Long-Term Ecological Research (LTER): Lessons from Alaskan Sites and the National Network

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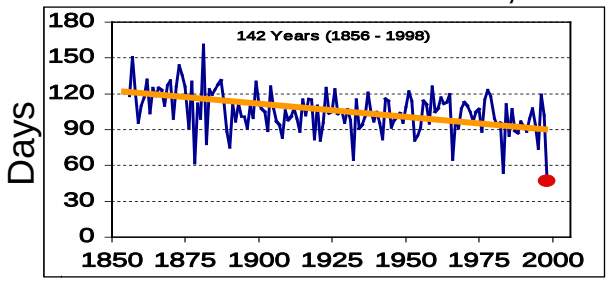
Long-term research is required to reveal:

- Slow processes or transients

Lake Mendota Ice Cover, NTL



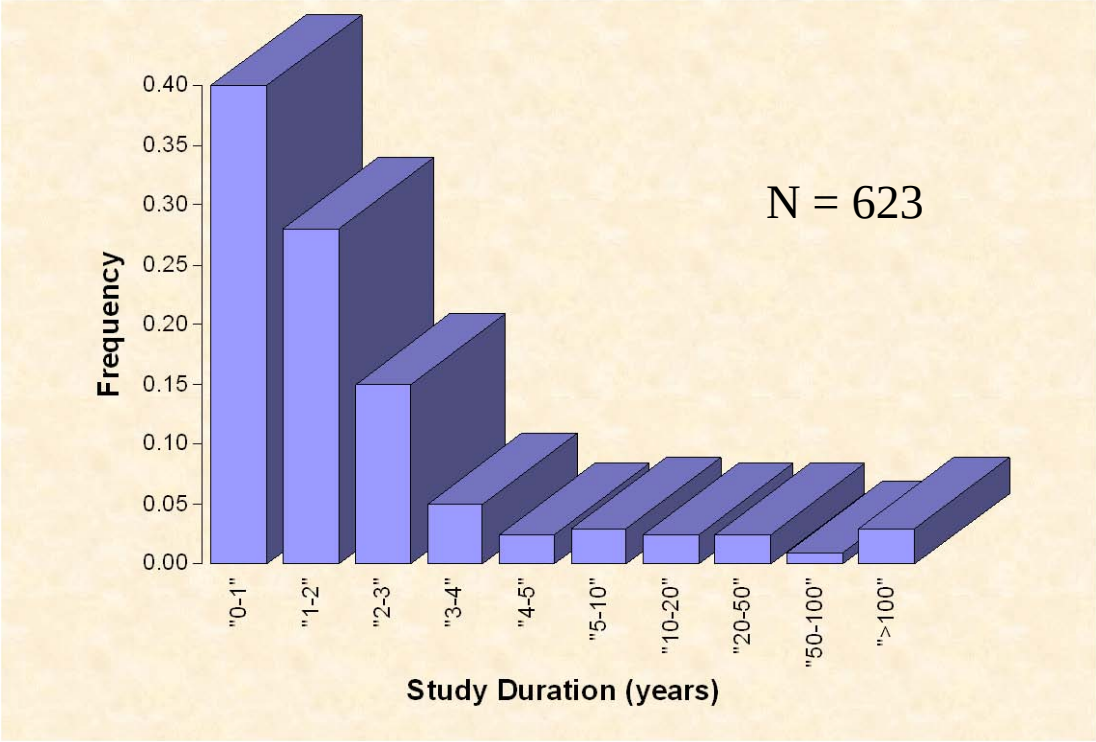
- Episodic or infrequent events
- Trends

Exotic invasives, KBS

- Multi-factor responses
- Processes with major time lags

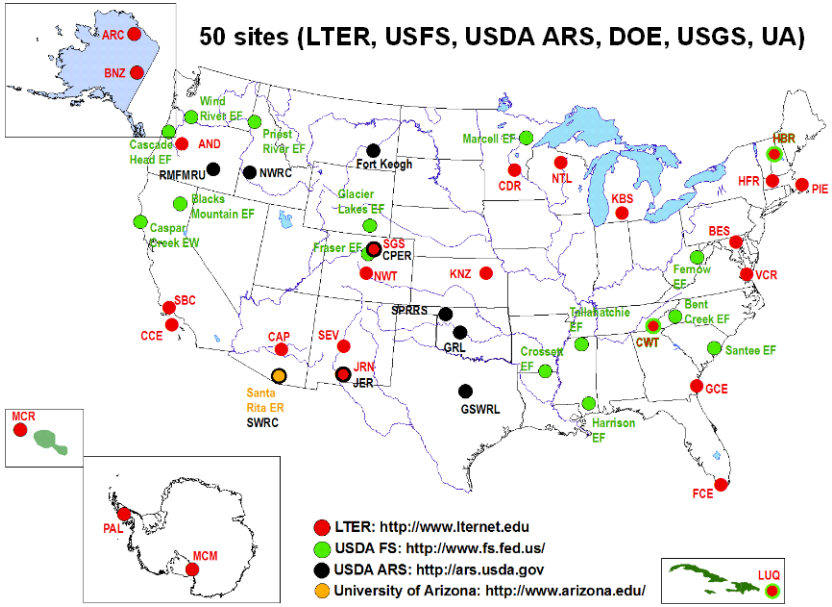
What are the challenges?

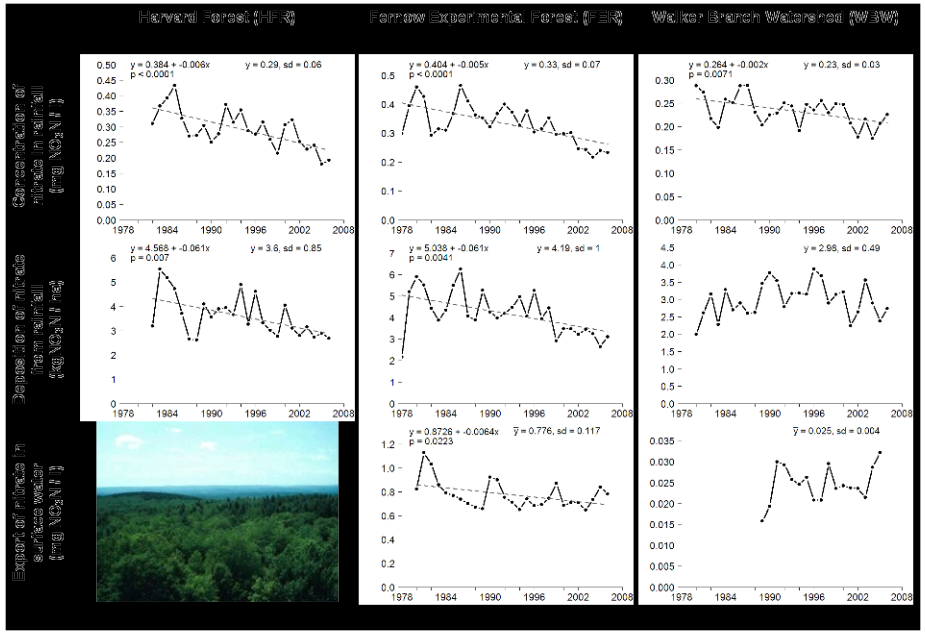
Long-term research generally requires change in the way studies are conducted and funded



Connectivity is a key issue for understanding change

Need networks of sites collecting similar information





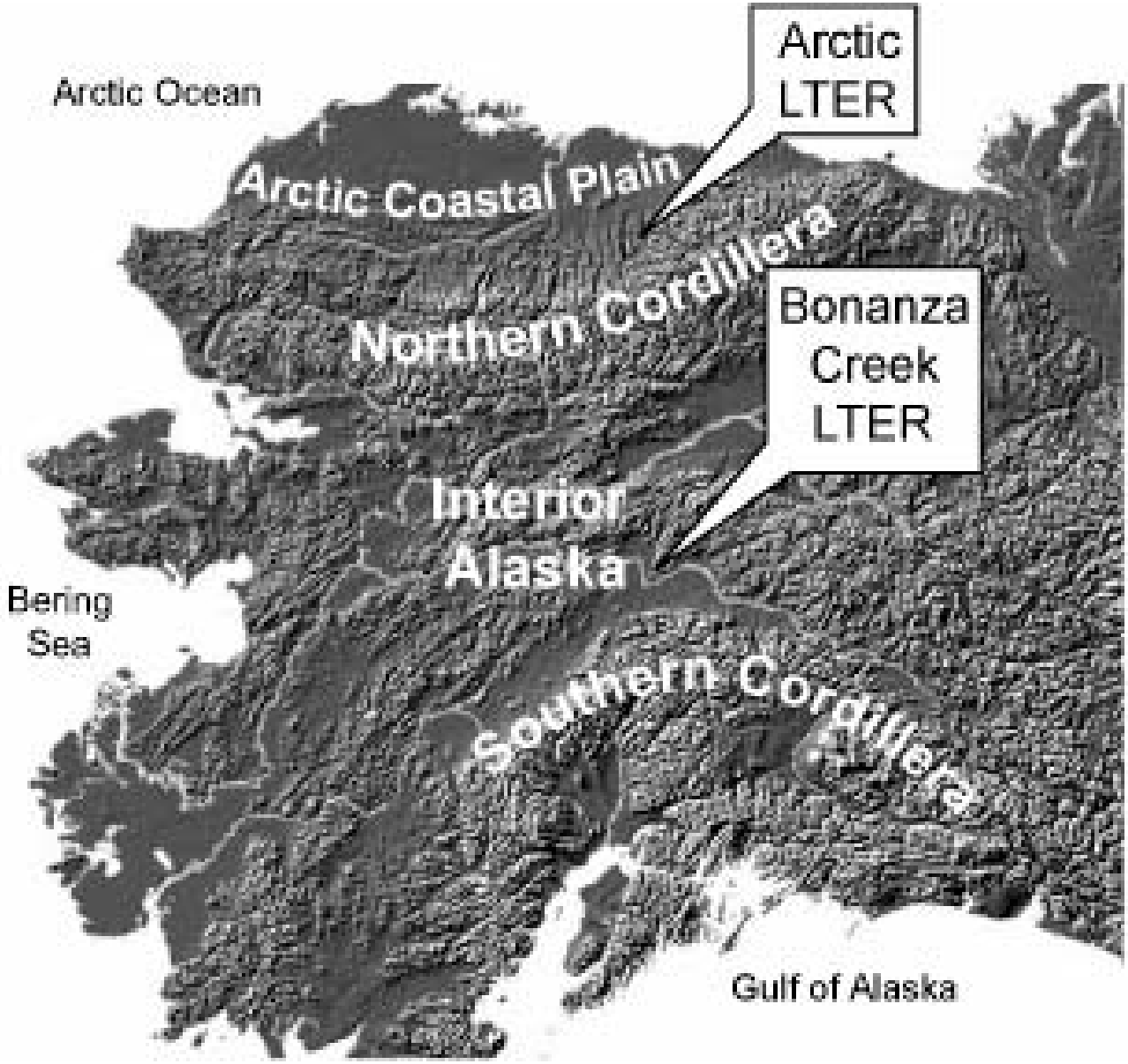
http://www.ecotrends.info

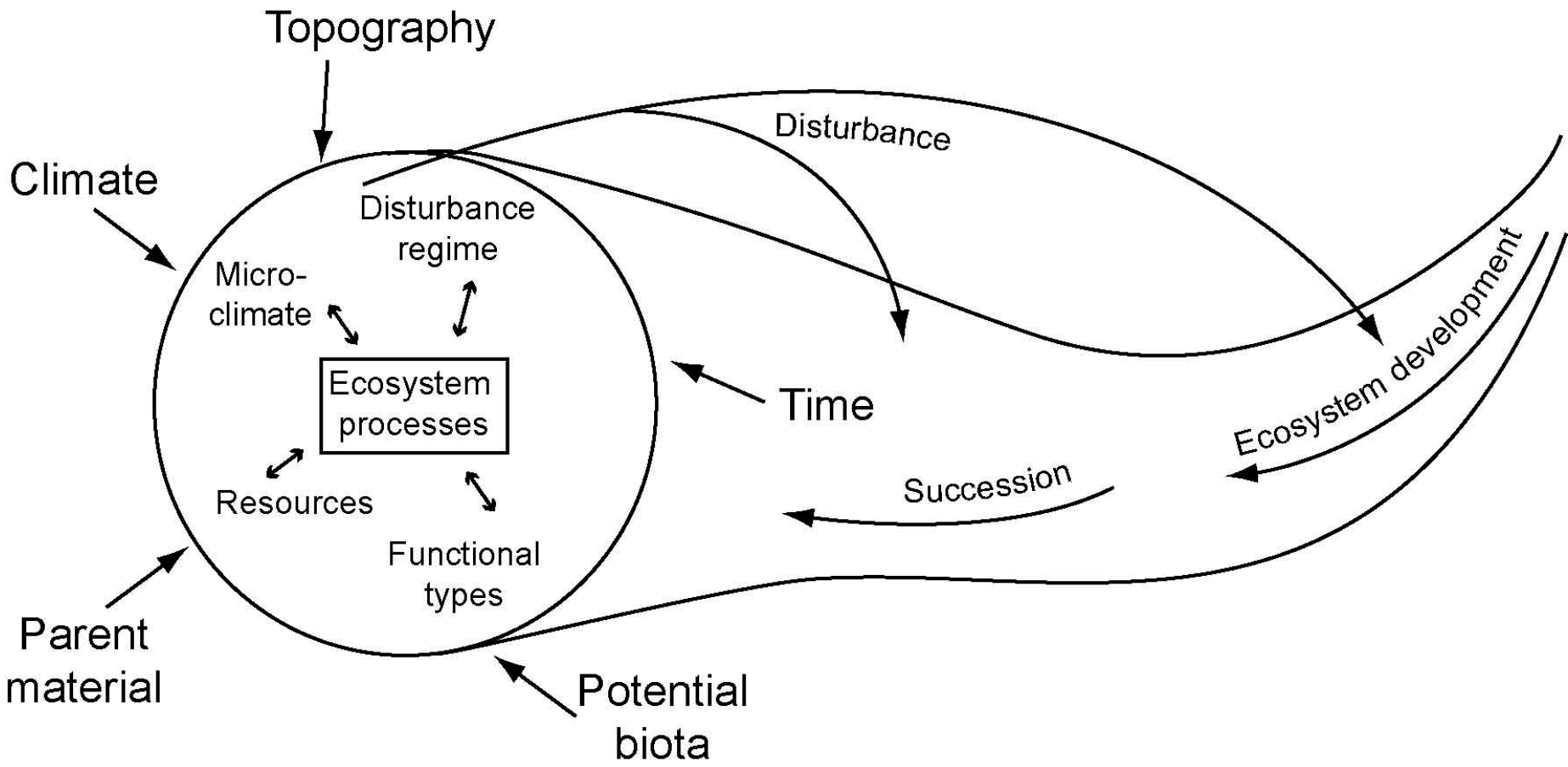
What disturbances are most important in LTER sites?

- Most important disturbance types (% of sites)
  - Influence on structure/function (i.e., supporting services)
  - Over time scales of decades to centuries

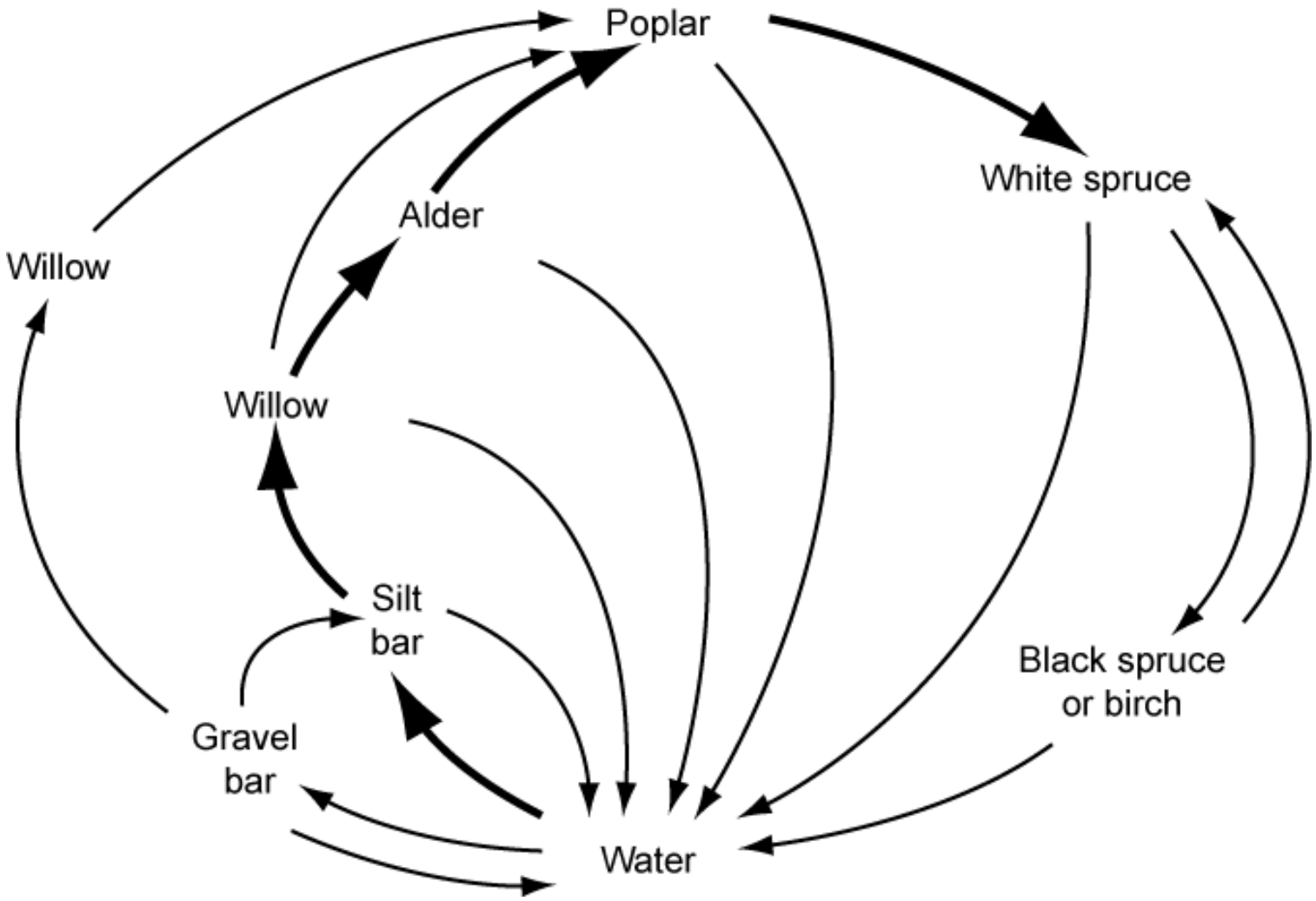
Disturbance type	(%of sites)
Climate (e.g., floods, drought)	33
Physical (e.g., fire, sedimenta.)	39
Biotic (pests, grazing, invasives)	11
Human (includes eutrophica.)	17

- Climatic and physical disturbances predominate in xeric sites; biotic and human disturbances in mesic sites

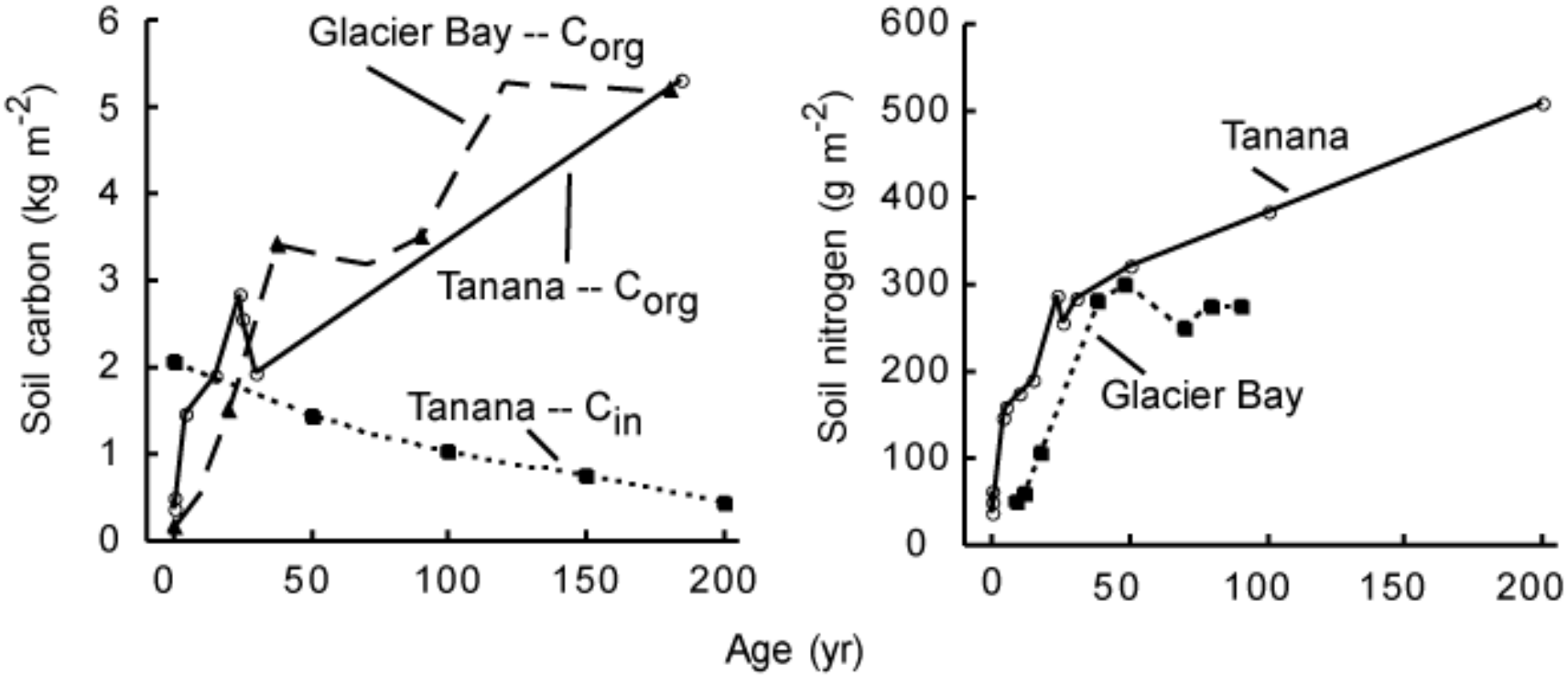

Arctic Ocean
Arctic LTER
Arctic Coastal Plain
Northern Cordillera
Bonanza Creek LTER
Interior Alaska
Bering Sea
Southern Cordillera
Gulf of Alaska

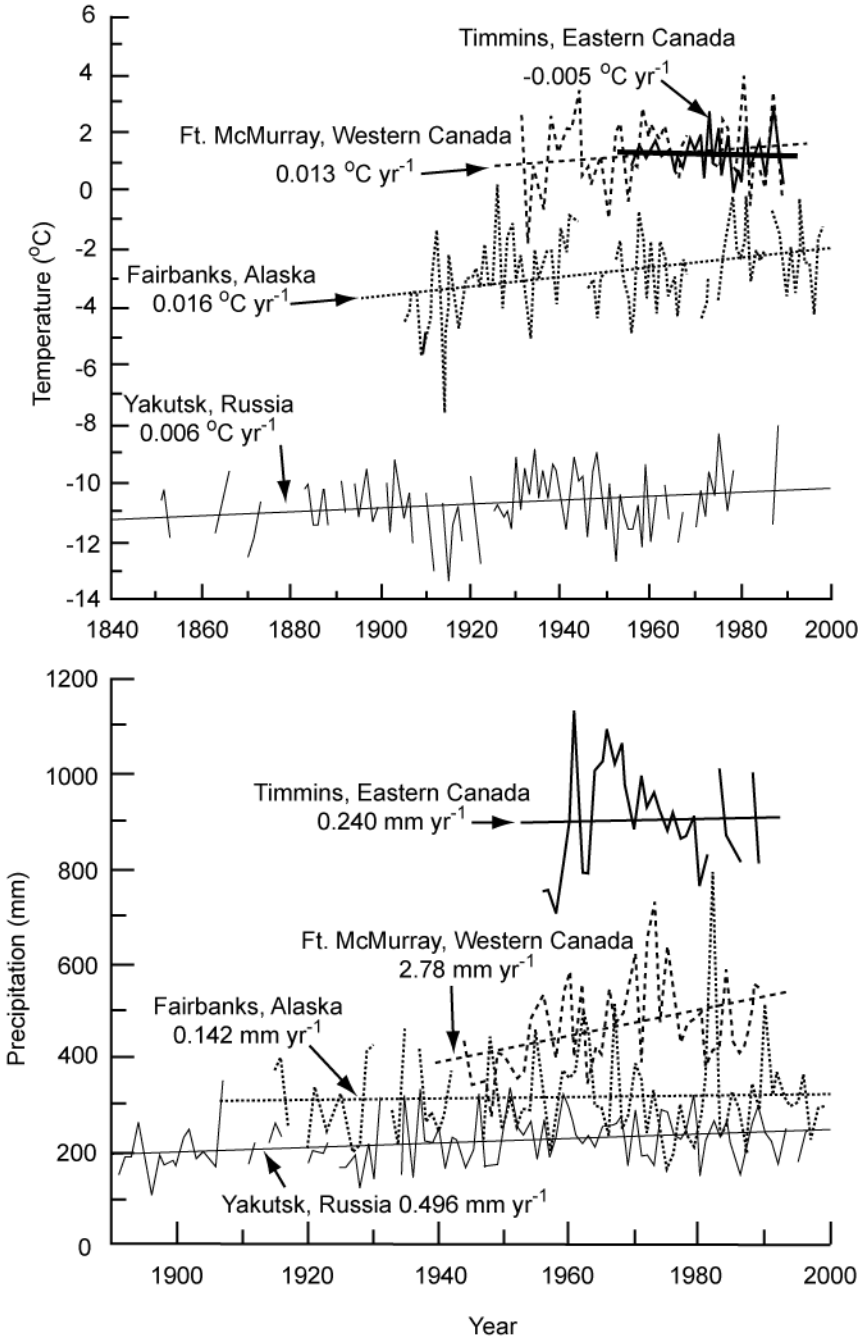

Topography
Climate
Disturbance
Disturbance regime
Micro-climate
Ecosystem processes
Resources
Functional types
Time
Succession
Ecosystem development
Parent material
Potential biota

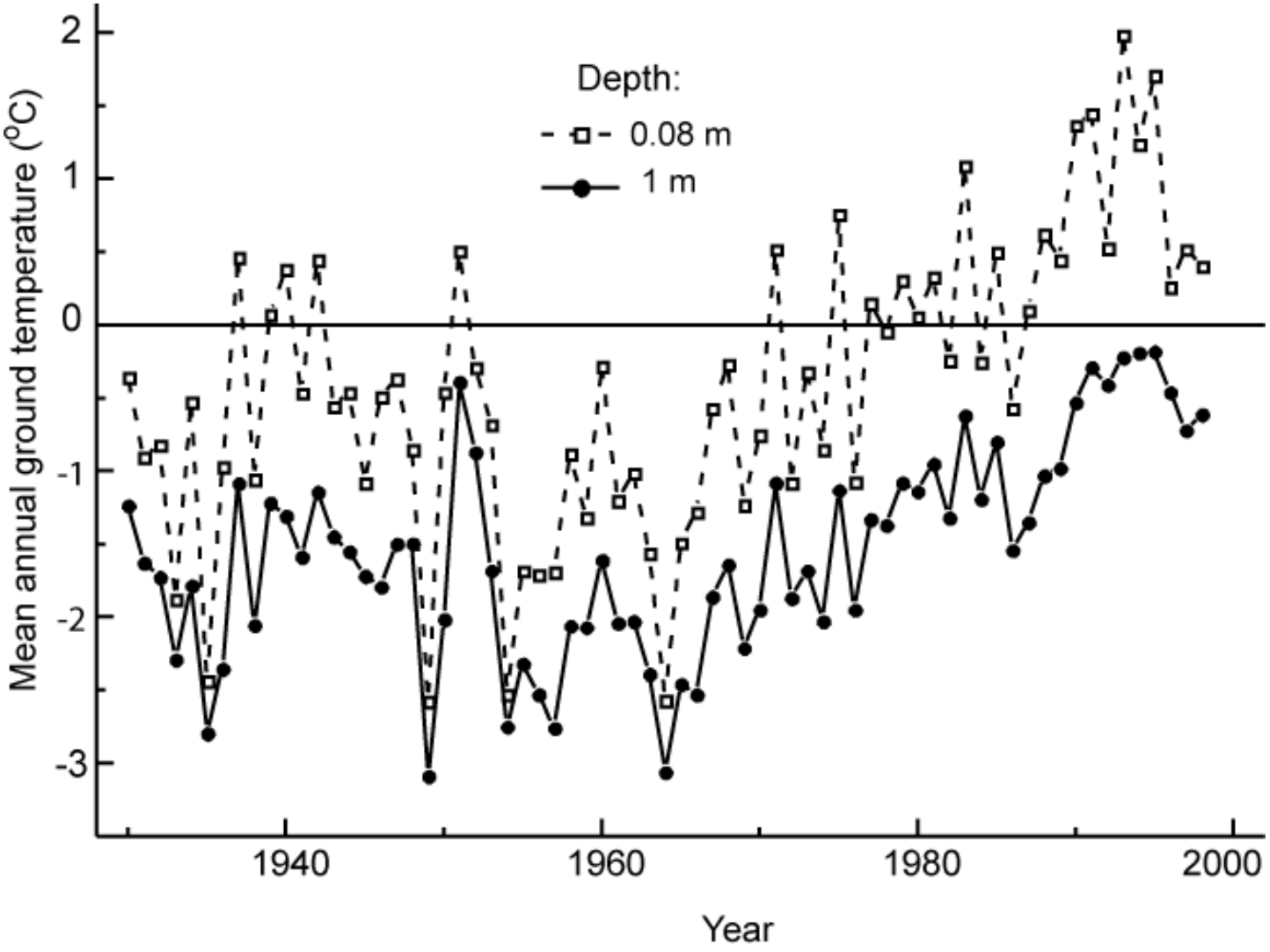
Our views of succession have changed

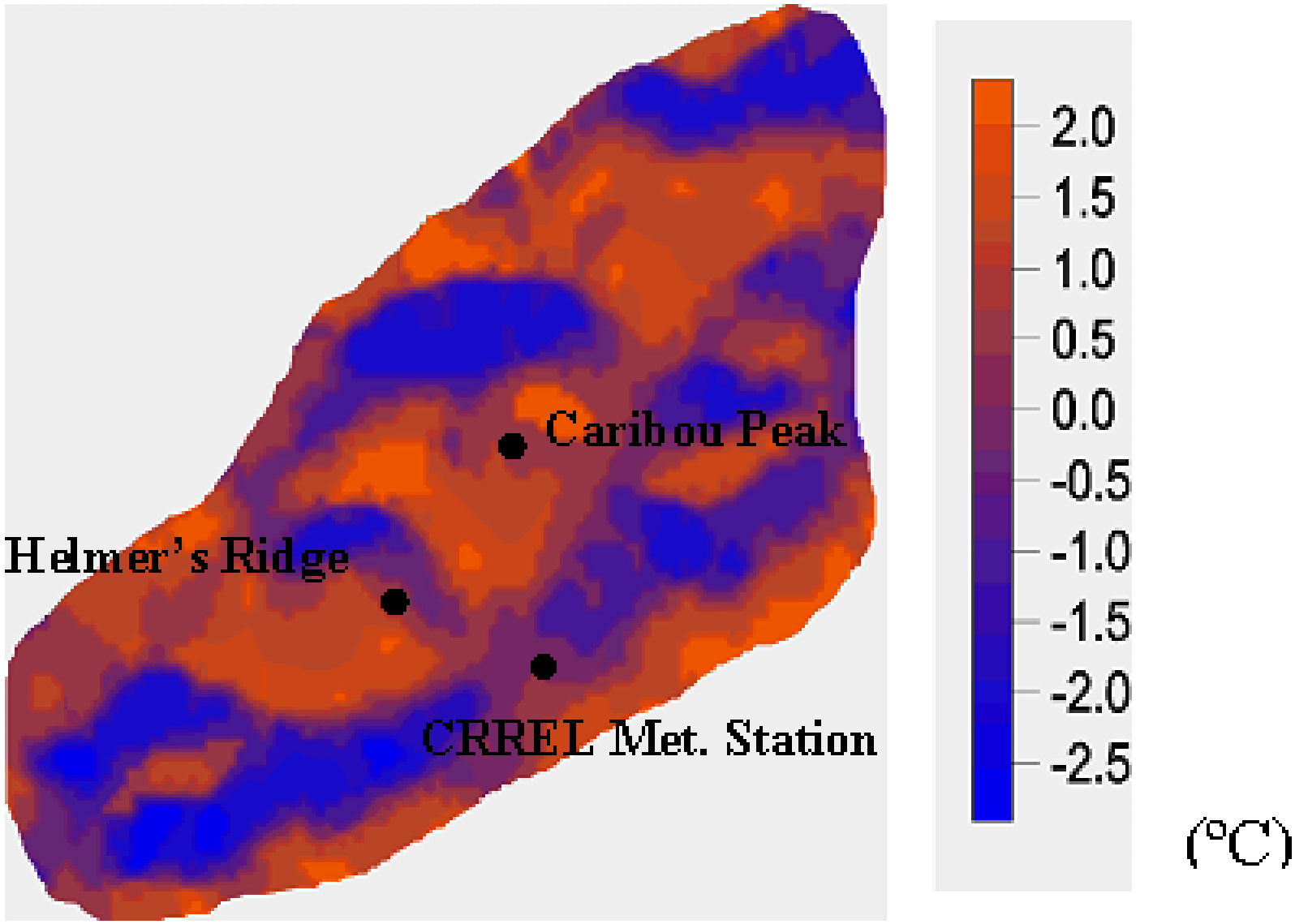


Carbon sequestration

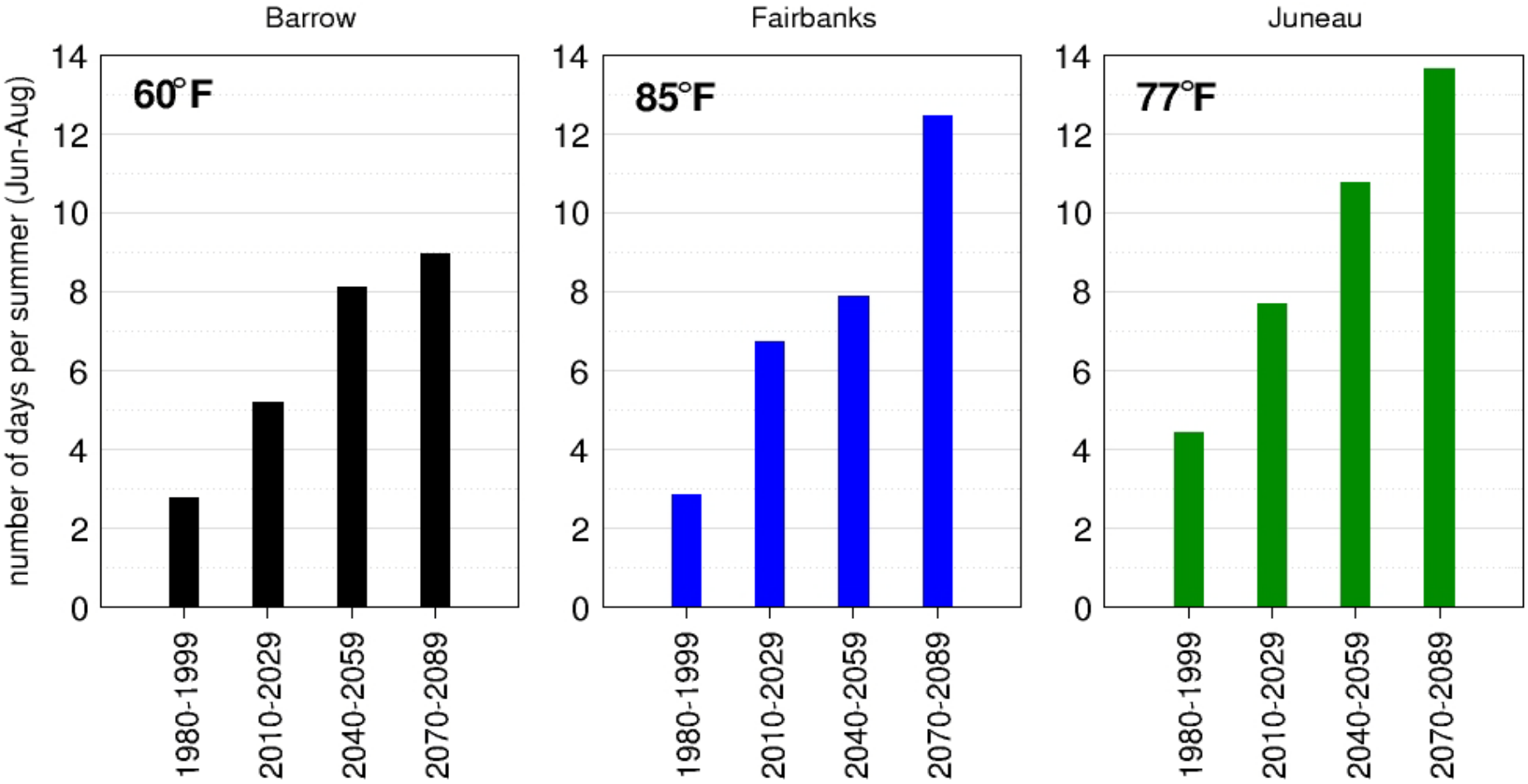



Timmins, Eastern Canada
-0.005 °C yr-1
Ft. McMurray, Western Canada
0.013 °C yr-1
Fairbanks, Alaska
0.016 °C yr-1
Yakutsk, Russia
0.006 °C yr-1
Temperature (°C)
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
1840
1860
1880
1900
1920
1940
1960
1980
2000
Timmins, Eastern Canada
0.240 mm yr-1
Ft. McMurray, Western Canada
2.78 mm yr-1
Fairbanks, Alaska
0.142 mm yr-1
Yakutsk, Russia 0.496 mm yr-1
Precipitation (mm)
1200
1000
800
600
400
200
0
1900
1920
1940
1960
1980
2000
Year


Depth:
0.08 m
1 m
Mean annual ground temperature (°C)
2
1
0
-1
-2
-3
1940
1960
1980
2000
Year

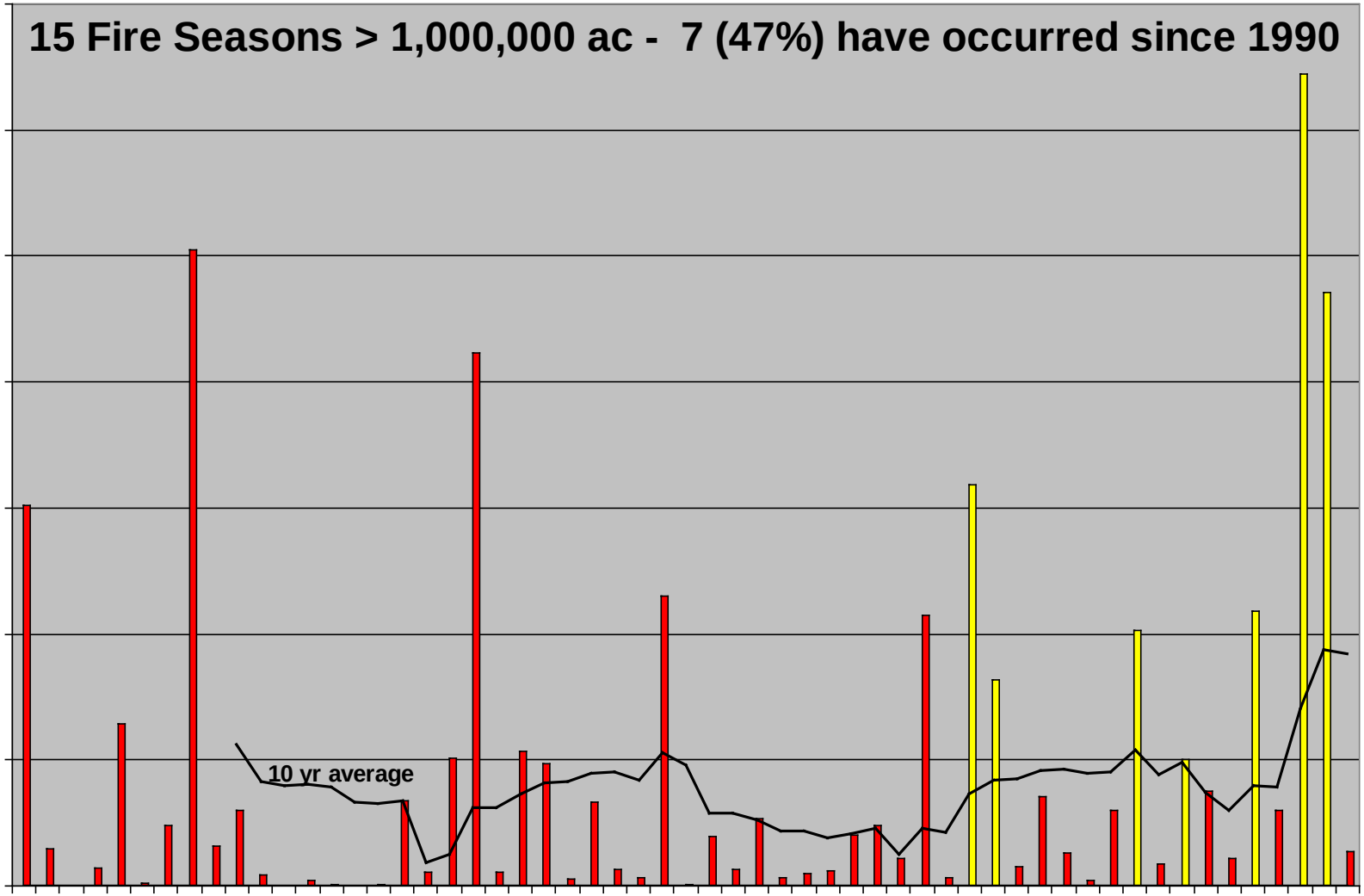

Caribou Peak
Helmer's Ridge
CRREL Met. Station
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
(°C)

Number of hot summer days in the future

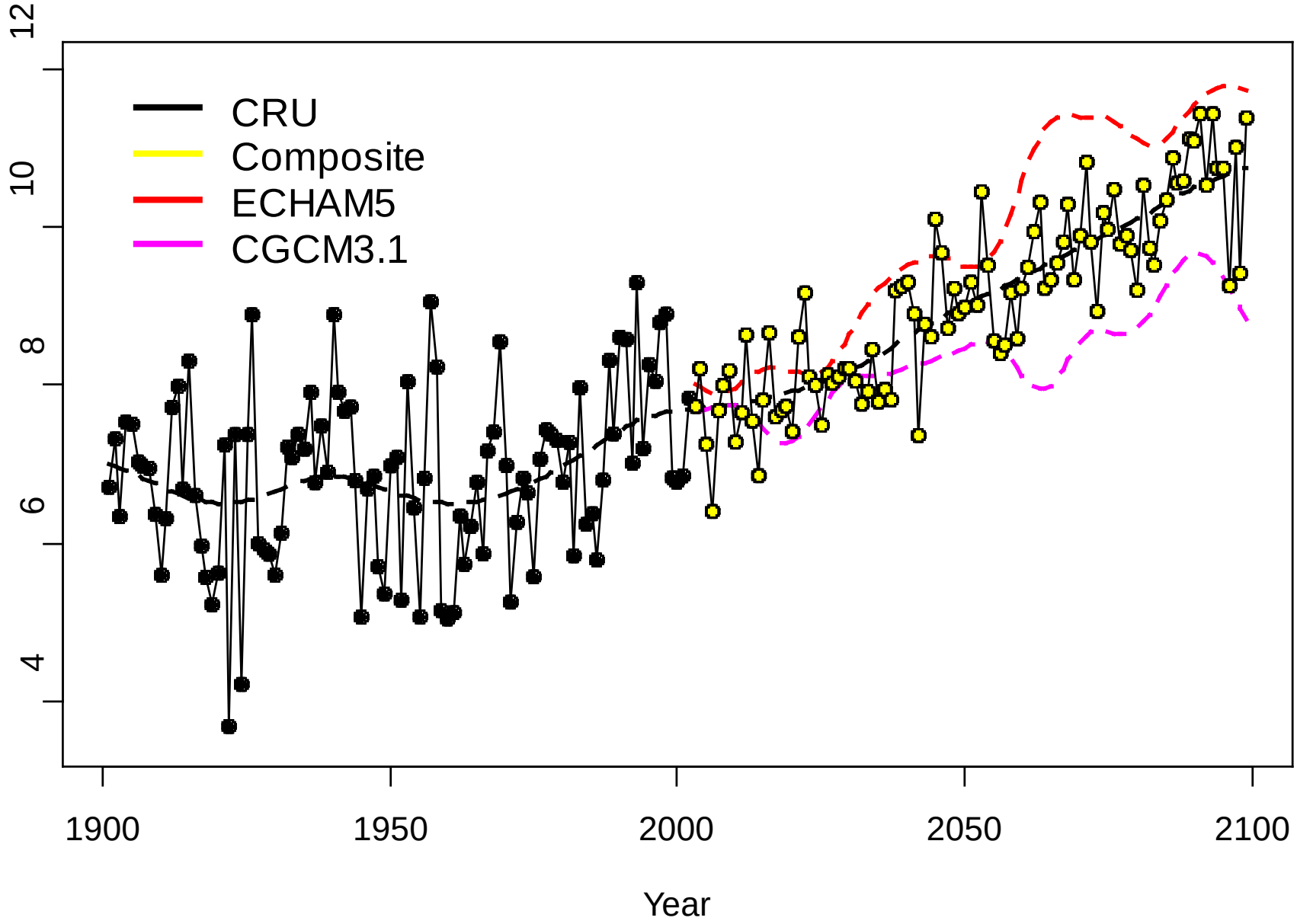


Area burned in W. North America has doubled in last 40 years

Total Annual Area Burned in Alaska 1950-2006

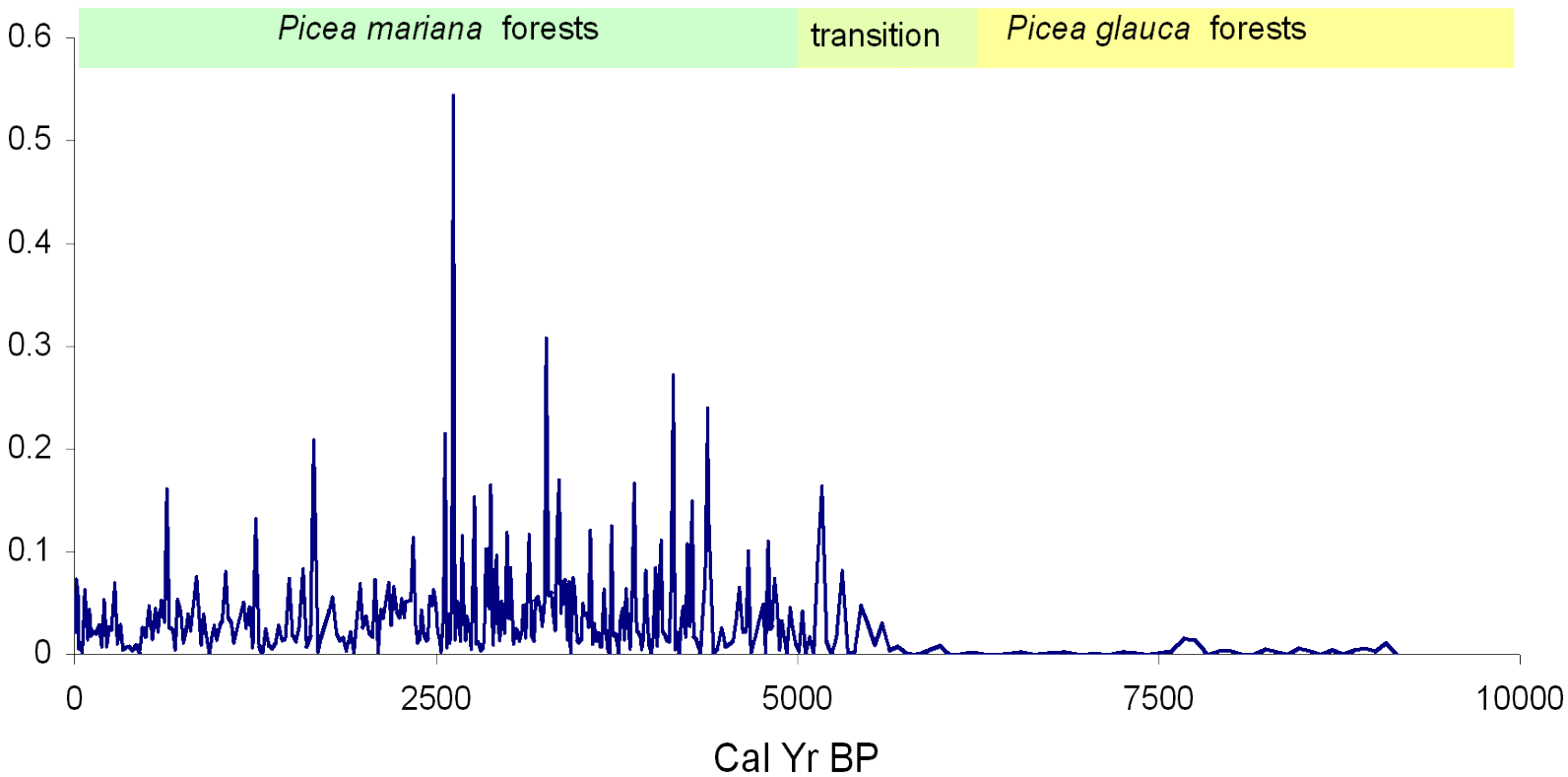


Boreal ALFRESCO FireClimate Relationship

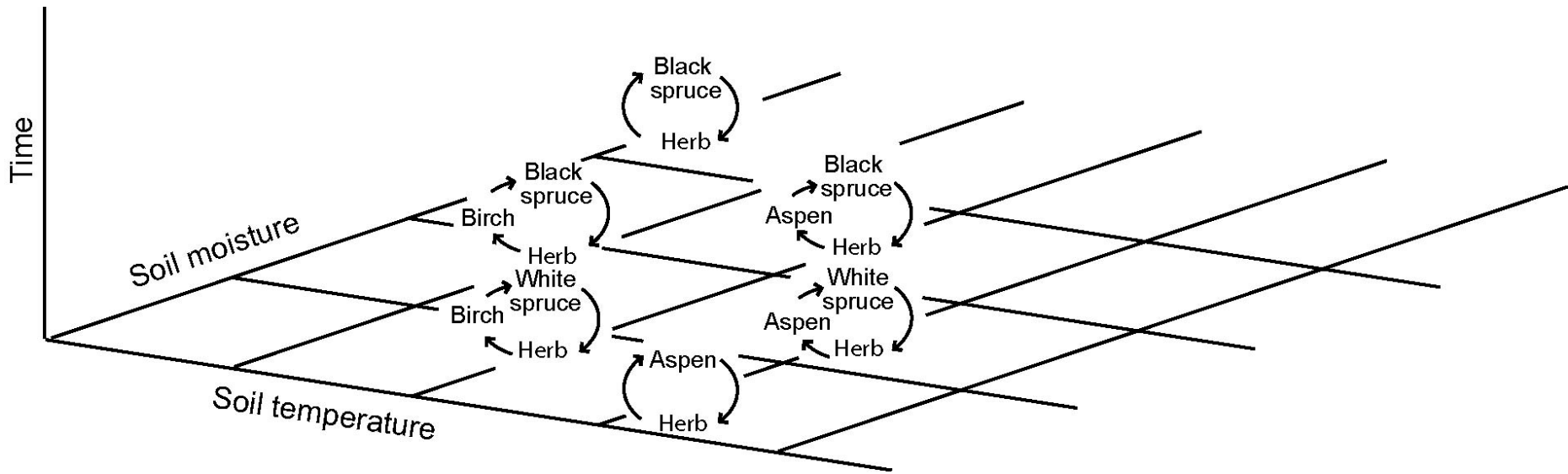


Scott Rupp

Species have a large effect on fire probability

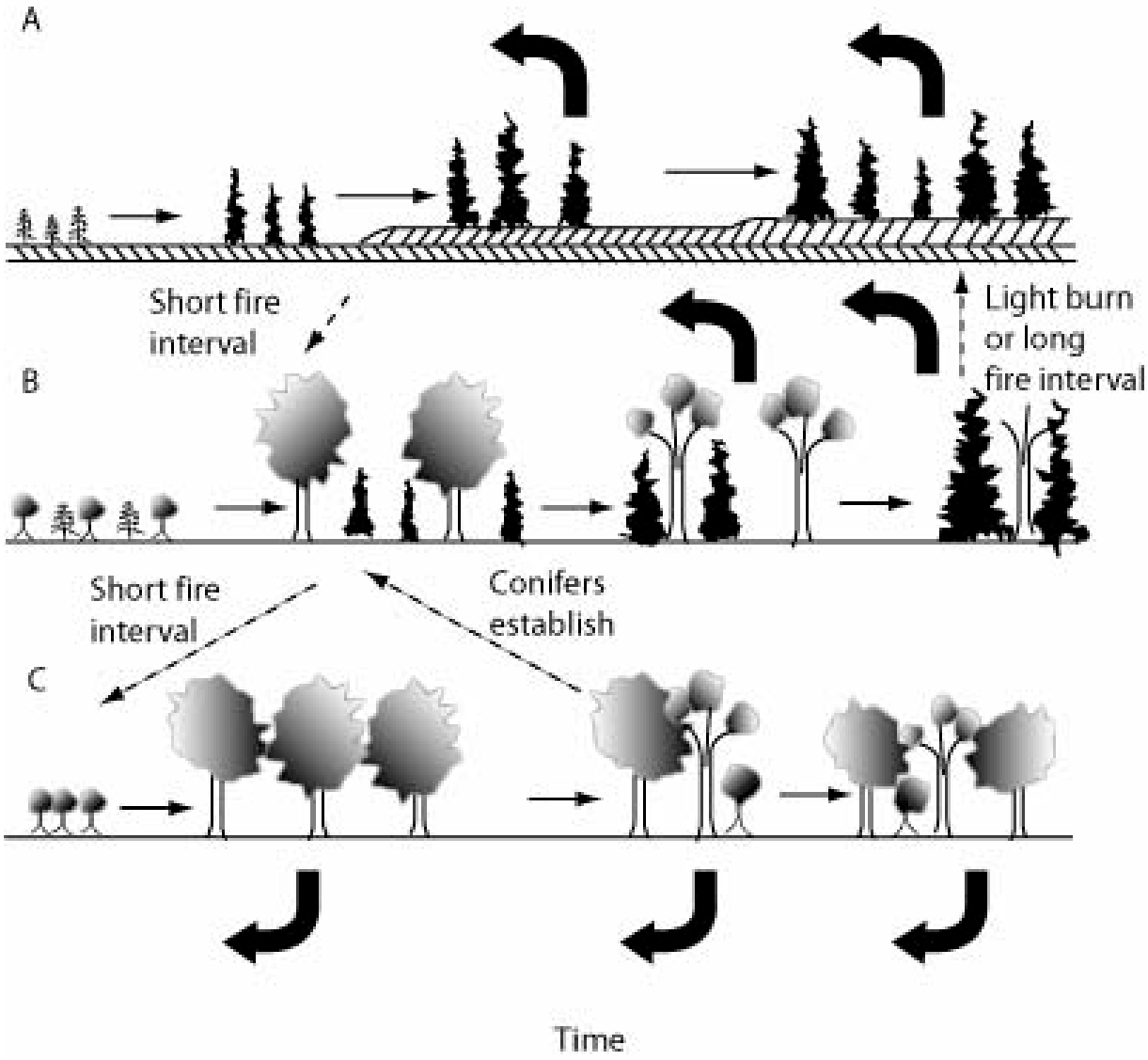


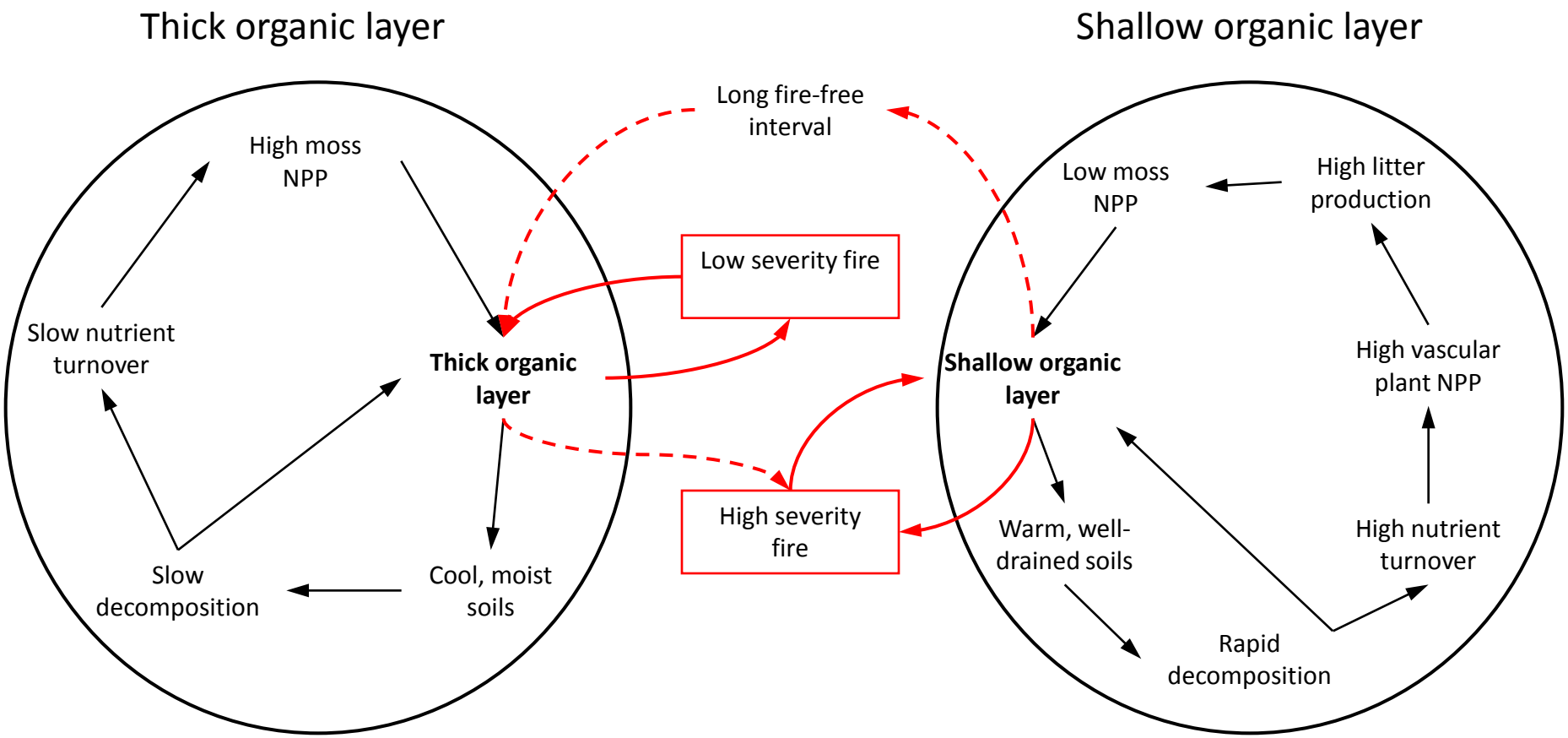
Jason Lynch


Time
Soil moisture
Soil temperature
Black spruce
Herb
Black spruce
Birch
Herb
Black spruce
Aspen
Herb
White spruce
Birch
Herb
White spruce
Aspen
Herb
Aspen
Herb

Potential for landscape change

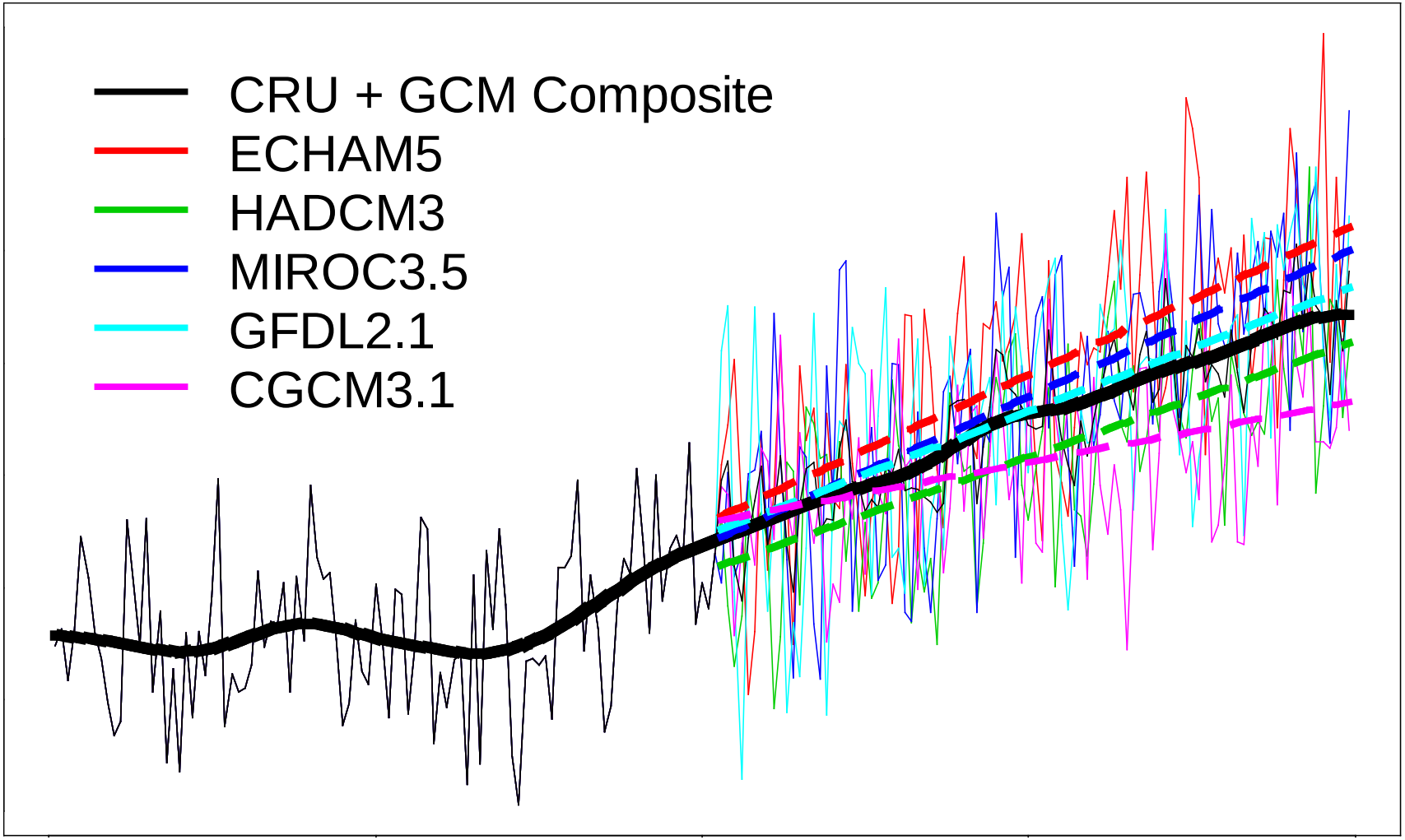
- Warming may cause re-sorting of species on landscape
  - Seed dispersal is more extensive than we realized
    - Especially for deciduous species
- Fire severity governs post-fire successional trajectory
  - Determines seed bed moisture and nutrients
  - Deciduous species establish where previously absent
  - Site conversion reduces landscape flammability
- Successional trajectory is locked in place within 10 years


A
Short fire
interval
Light burn
or long
fire interval
B
Short fire
interval
Conifers
establish
C
Time

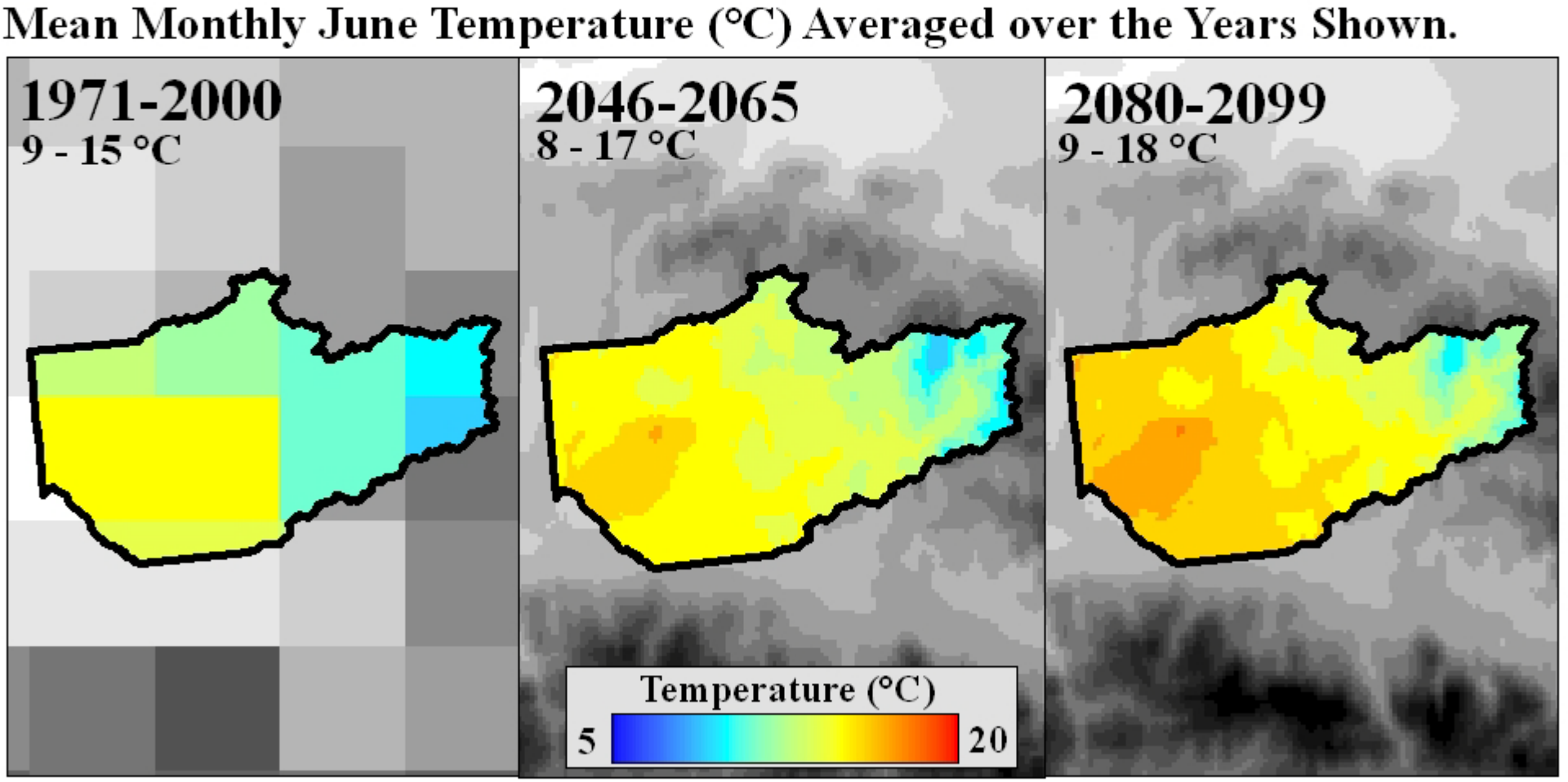


Jill Johnstone

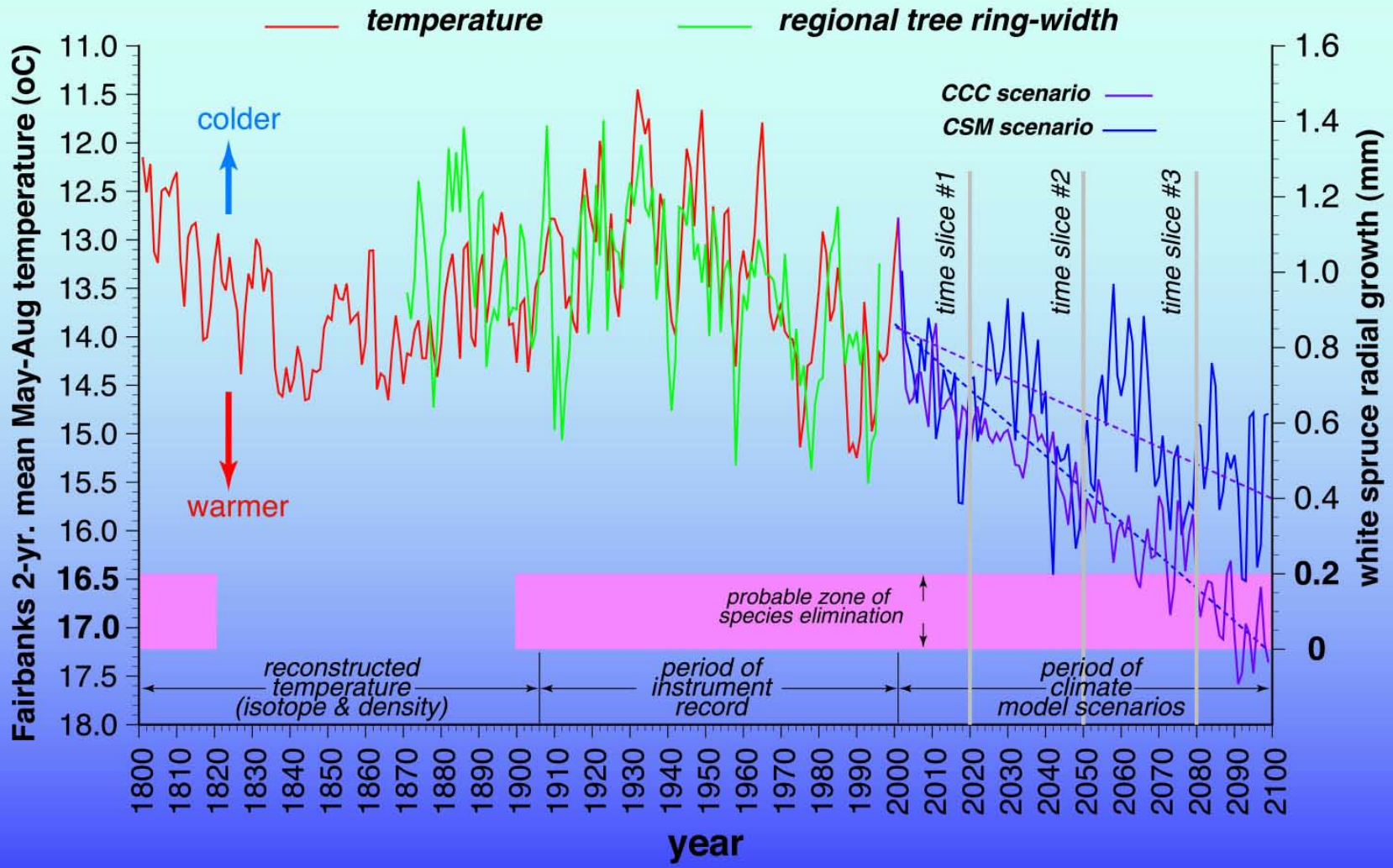
March-June Average Temperature (C°) Alaska: 1901-2099



Fairbanks is expected to get warmer



Historic and reconstructed relationship between white spruce growth and summer temperature and climate scenarios in central Alaska



Juday 2005

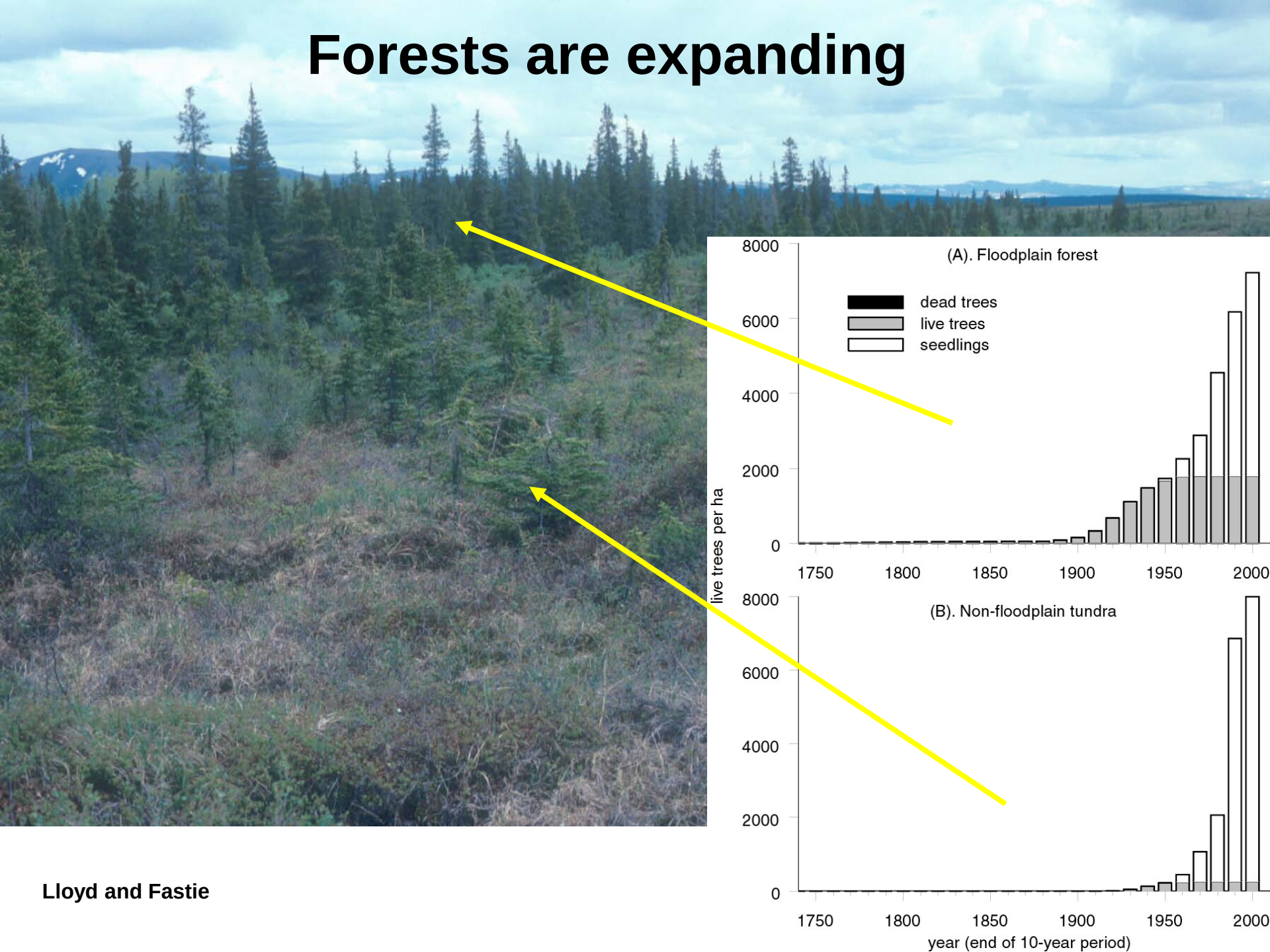
1949

Shrub density has increased

2000

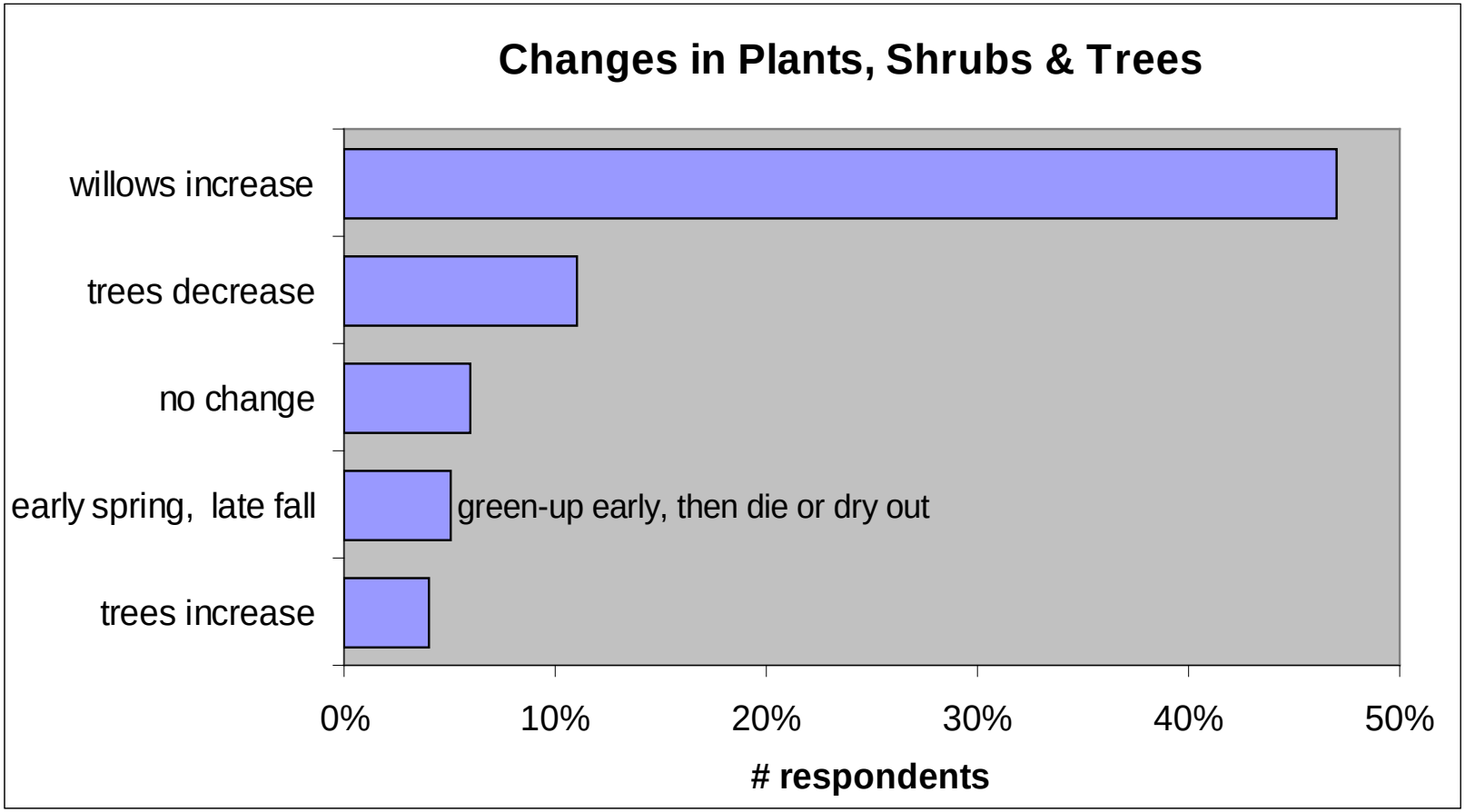
Sturm

Forests are expanding



Lloyd and Fastie

Community monitoring: How are plants changing?



Conclusions

- Monitoring is critical at times of rapid change and high uncertainty
- Networks greatly increase value of measurements
- Many monitoring approaches available
  - Field observations
  - Satellites
  - Experiments
  - Community surveys and collaborations