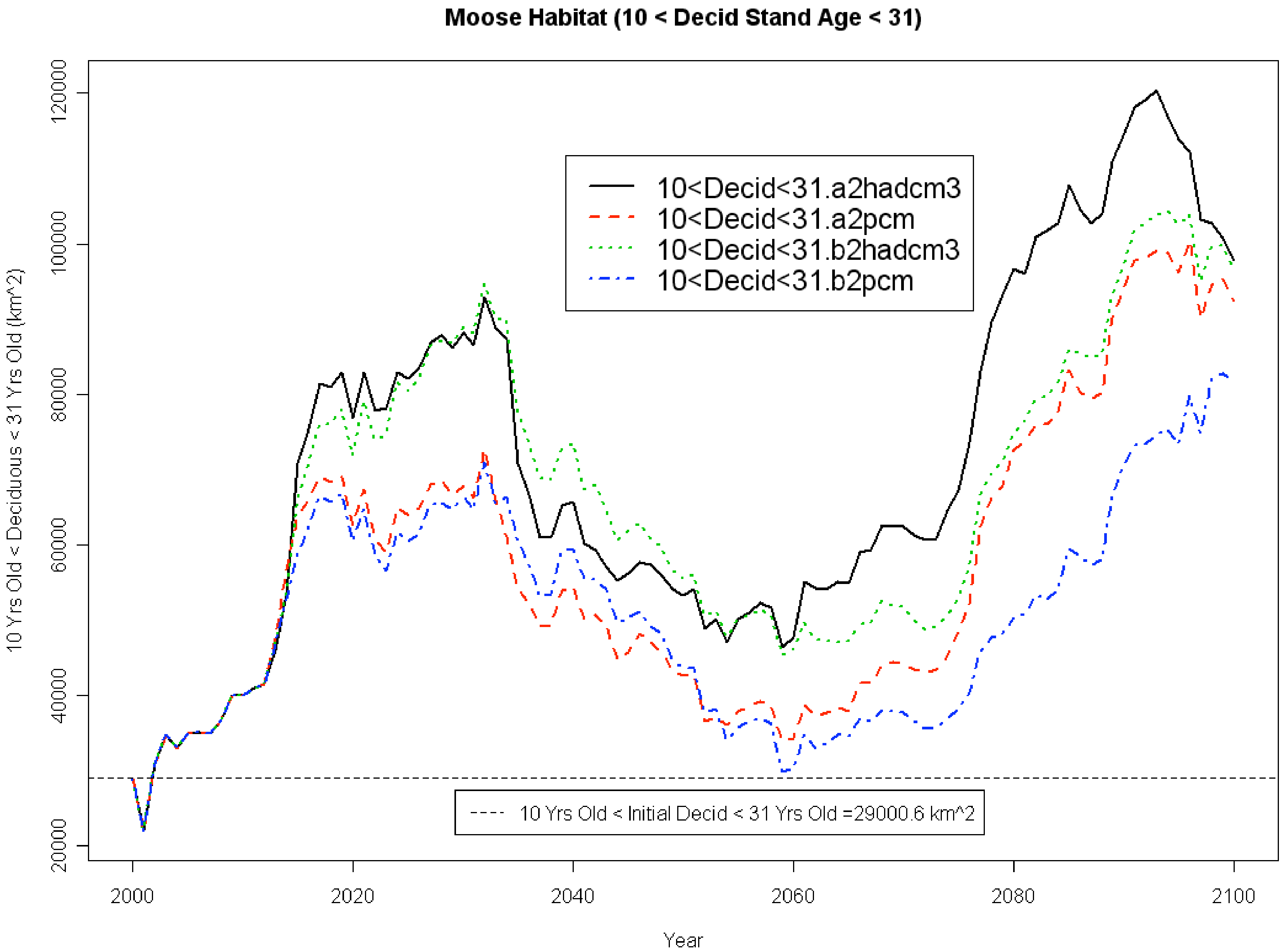
Caribou Habitat



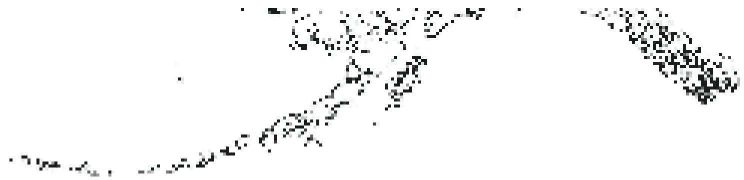
Moose Habitat



Community engagement

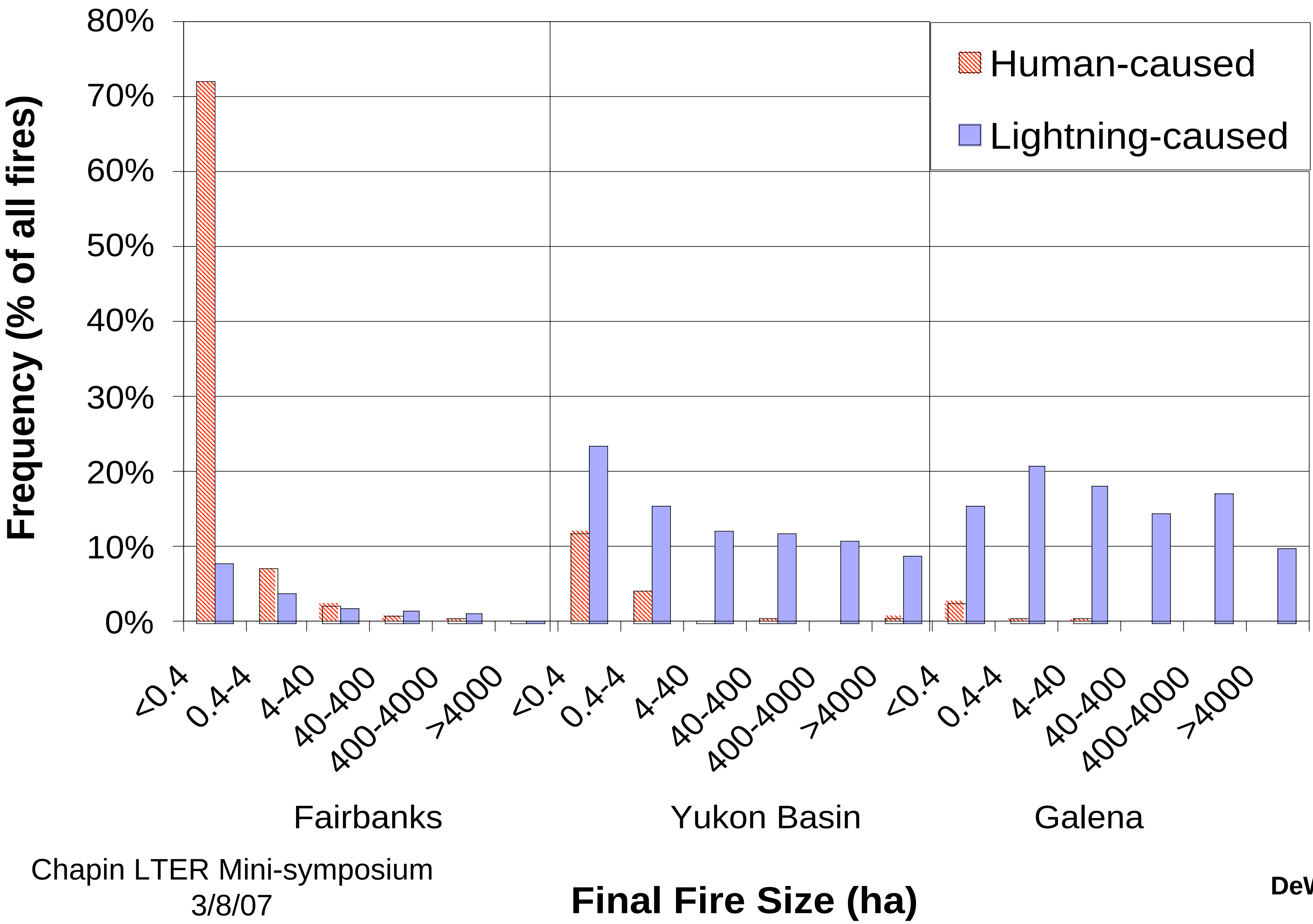
- We hate fire!
  - Cultural kinship with animals
  - Risk to life and property
  - Economic benefits of fire-fighting
- Fuel costs > $6/gallon
  - Drives rural-urban migration
- Biofuel harvest to reduce fire risk
  - Ecologically sustainable (90% of communities)
  - Economically viable (>80% of communities
  - 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**

Fire size distribution from 1990-1999.



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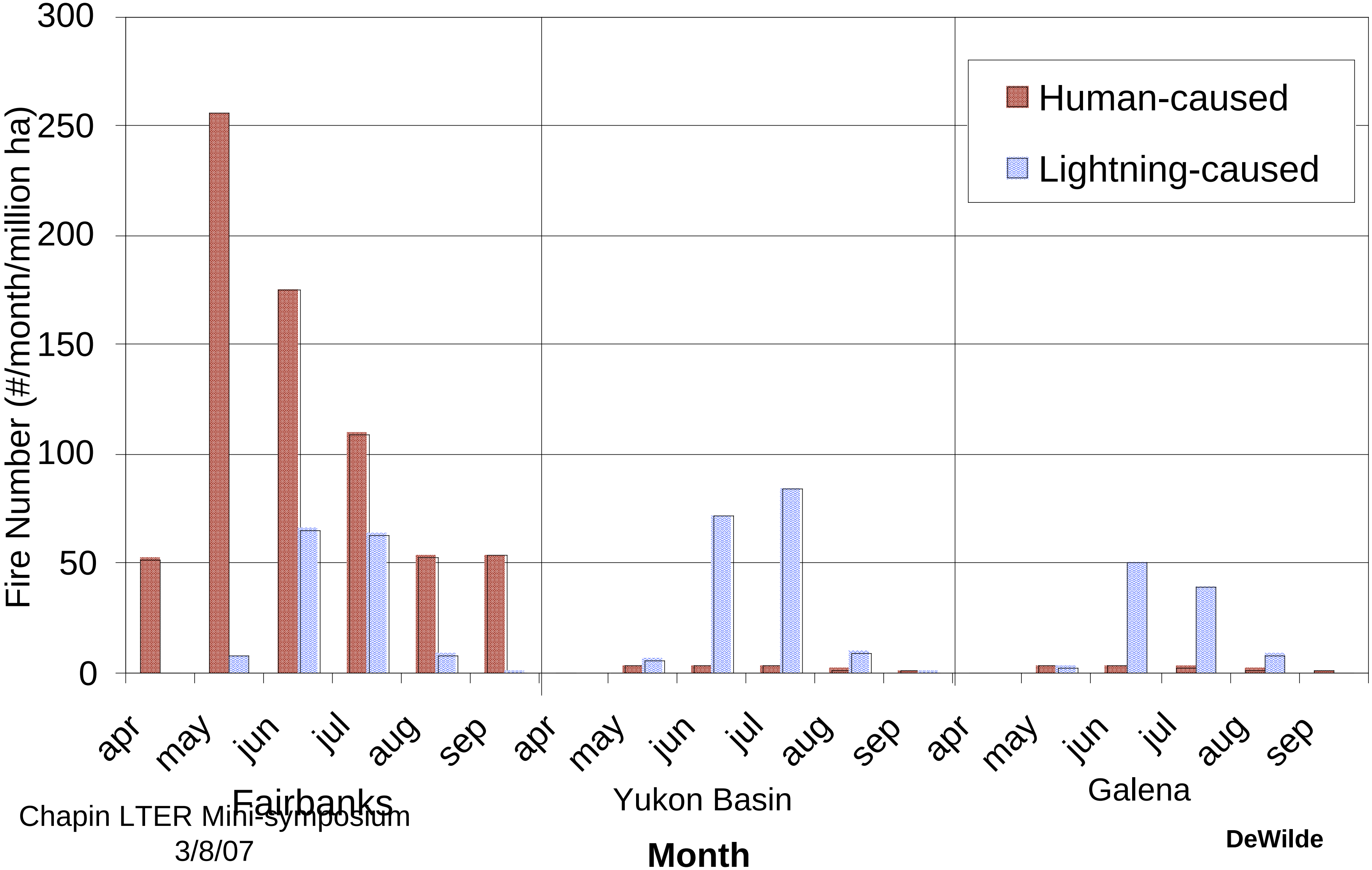
DeWilde

Total number of fires per unit area from 1950-2000.



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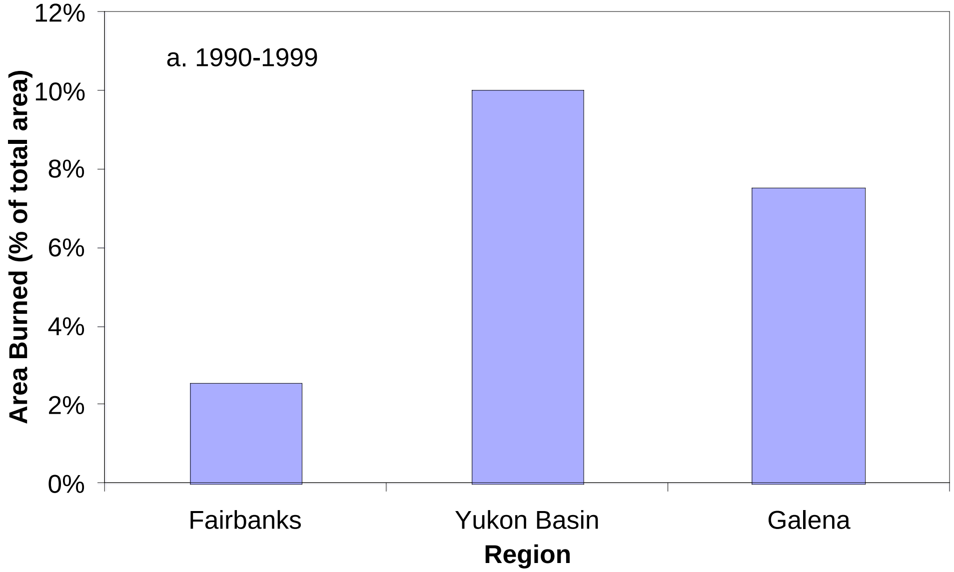
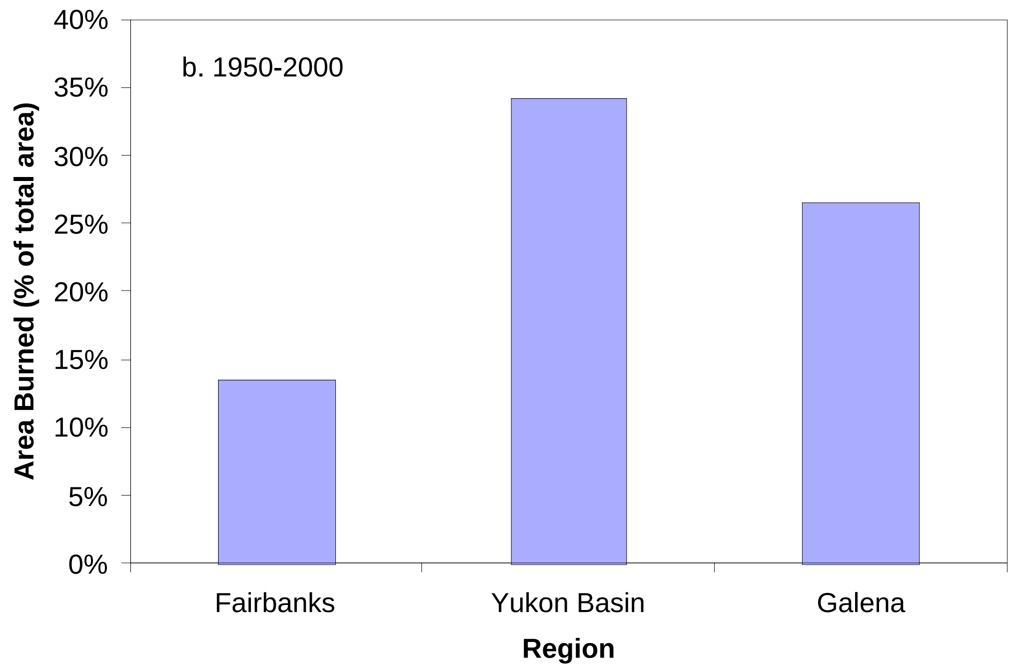
DeWilde

Area burned



DeWilde



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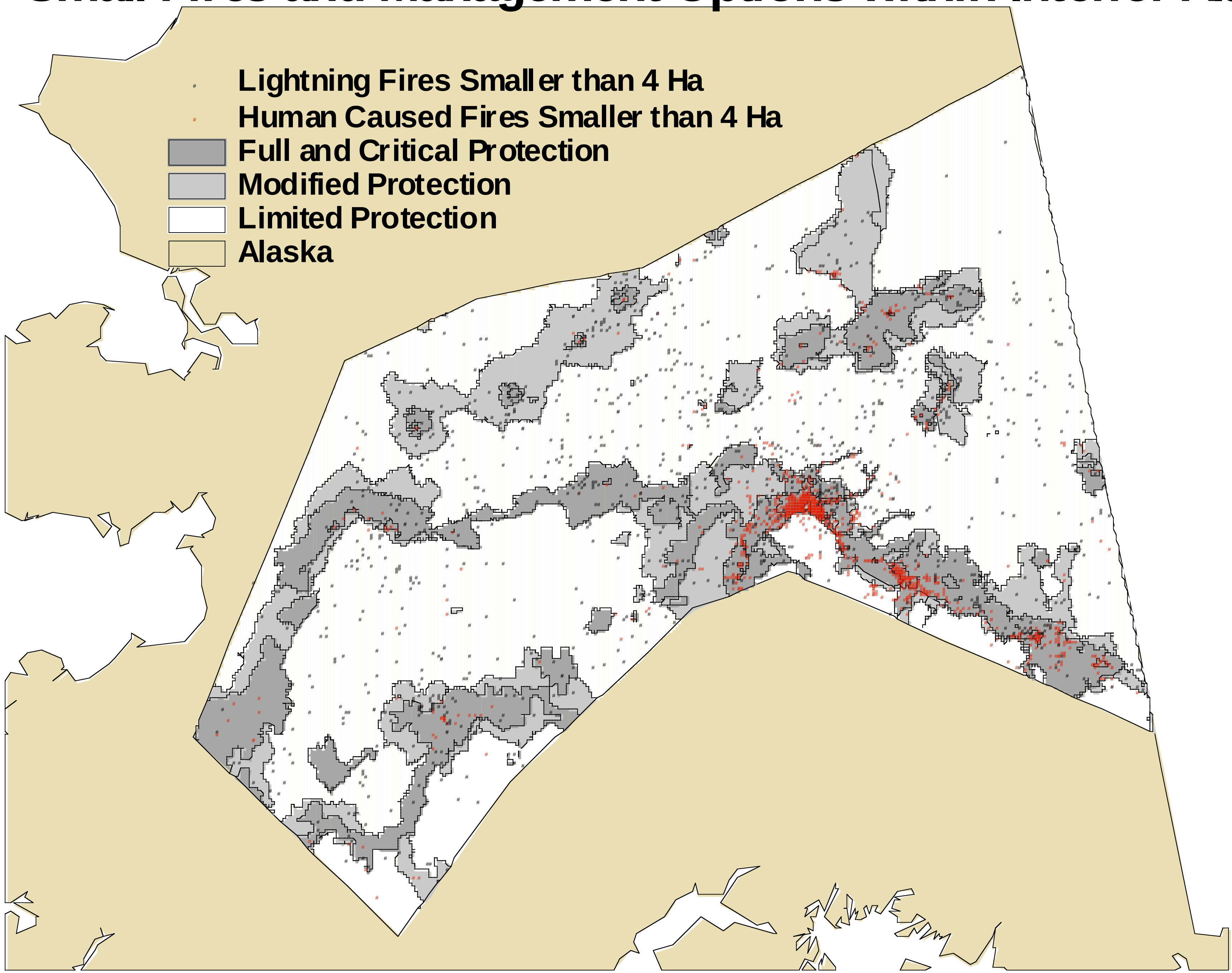
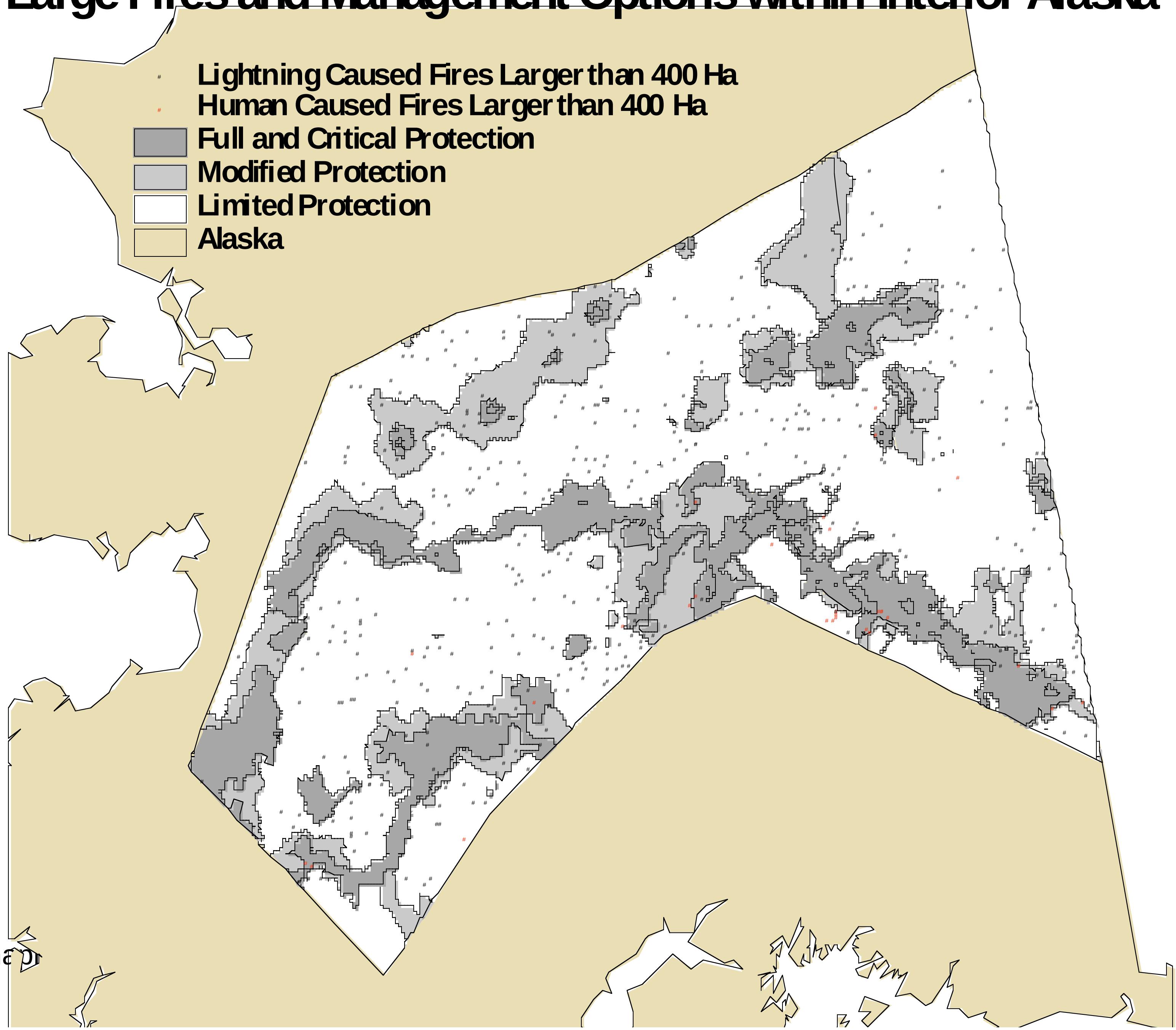
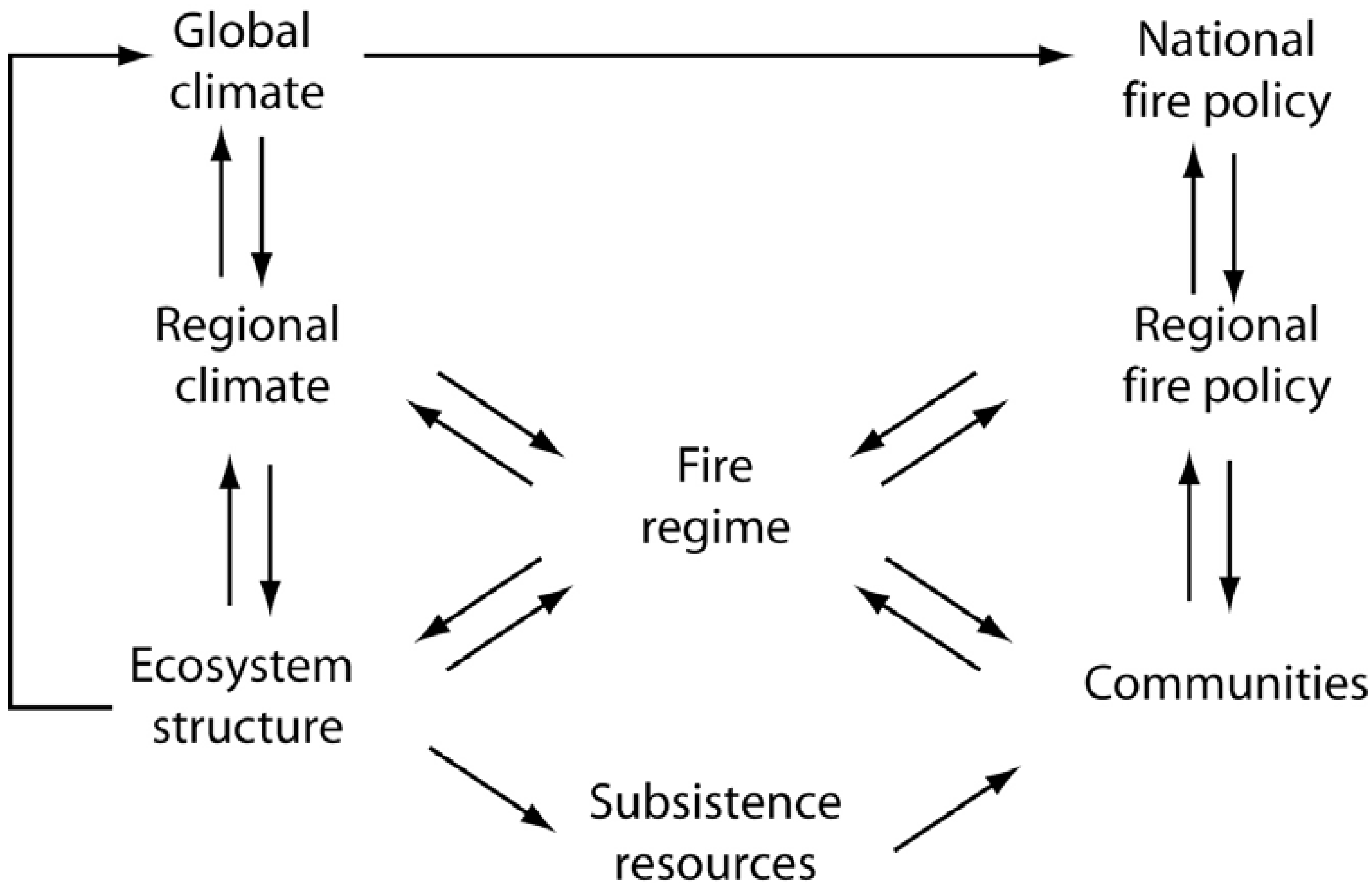
Small Fires and Management Options within Interior Alaska



Large Fires and Management Options within Interior Alaska




Global
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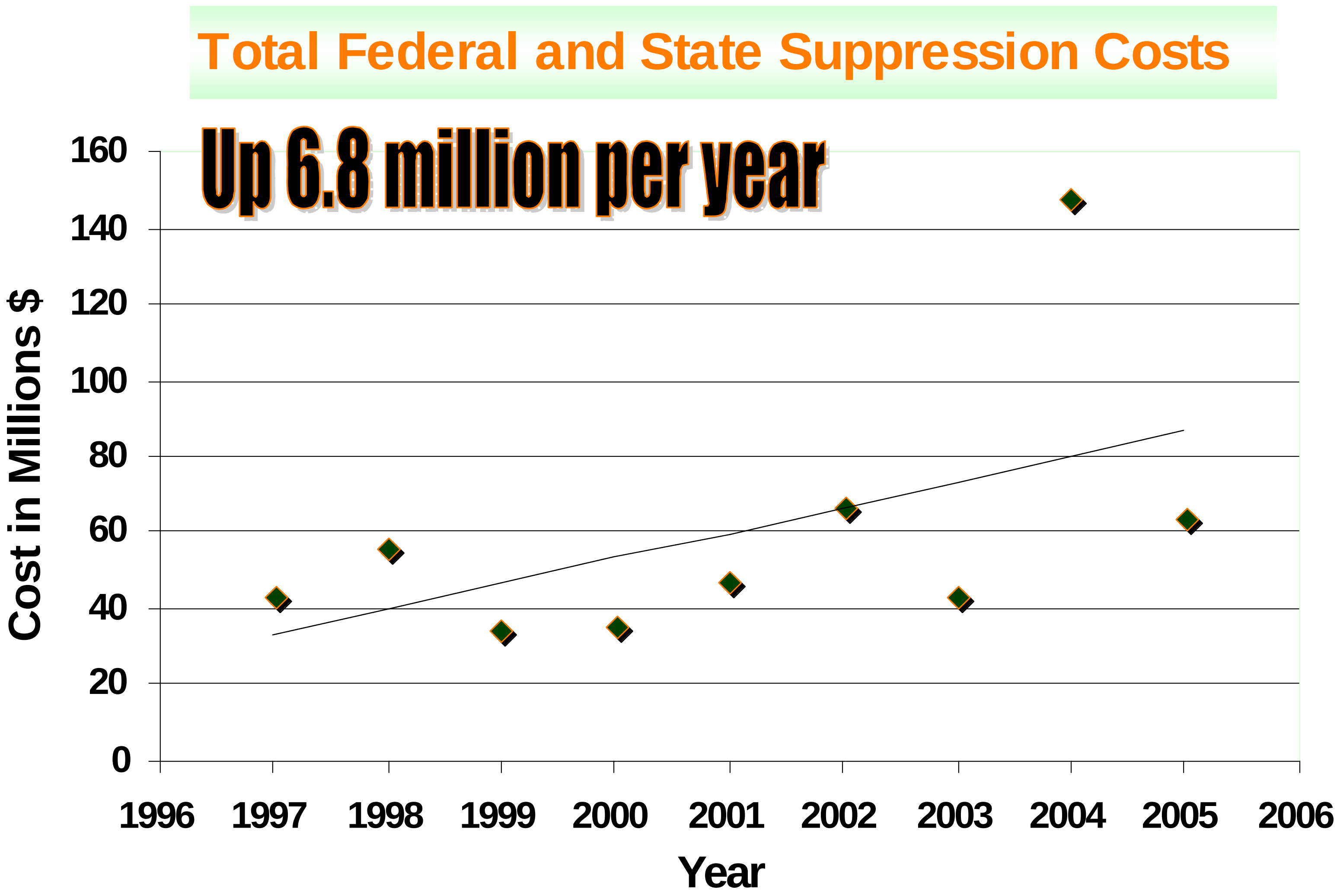

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Key Factors Driving Fire Costs

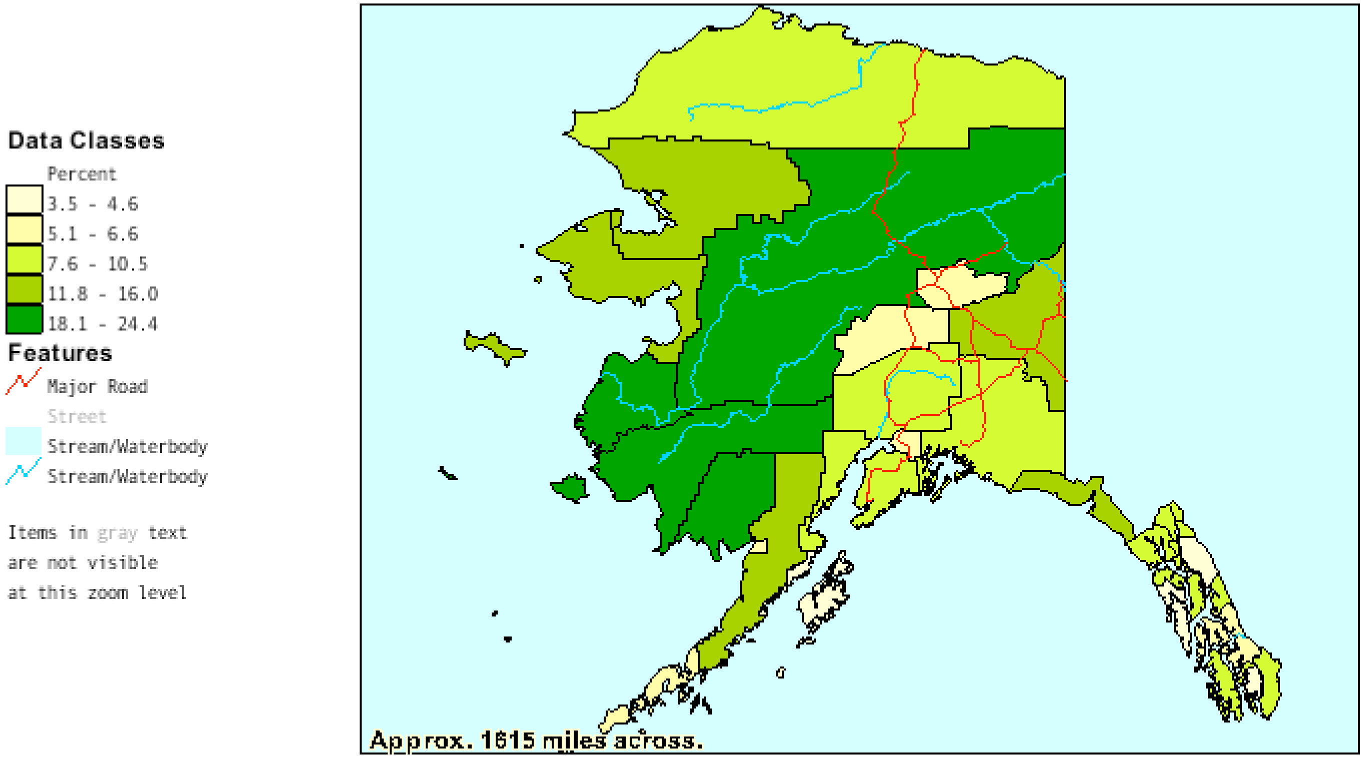
- **Rising human population (30 year doubling time)**
  - **Driven by migration from lower 48**
    - **More human ignitions**
    - **More demand for suppression**

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

- **Increased aircraft use**

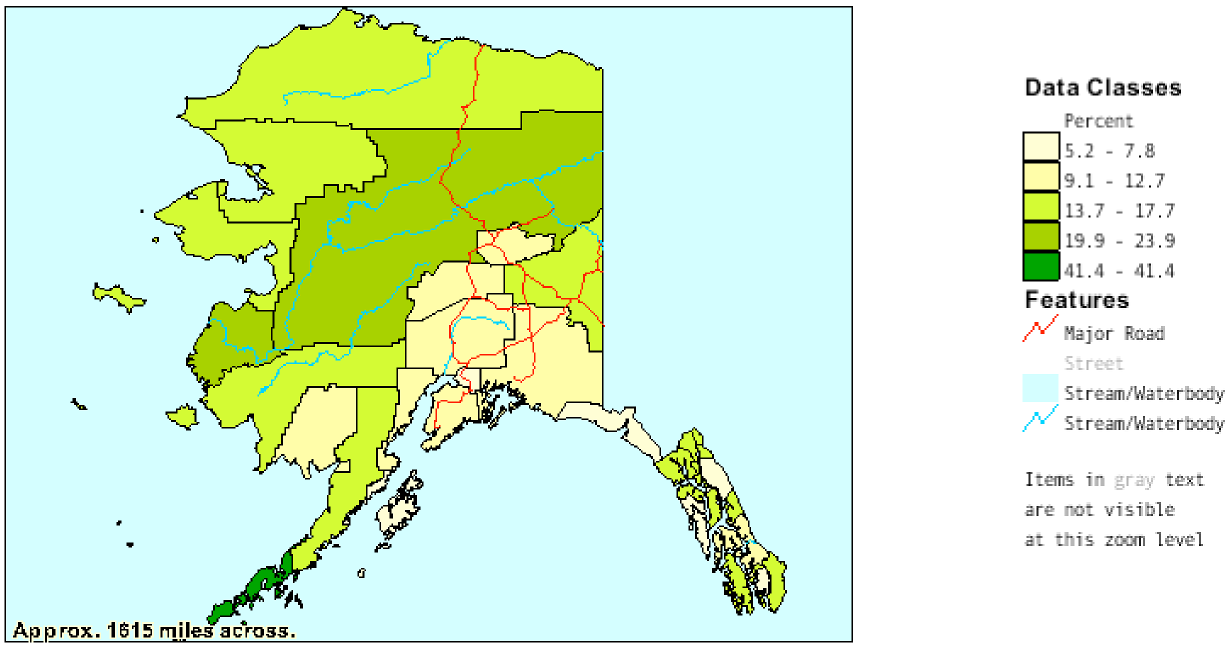
- **Training/Safety Costs**
  - **Driven by fire events in lower 48**

Percent of Families Below the Poverty Level in 1999: 2000



U.S. Census, **TM-P069.**

Percent of Civilian Labor Force That Is Unemployed: 2000



U.S. Census **TM-P049.**

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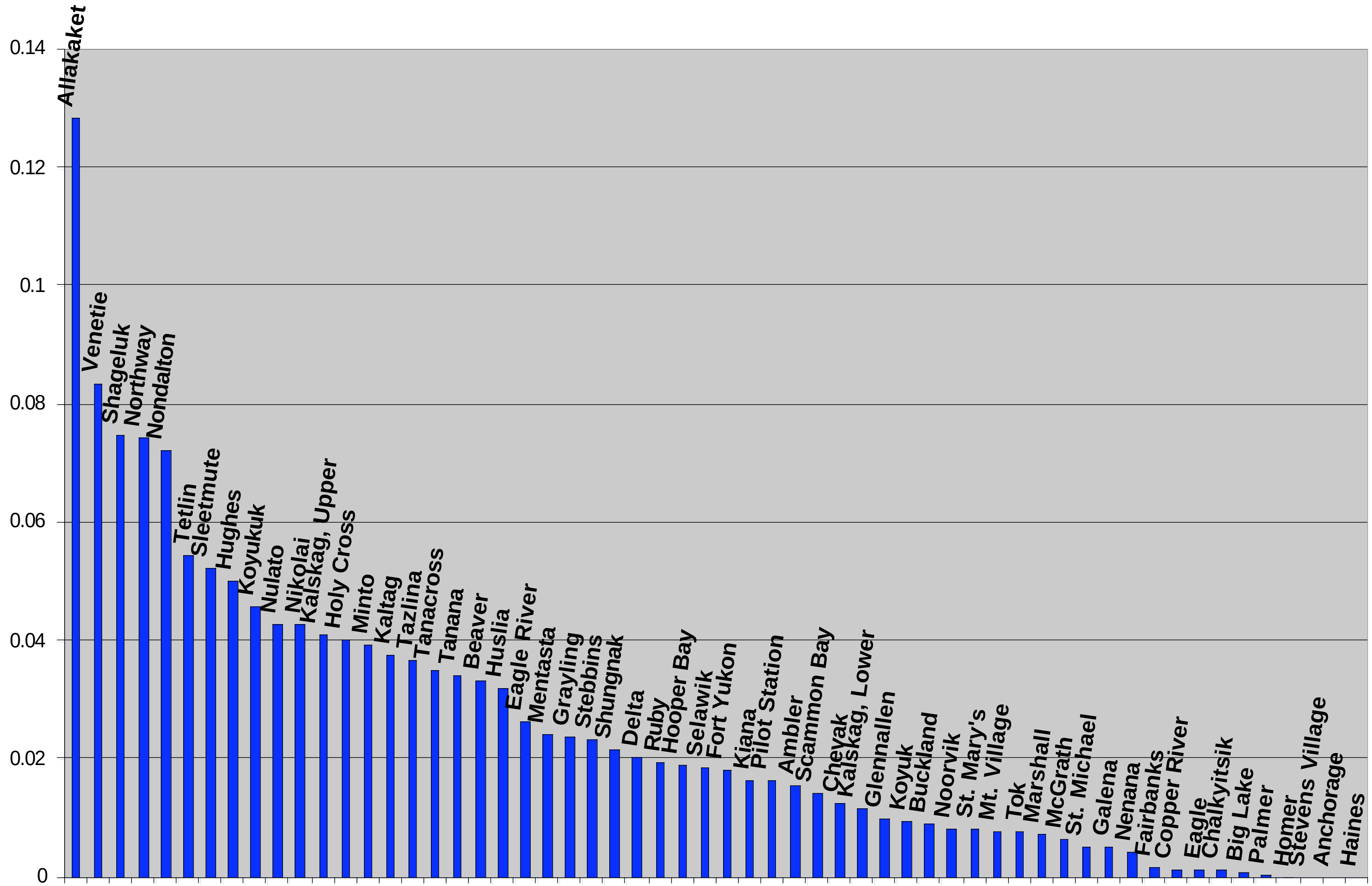
Median EFF Wages 1995-2004 as Percent of Total Village Income (2000 Census)



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

http://fire.ak.blm.gov/unique/photos/f_solstice/5.jpg

Top 10 EFF Earners – Average, 1986-2004

1. Fairbanks	$1,586,842
2. Delta	$ 502,363
3. Tok	$ 333,823
4. Fort Yukon	$ 301,870
5. Hooper Bay	$ 249,265
6. Palmer	$ 220,229
7. Northway	$ 212,442
8. Nulato	$ 202,629
9. Allakaket	$ 180,886
10. Glennallen	$ 168,550

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?

Disturbance type	Most important disturbance (% of sites) #1	#2	#3	
Climate (e.g., floods, drought)	33	28	53	(mostly xeric climates)
Physical (e.g., fire, sedimenta.)	39	22	7	“
Biotic (pests, grazing, invasives)	11	28	20	(mostly mesic climates)
Human (includes eutrophica.)	17	22	20	“

Most important *changes* in disturbance regime

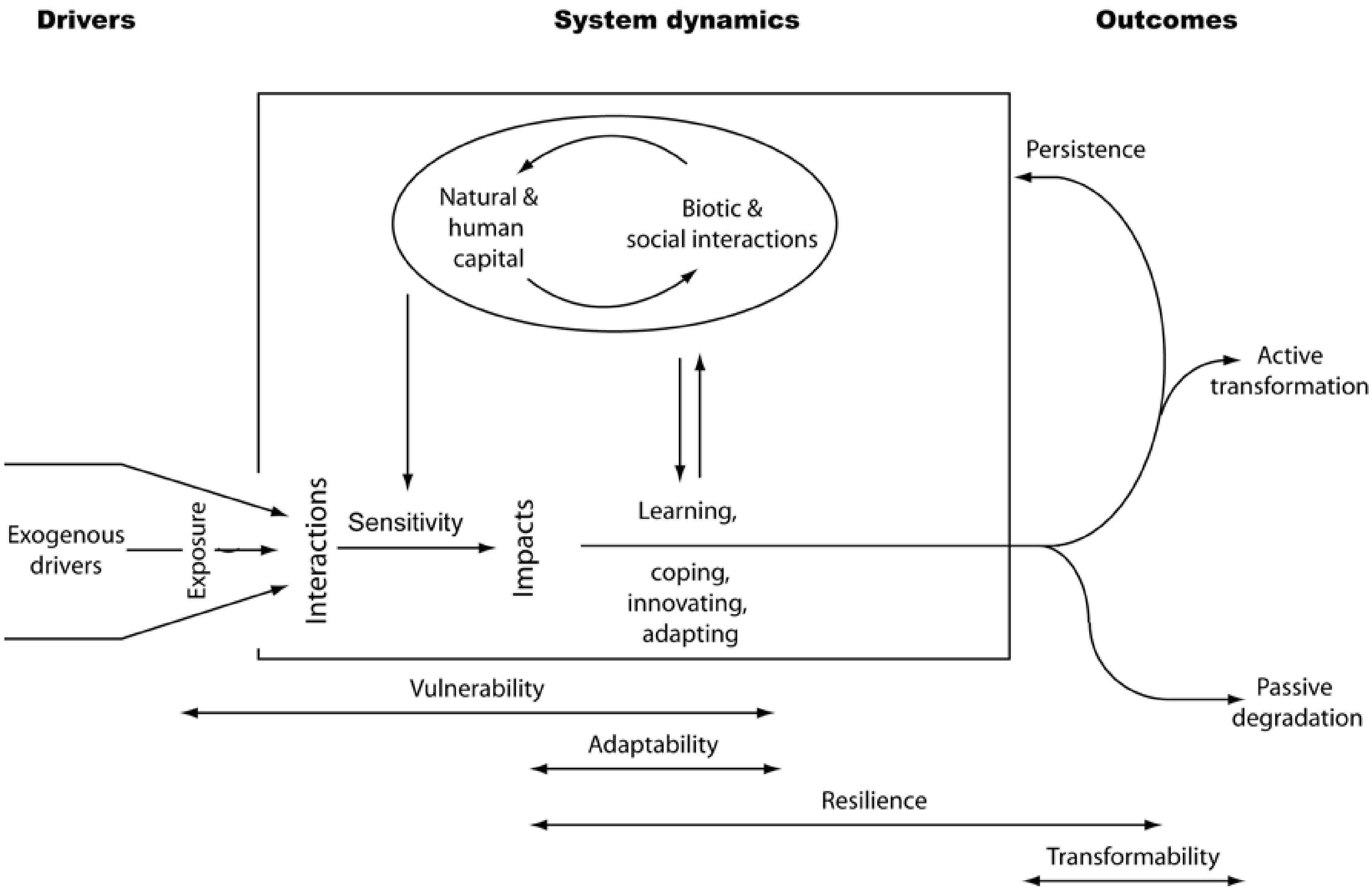
Most important disturbance (% of sites)

	#1	#2	#3
Climate	33	17	40 (mostly xeric sites)
Physical	28	11	20 “
Biotic	11	39	20 (intermediate sites)
Human	28	33	20 (mostly mesic sites)

Presumed cause of change in disturbance (% of sites)

	#1	#2	#3
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



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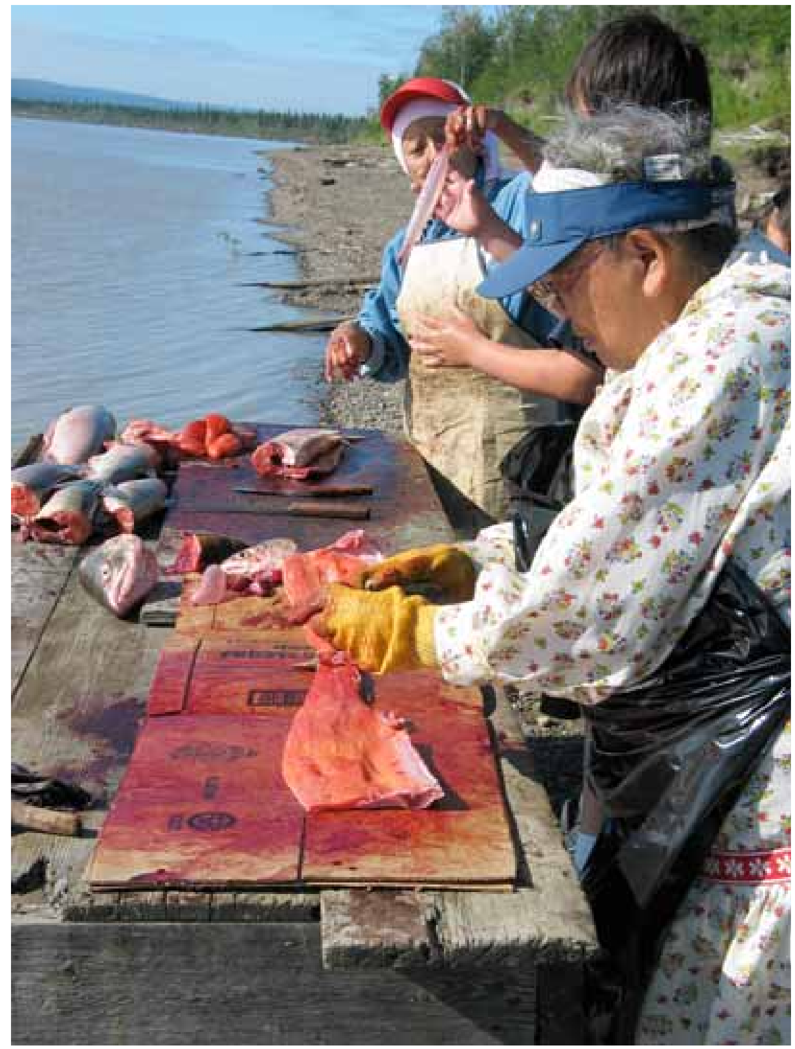
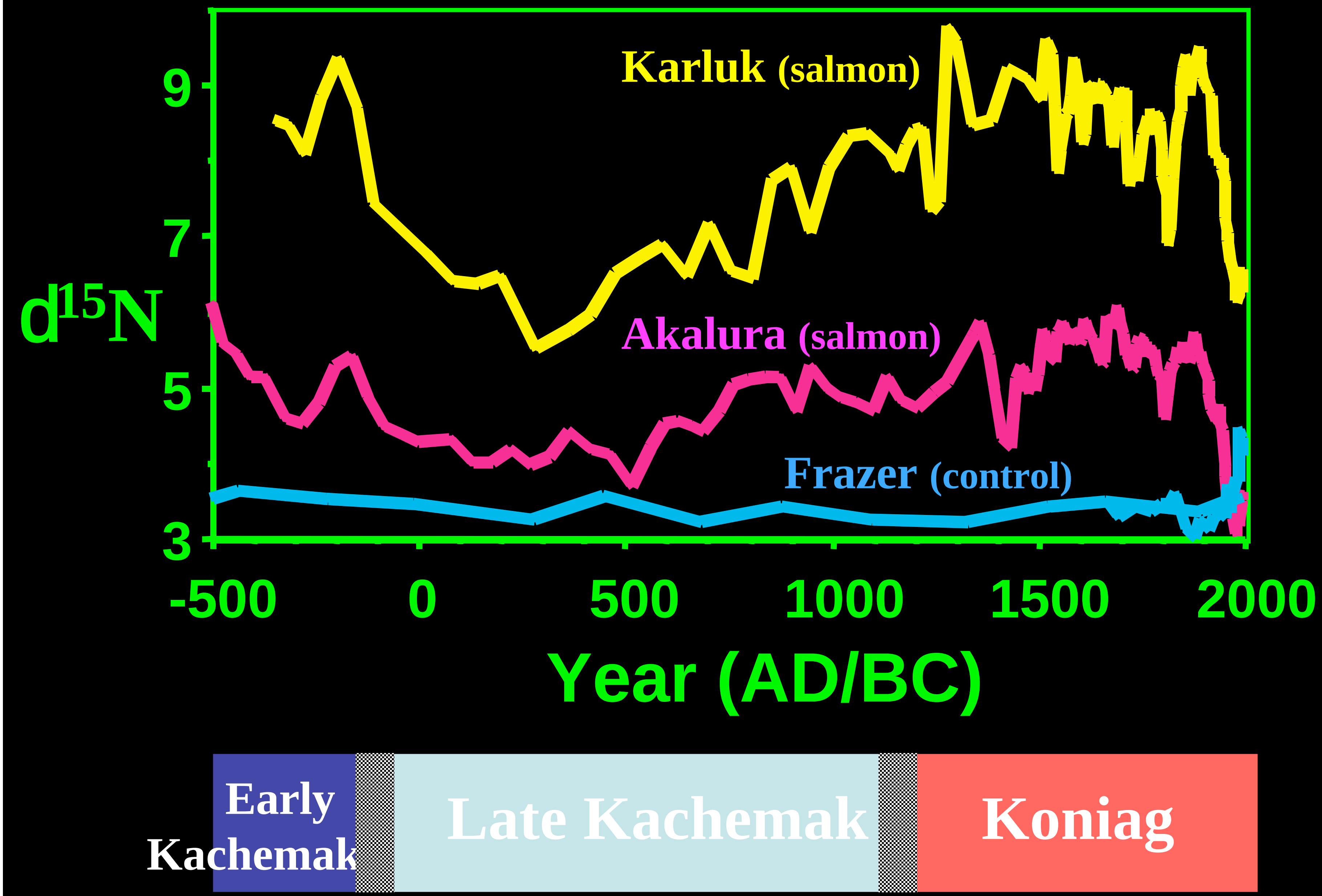
Modified from Chapin et al. 2006

Interior Athabascan culture is tied to salmon

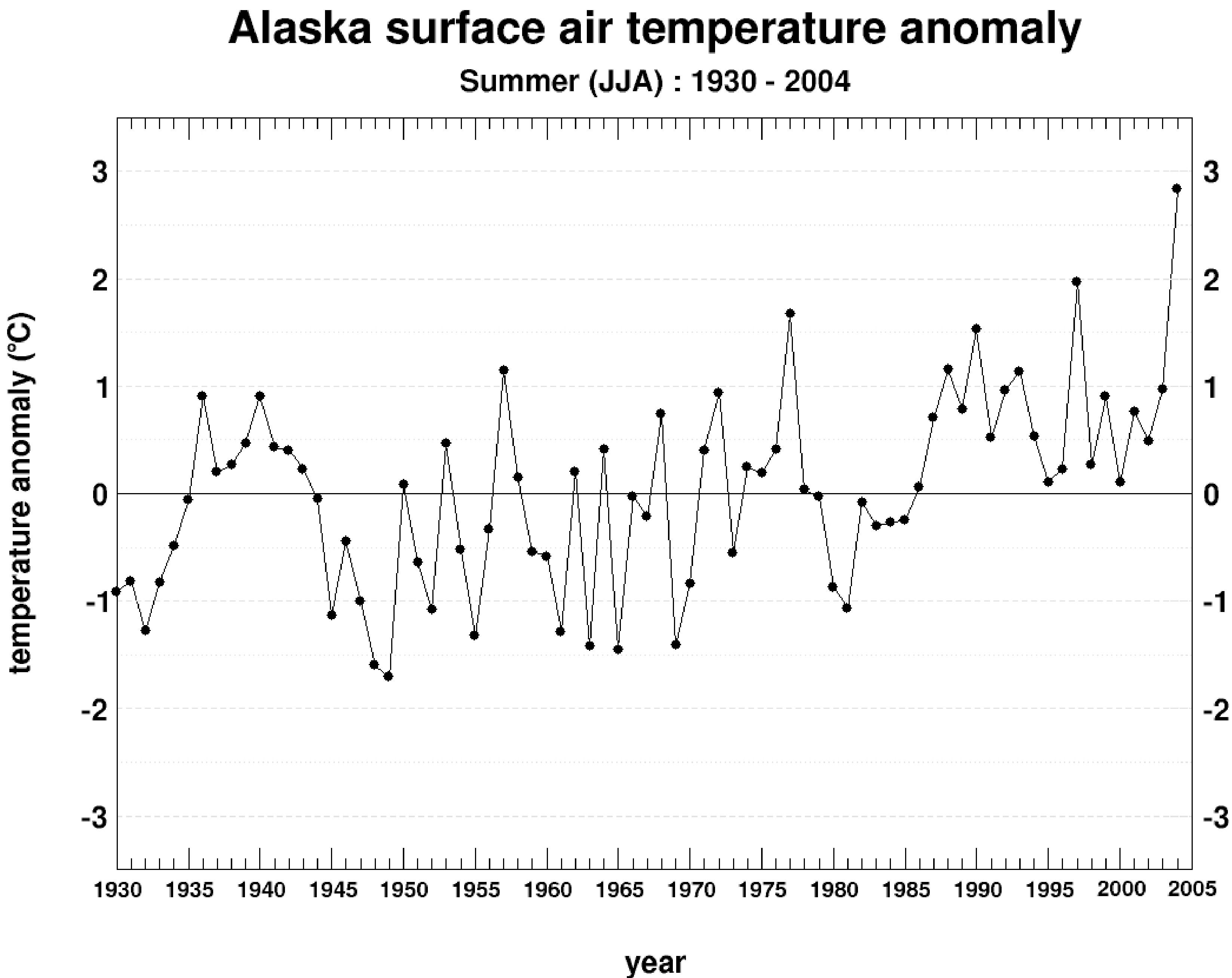


Subsistence now uses modern technology



Kodiak Archeology

Finney et al. (2002)



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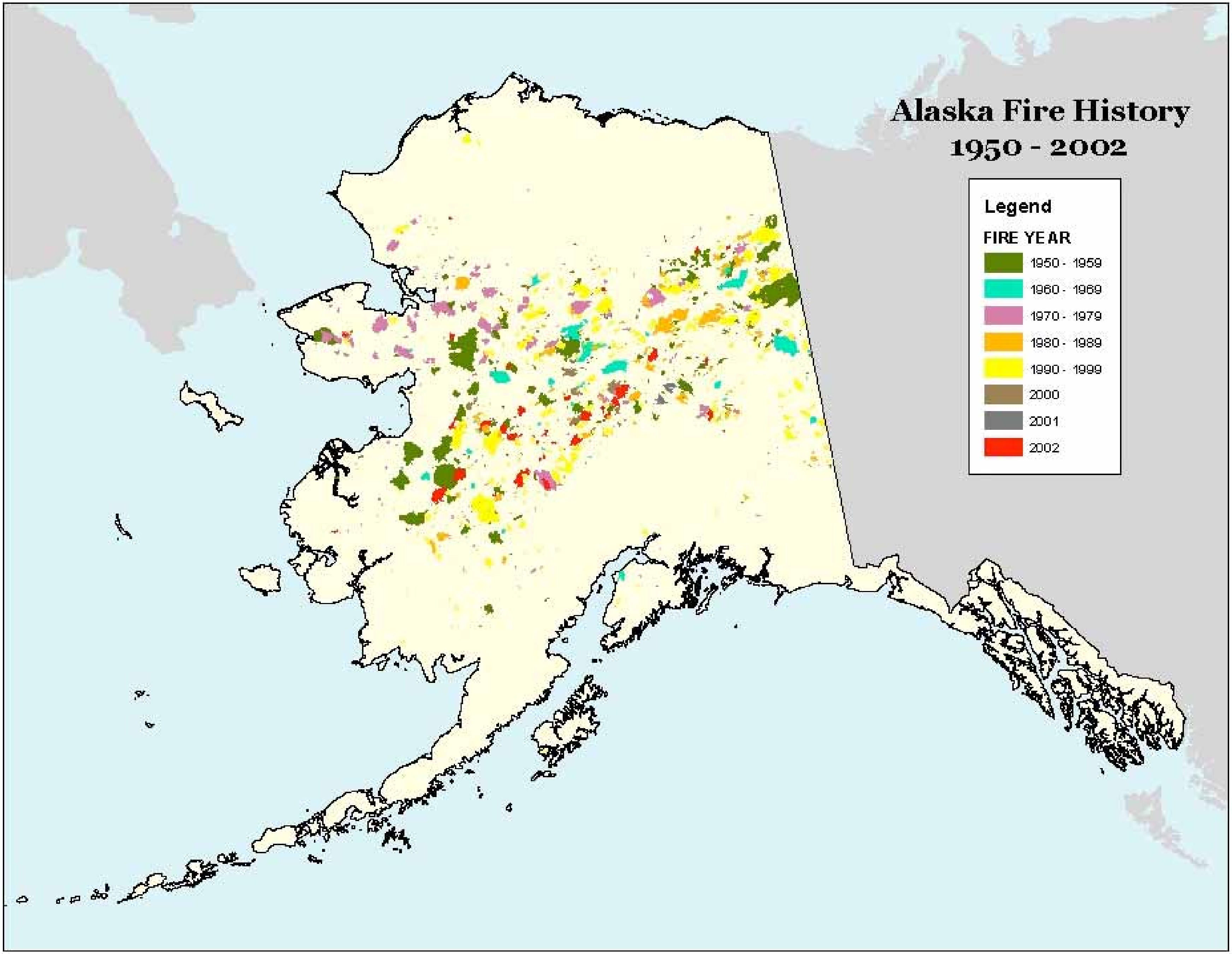
Chapin et al. 2005


Alaska Fire History
1950 - 2002
Legend
FIRE YEAR
1950 - 1959
1960 - 1969
1970 - 1979
1980 - 1989
1990 - 1999
2000
2001
2002

Today’s Tanana Floodplain

Tomorrow’s Tanana Floodplain?

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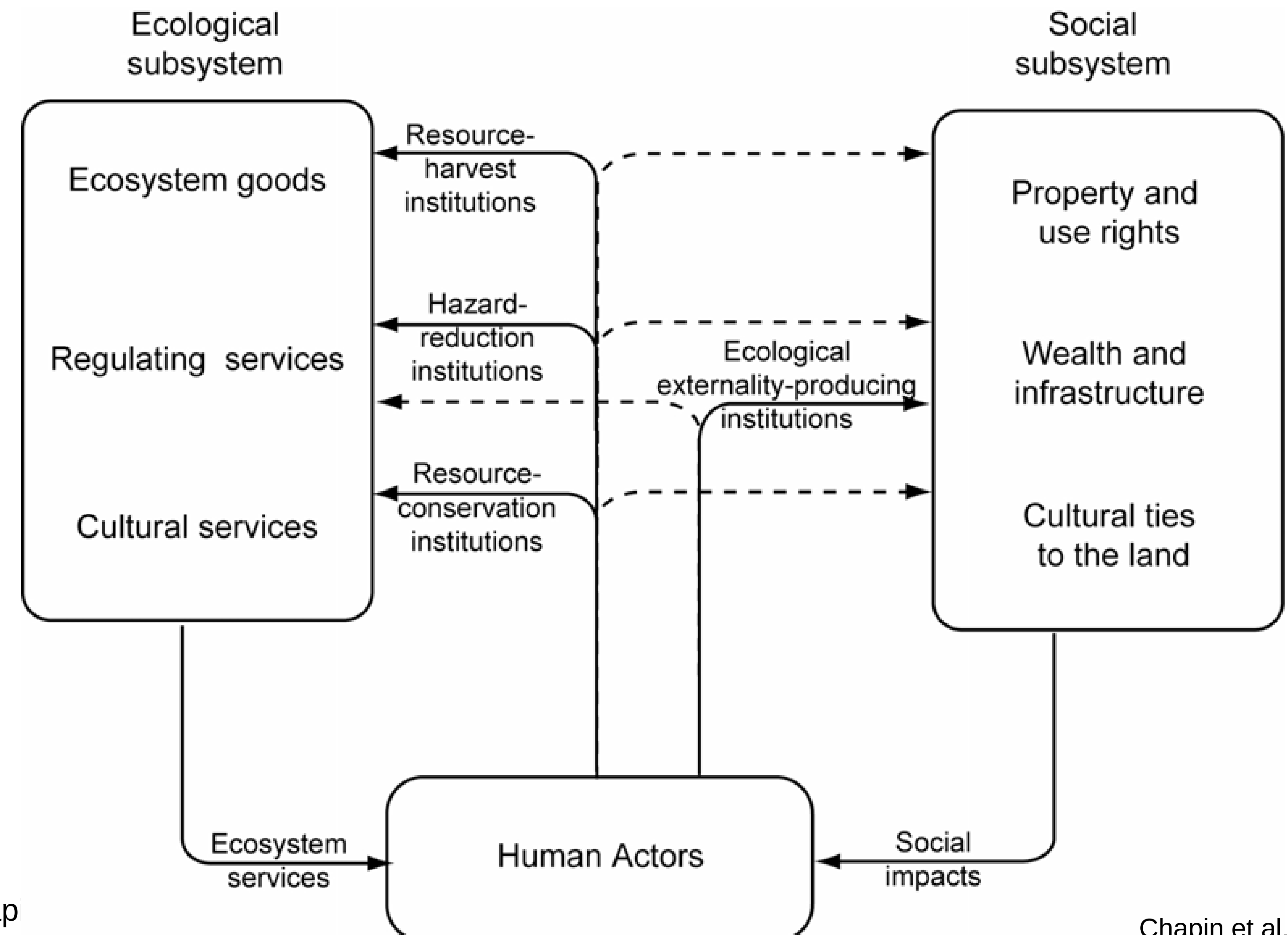
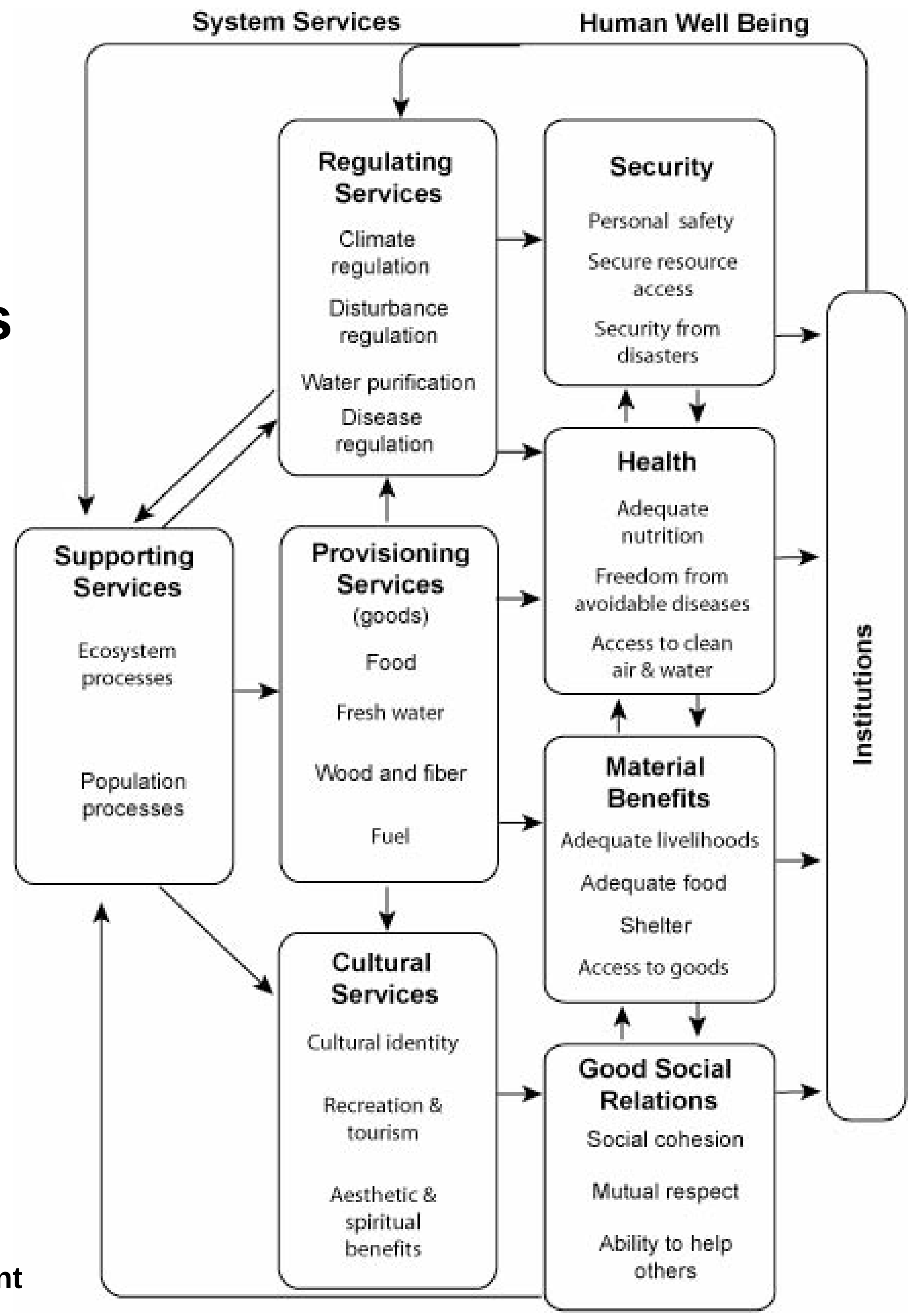
Ecological Institutions:
Their response to warming

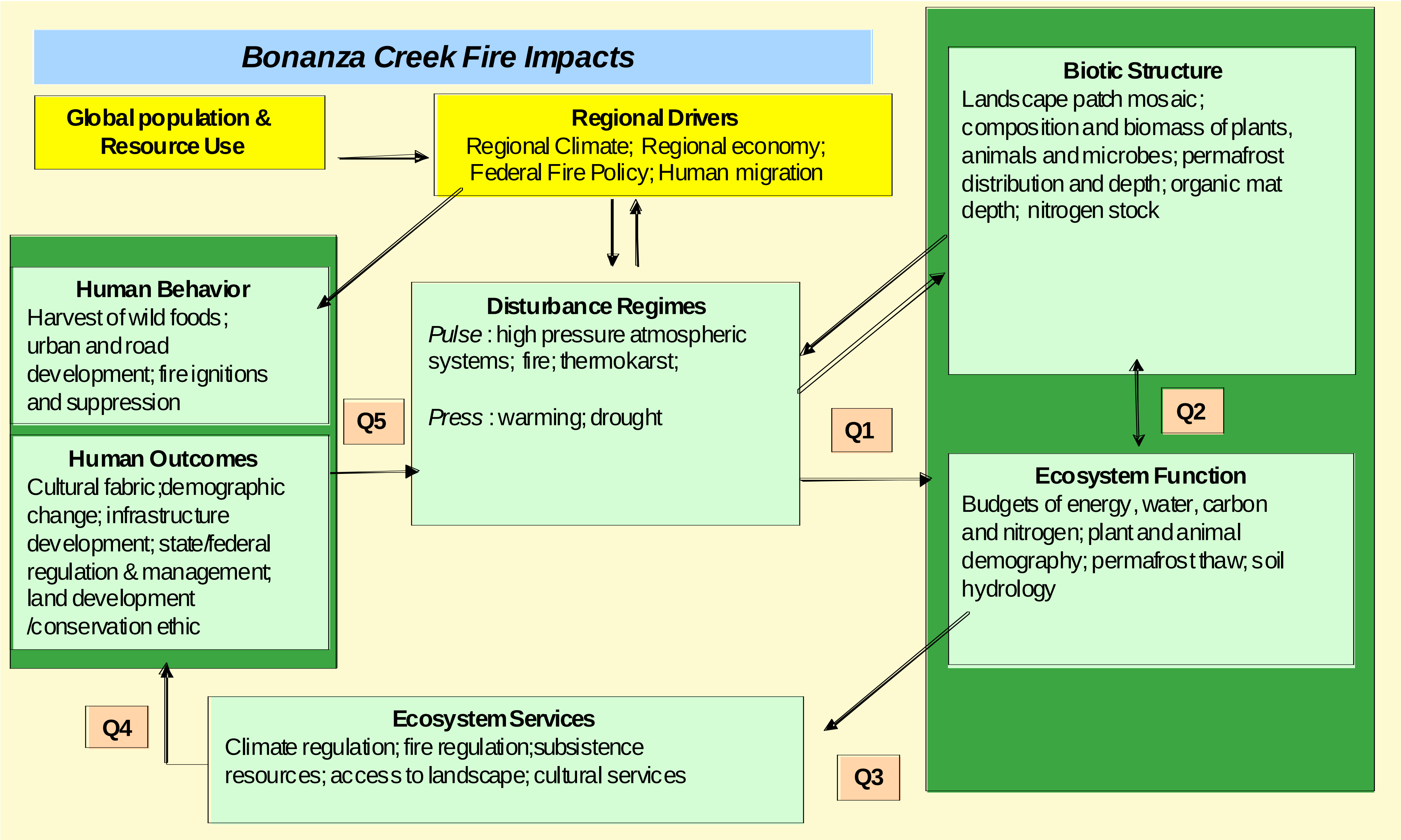


Chapin et al. 2006

Ecosystem services define societal impacts of climate warming



Adapted from Millennium Ecosystem Assessment



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