Climate Change – Forest Health and Insect Outbreaks

Bonanza Creek LTER 2014 Symposium

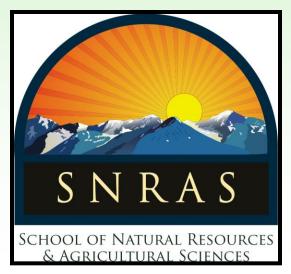
Glenn Patrick Juday, Ryan Jess, Thomas Grant School of Natural Resources and Agricultural Sciences University of Alaska Fairbanks

Fairbanks, AK

15 February, 2014

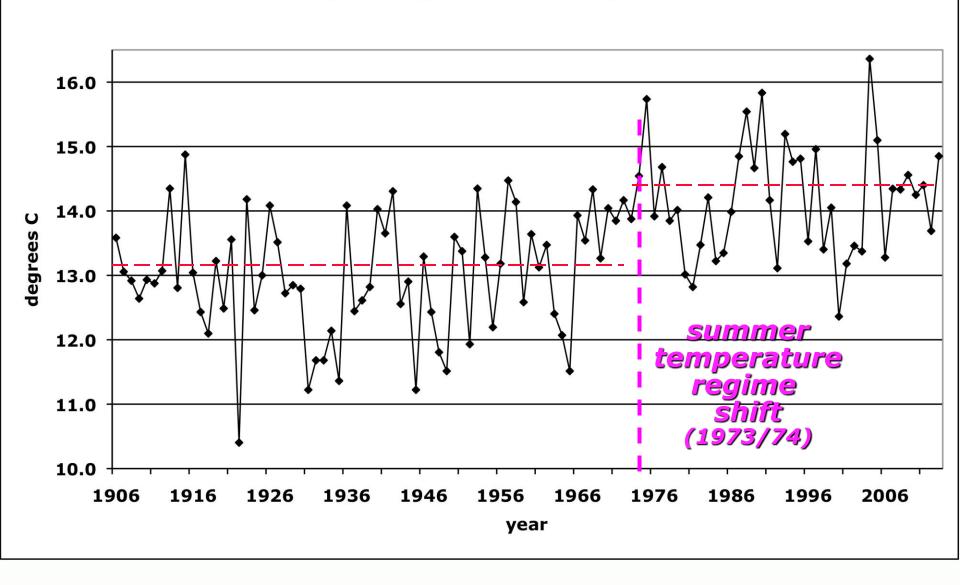


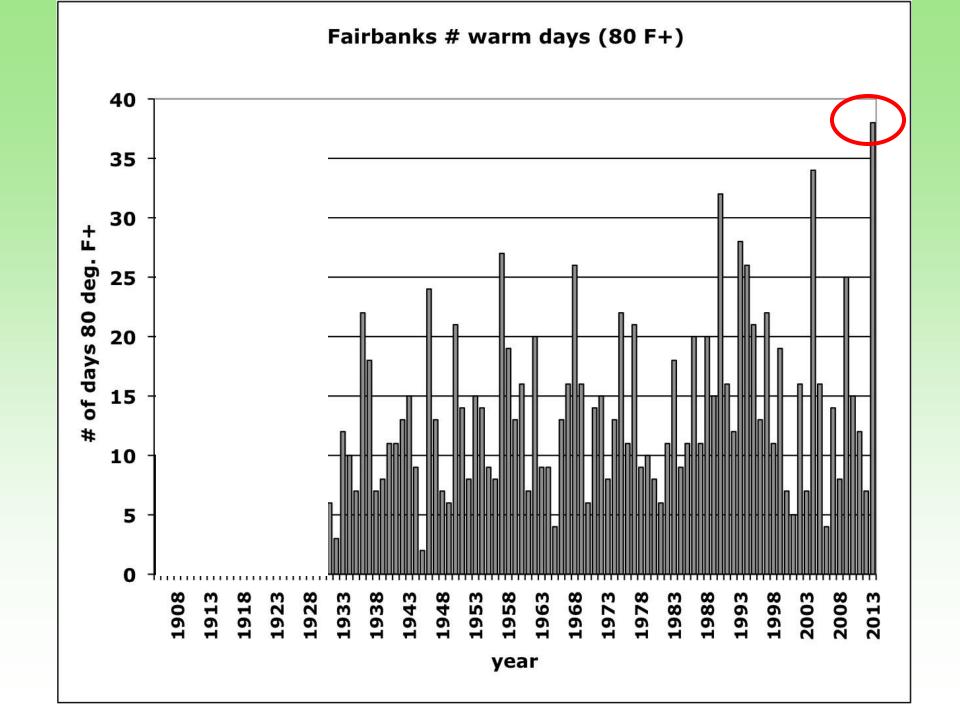


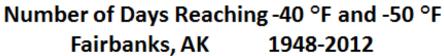


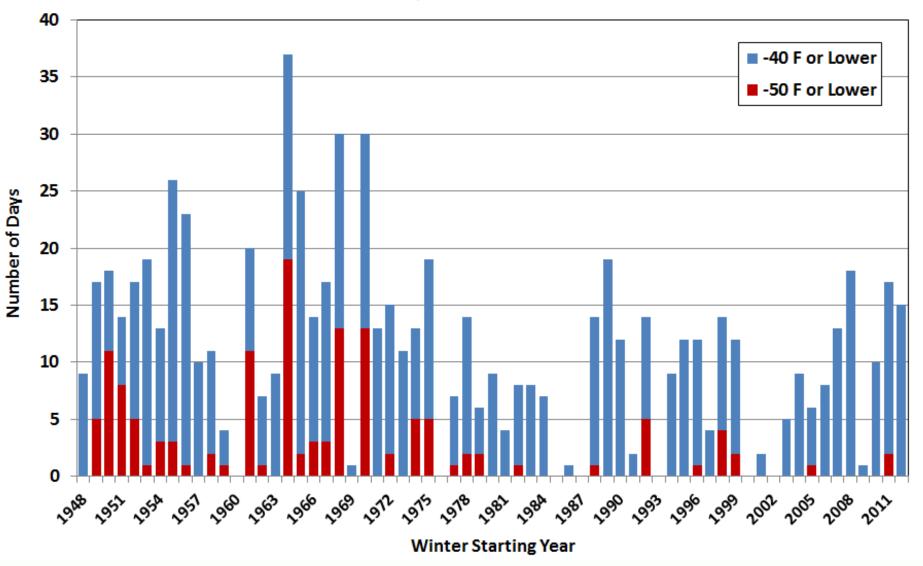


Mean Monthly Temperature, 01 May: 31 Aug, UES/Fairbanks, Alaska

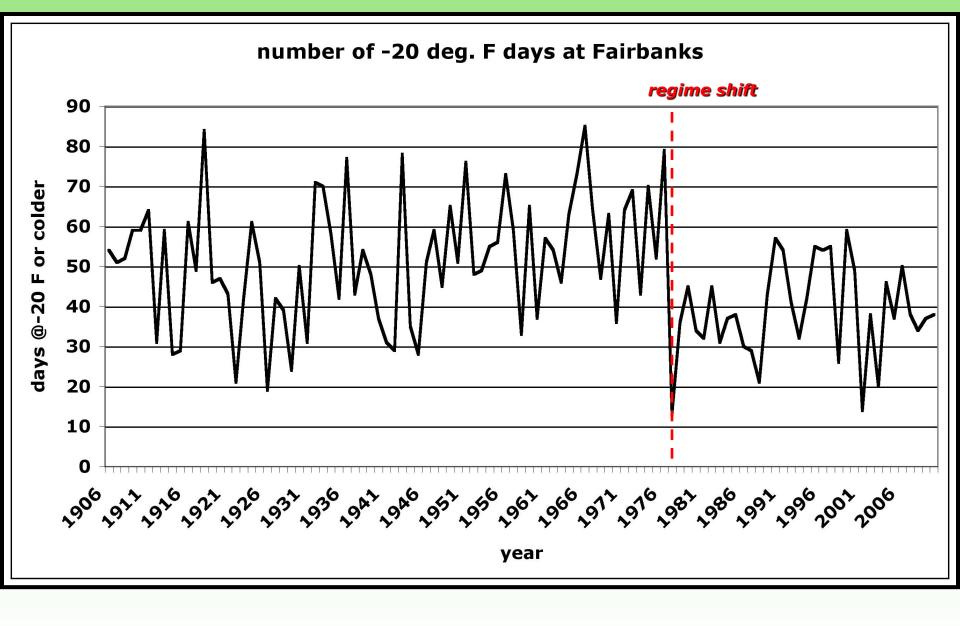




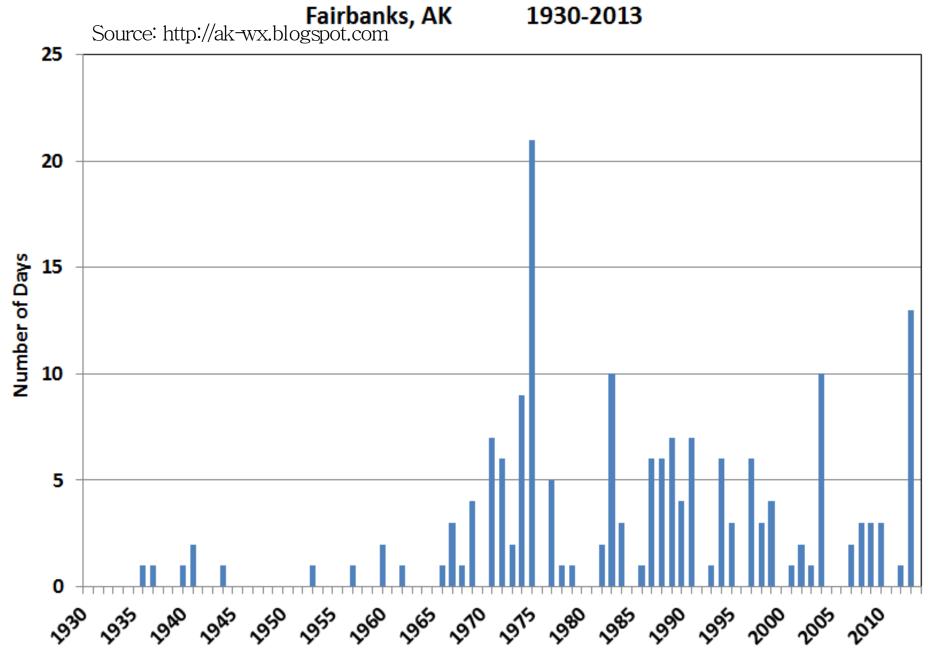


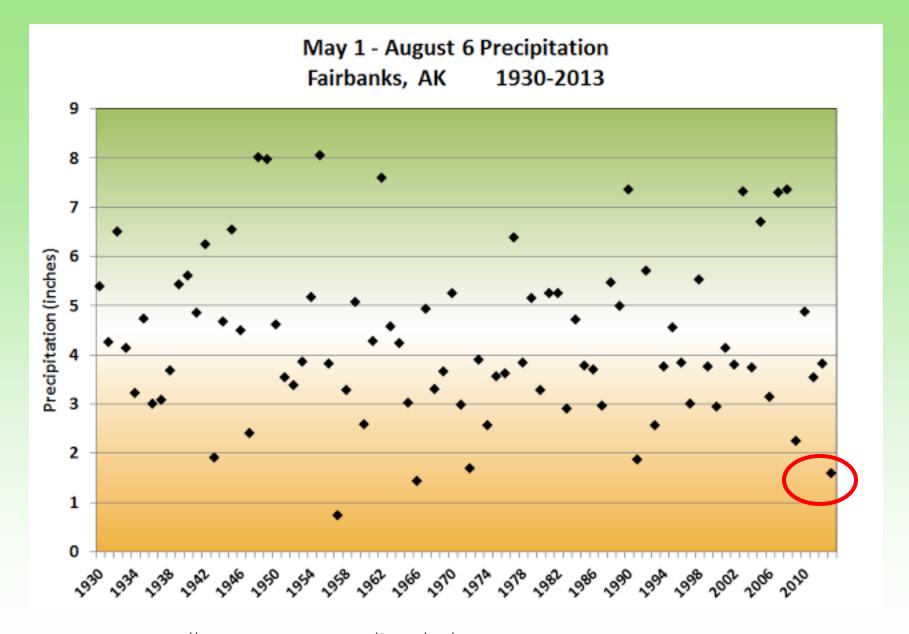


Source: http://ak-wx.blogspot.com



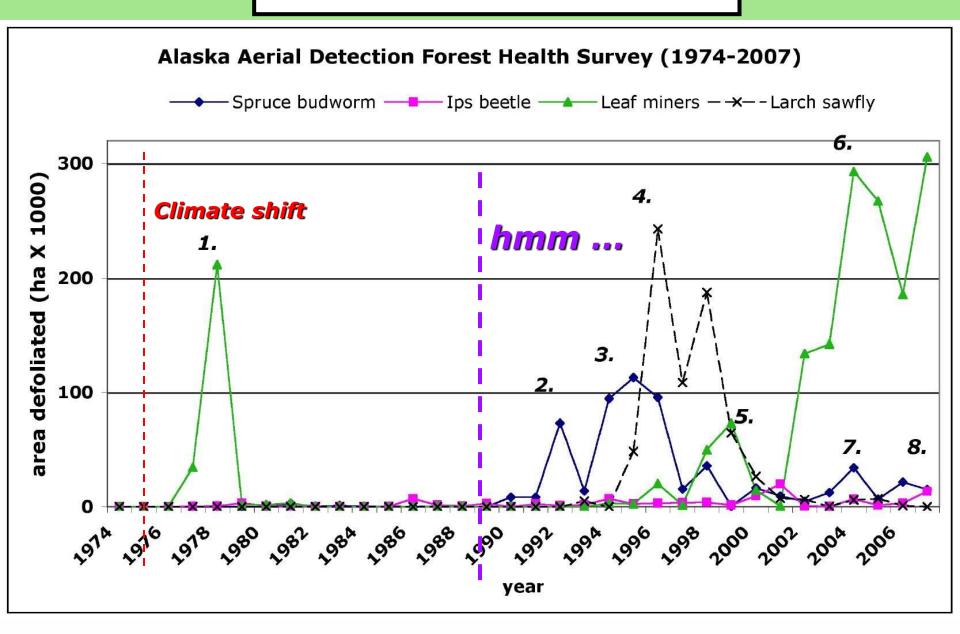
Annual Number of Days With Minimum Temperature 60 °F or Above Fairbanks, AK 1930-2013





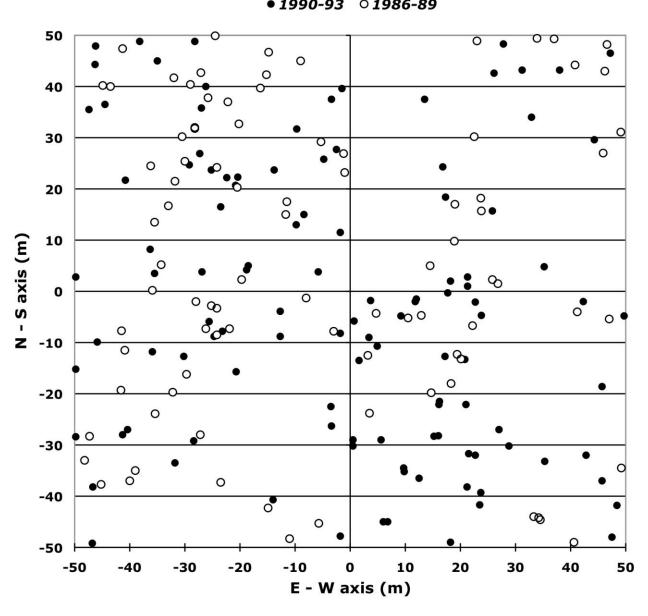
Source: http://ak-wx.blogspot.com/2013/08/fairbanks-precipitation-update.html

Forest area defoliated or killed

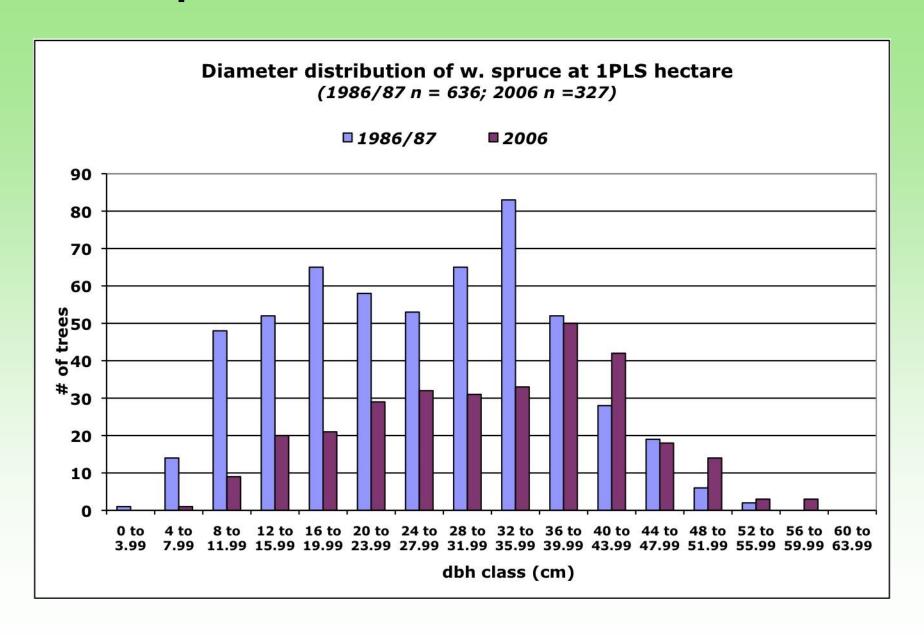


Hectare 1, Parks Loop South, location of snapped or broken-topped w. spruce





Parks Loop South Reference Hectare



A Tale of 3 Research Natural Areas

- Limestone Jags RNA (BLM 1982-2010)
- Caribou Crossing RNA (State Forest 1986-2008)
- Serpentine Slide RNA (BLM 1987-2011)

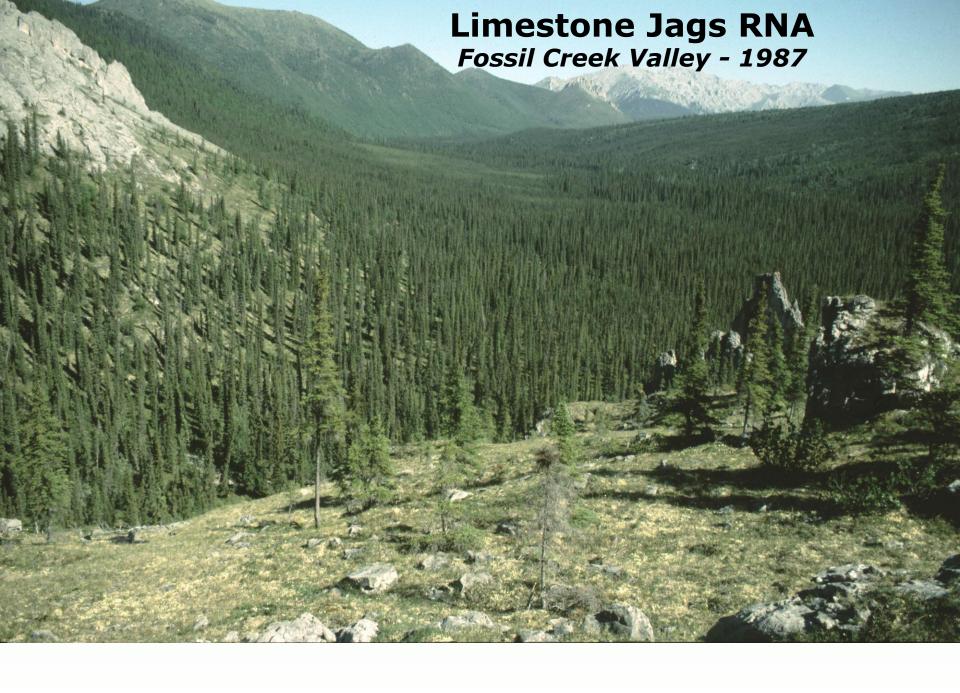
Limestone Jags RNA

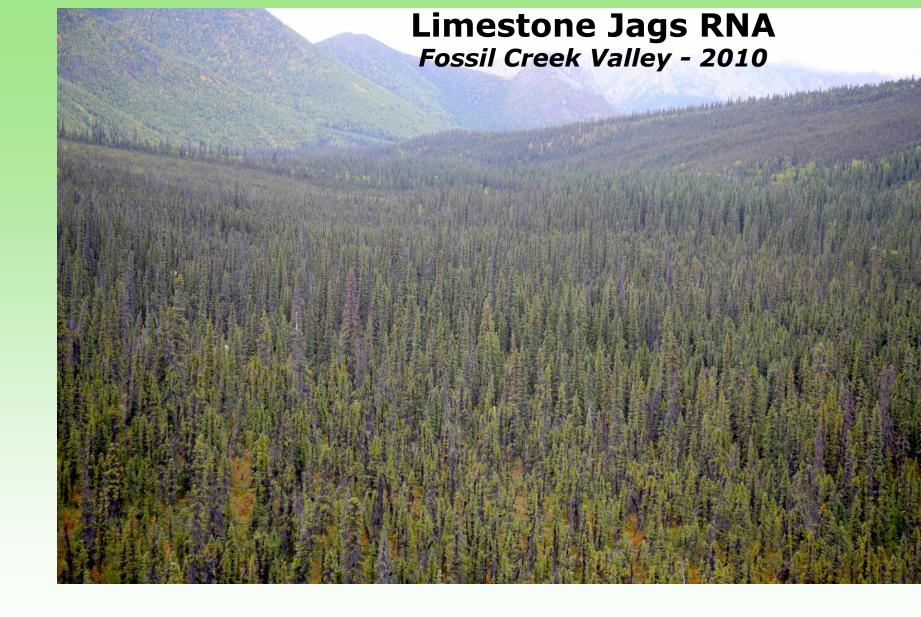




Limestone Jags RNA (BLM - 1982) Fossil Creek Bottomland Plot







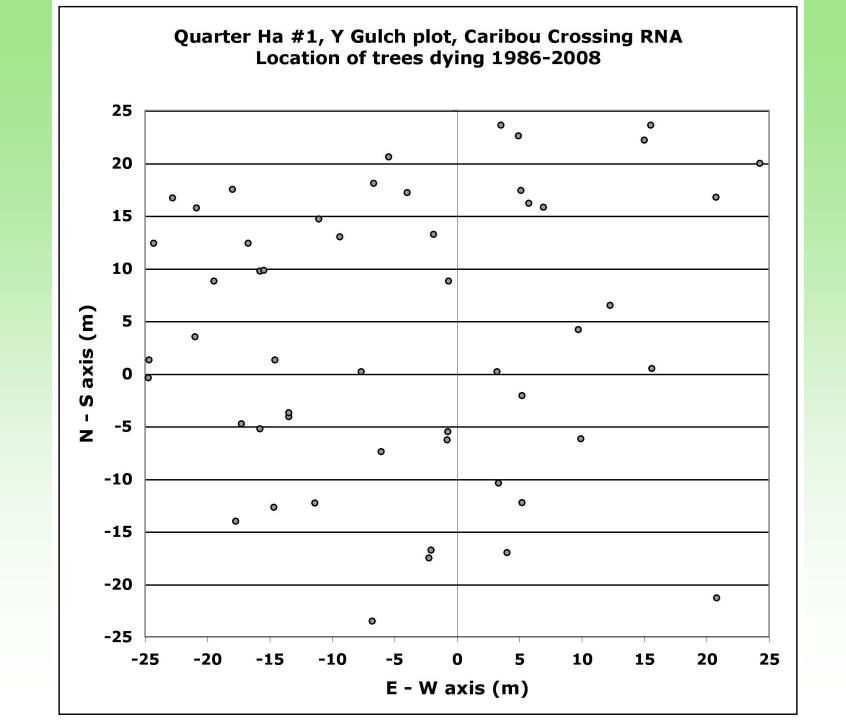
Extreme desiccation and defoliation

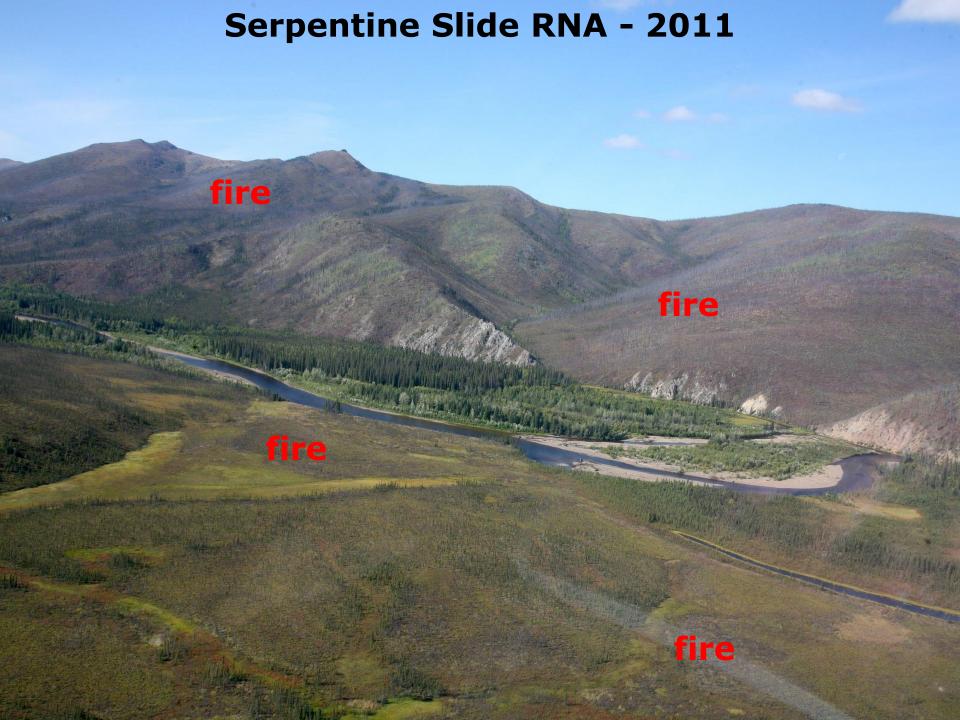


Caribou Crossing RNA

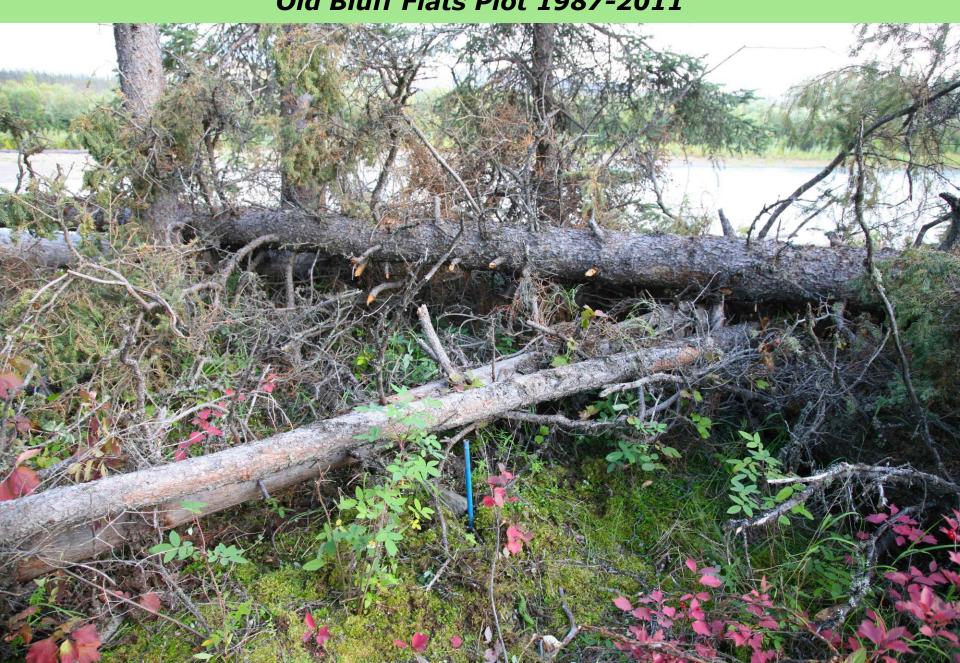
Canopy opening from death of large trees, Y-Gulch plot, Sep. 2008



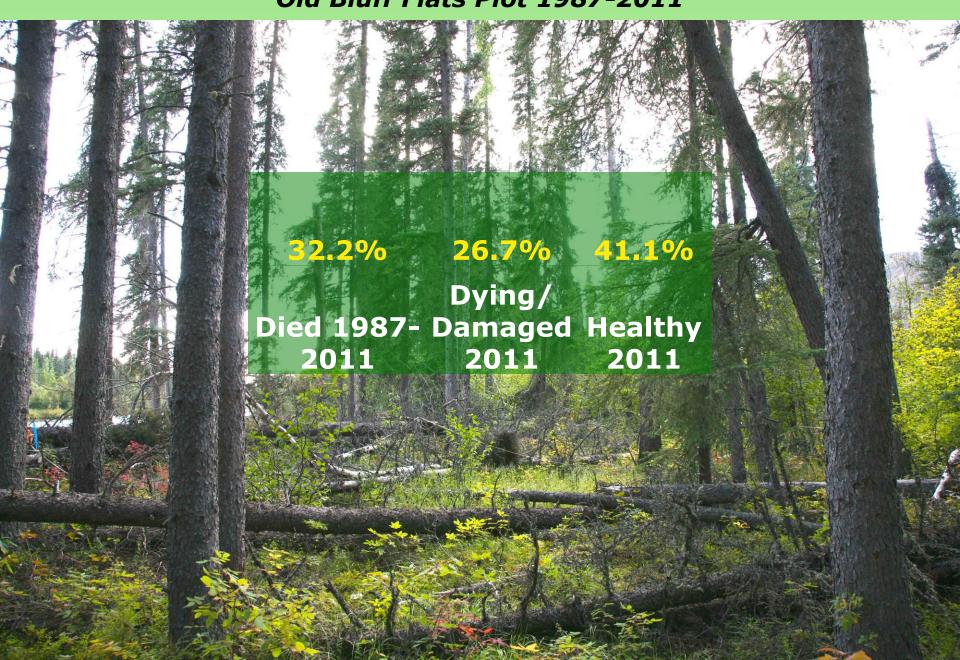




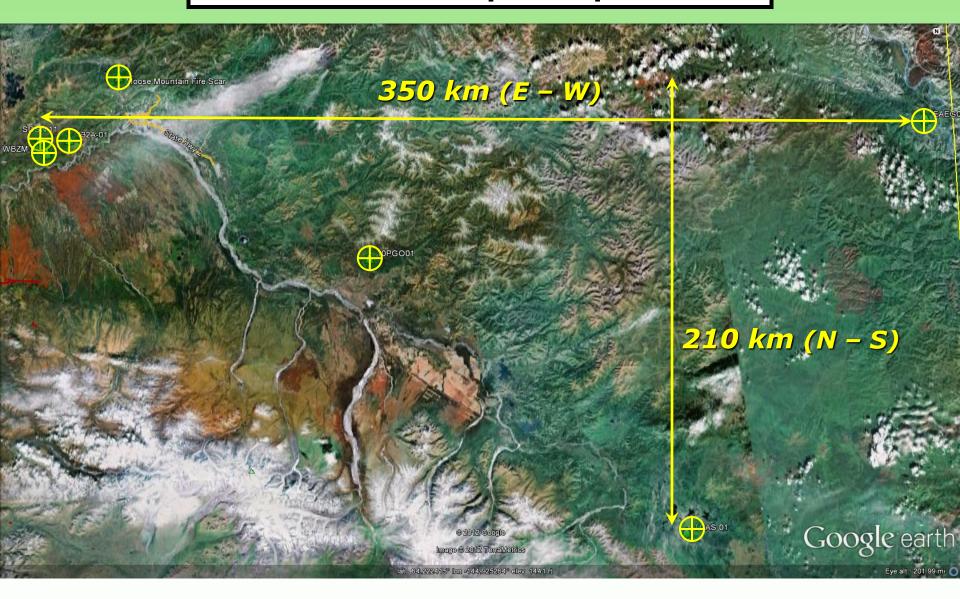
Serpentine Slide RNA *Old Bluff Flats Plot 1987-2011*

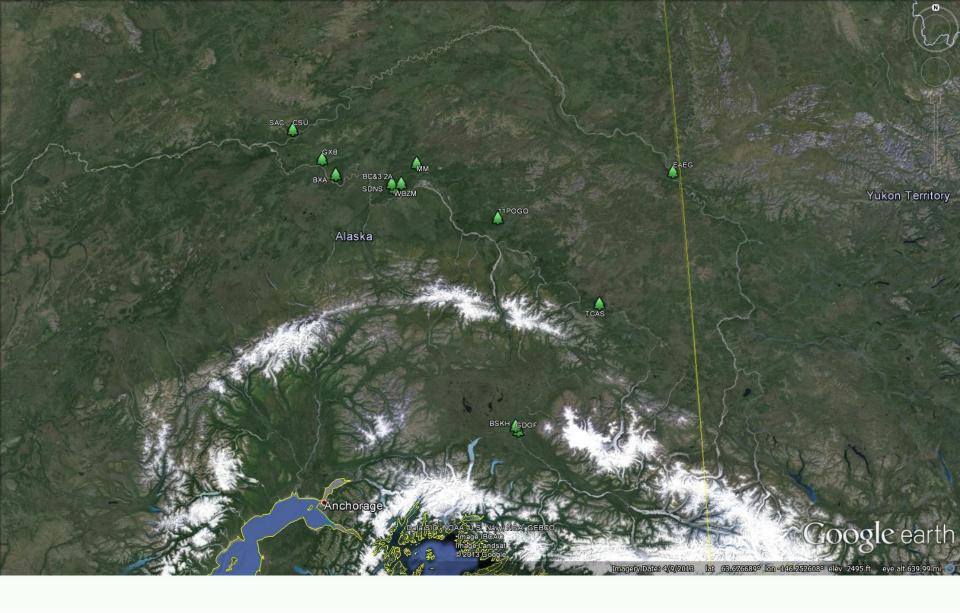


Serpentine Slide RNA *Old Bluff Flats Plot 1987-2011*



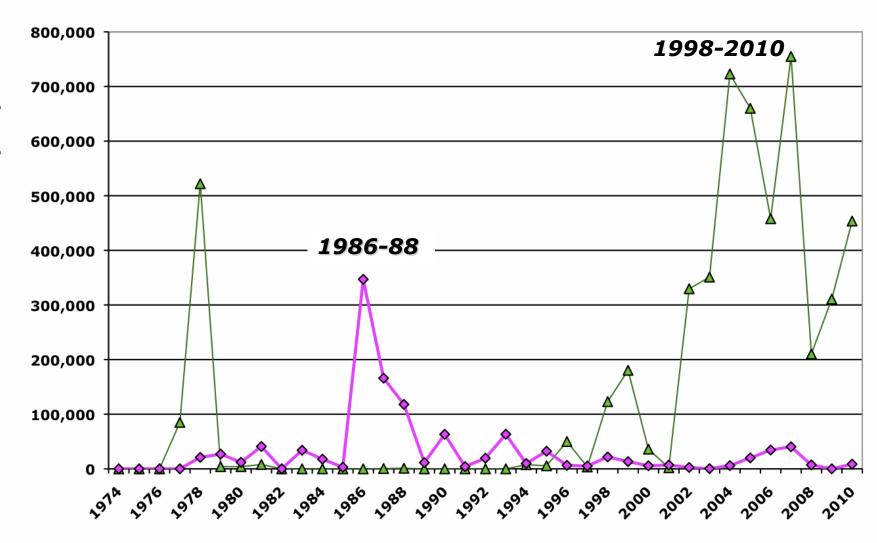
Distribution of sampled aspen stands



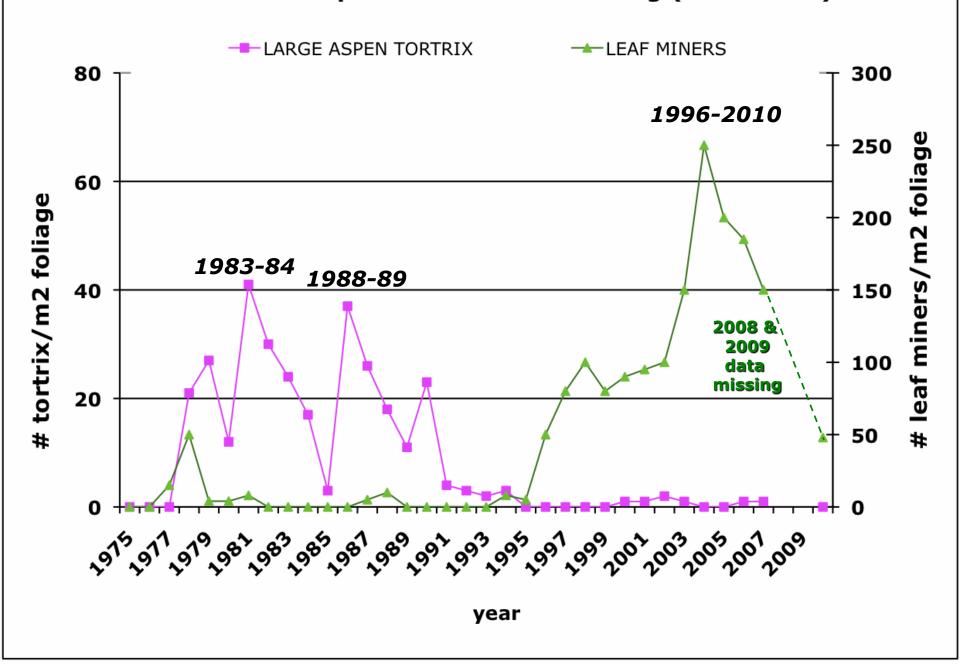


Statewide area of aspen defoliators in AK Forest Health Monitoring (1974-2010)

area defoliated (k ha)



BNZ LTER Aspen Defoliator Monitoring (1975-2010)



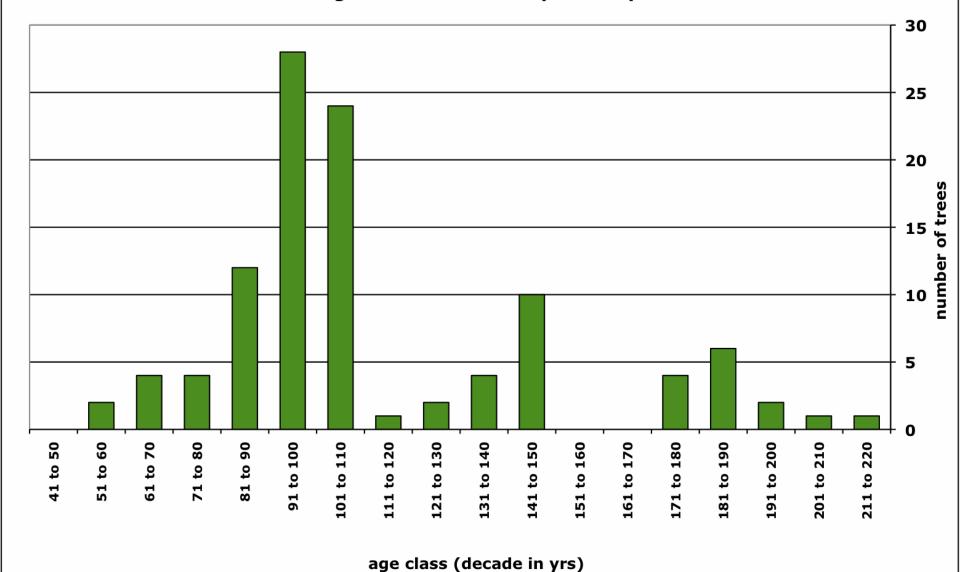
OBJECTIVES

- Identify climate controls of the growth of aspen in boreal Alaska.
- Identify effects of defoliating insect outbreaks on growth of aspen – magnitude, pattern, etc.
- Detect level of tree mortality in aspen, especially related to recent temperature increases.
- Establish basis for outlook for aspen growth and health.

Aspen sample characteristics

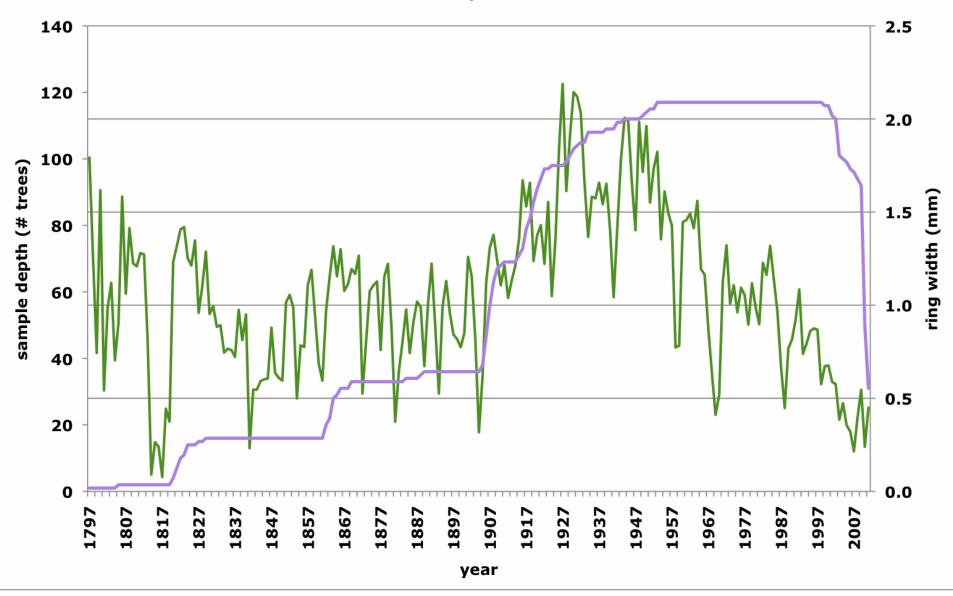
- 7 (+4) stands from eastern to central Alaska
- 117 (156) trees; all w/basal disks (40 to 100 cm ht.)
- age = min. 59 to 214 yrs (median = 101 yrs.)
- n = 83 alive at sample collection; 34 = dead
- FYOG = 1797 to 1953
- d.i.b. at disk ht. = 39.5 to 10.4 cm
- sanded to 600-grit (furniture grade)
- measured 2 radii per disk (each yr. is mean of 2 radii)
- 13,204 mean ring widths; (~26,500 measurements)

Age Distribution of Aspen Sample



Growth of Interior Alaska Aspen

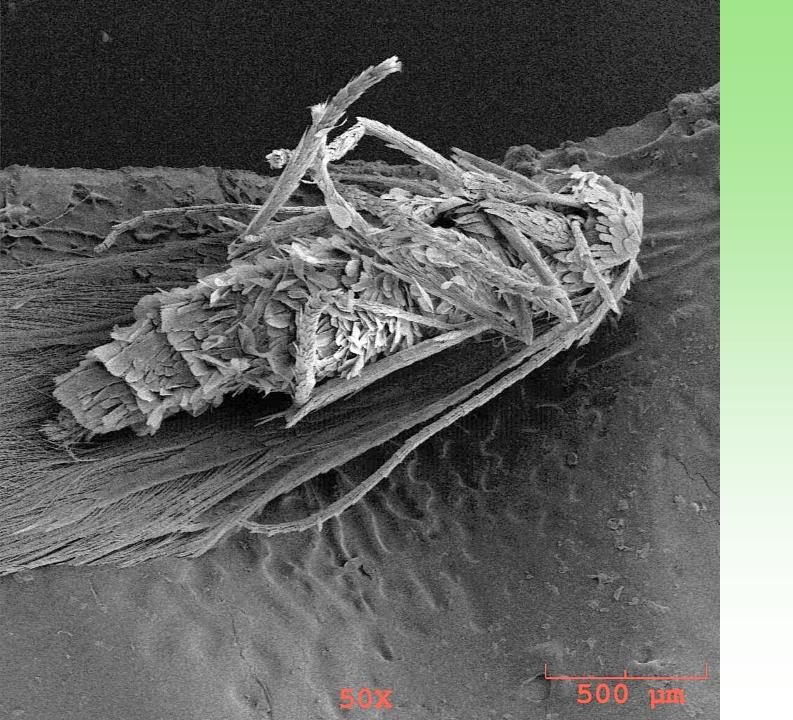
— raw rw aspen — #trees



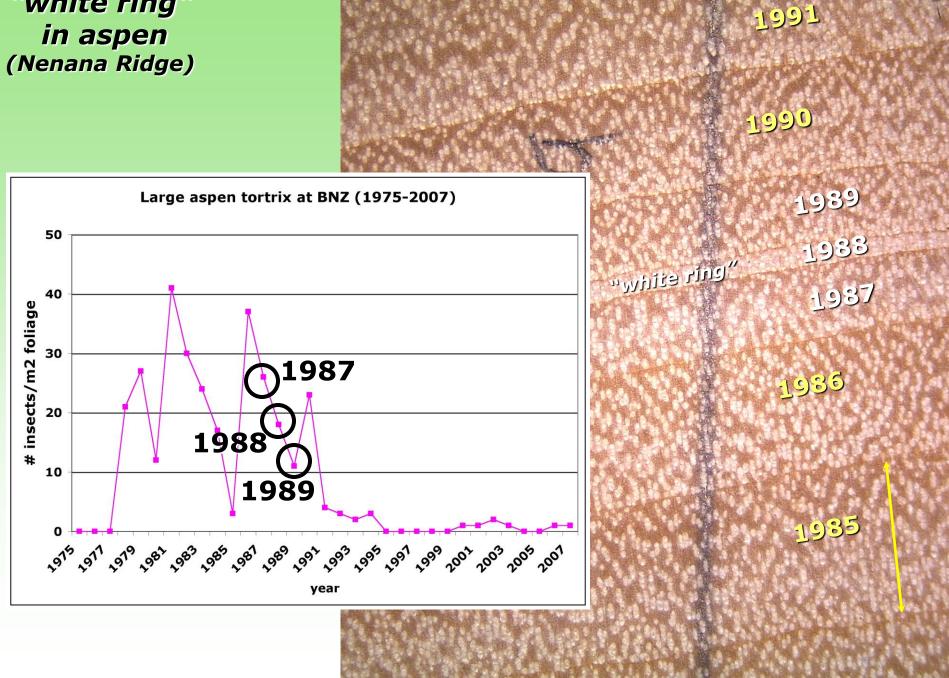
Classic pattern of large aspen tortrix defoliation

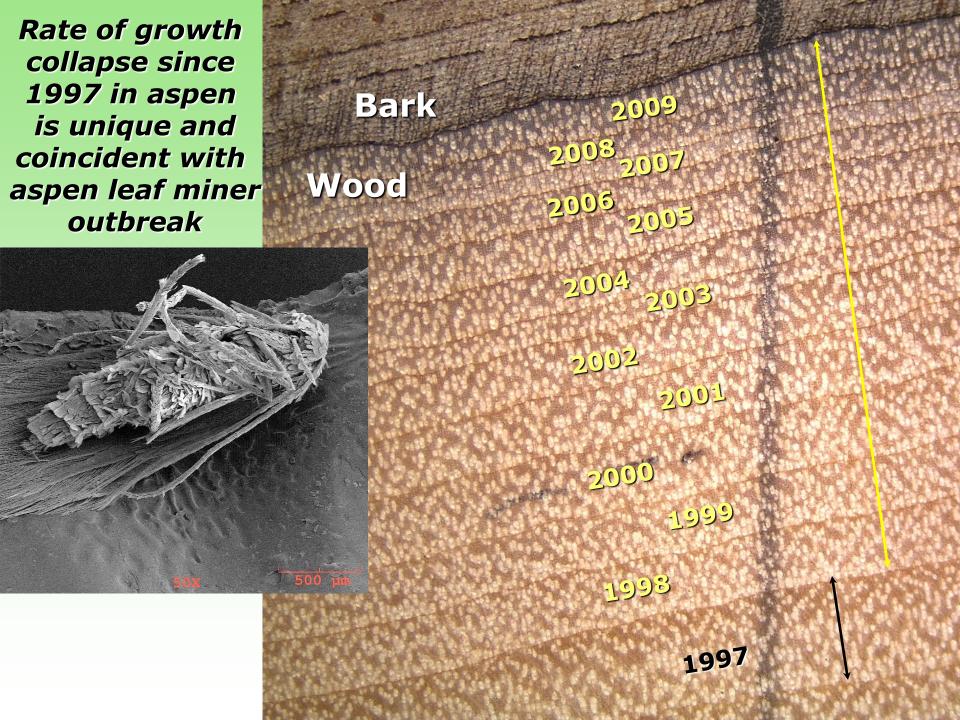
(1 or 2 yr sudden growth reduction/recovery)

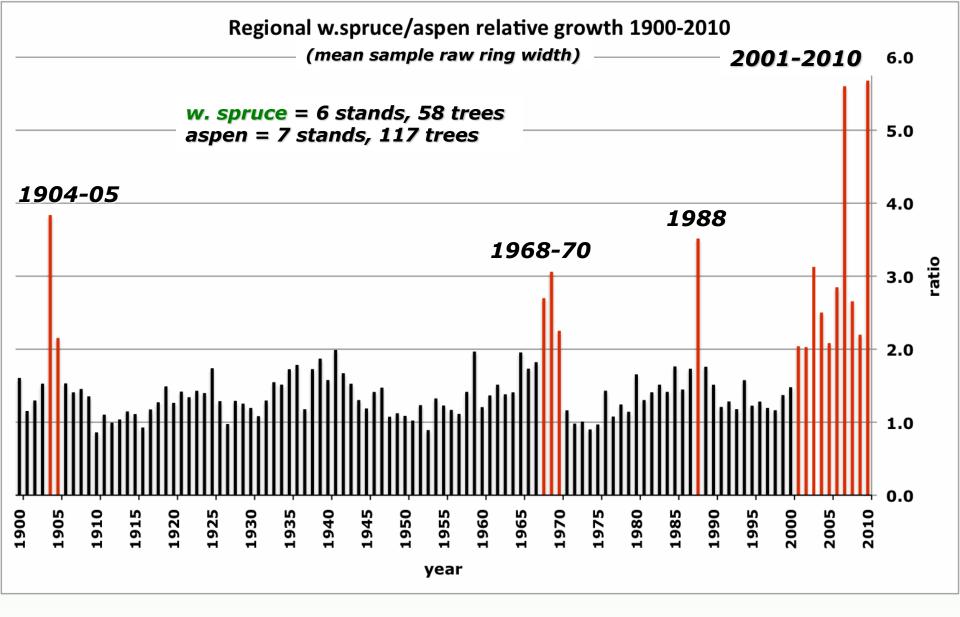


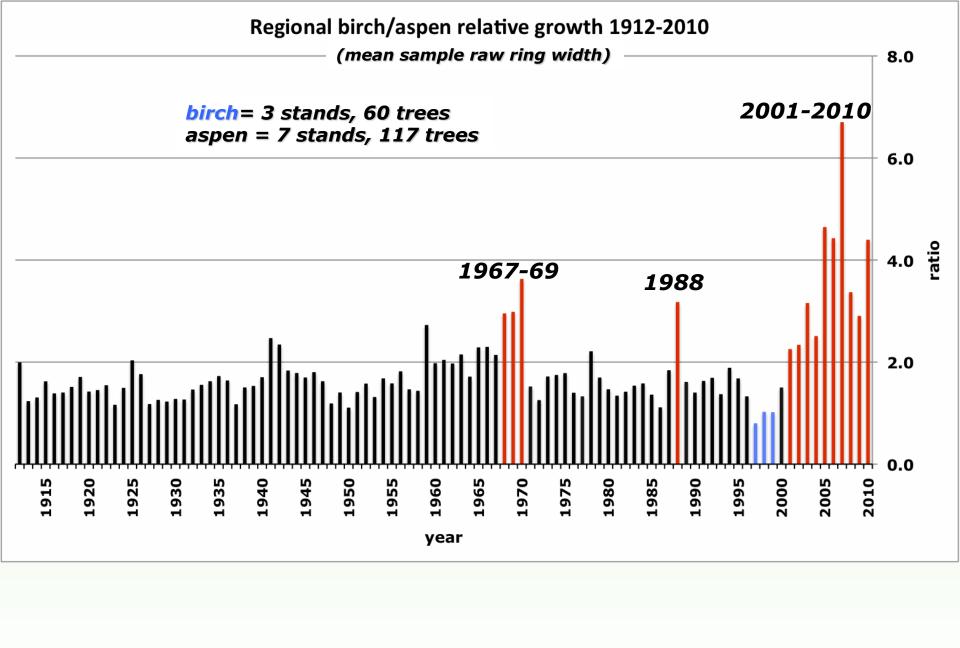


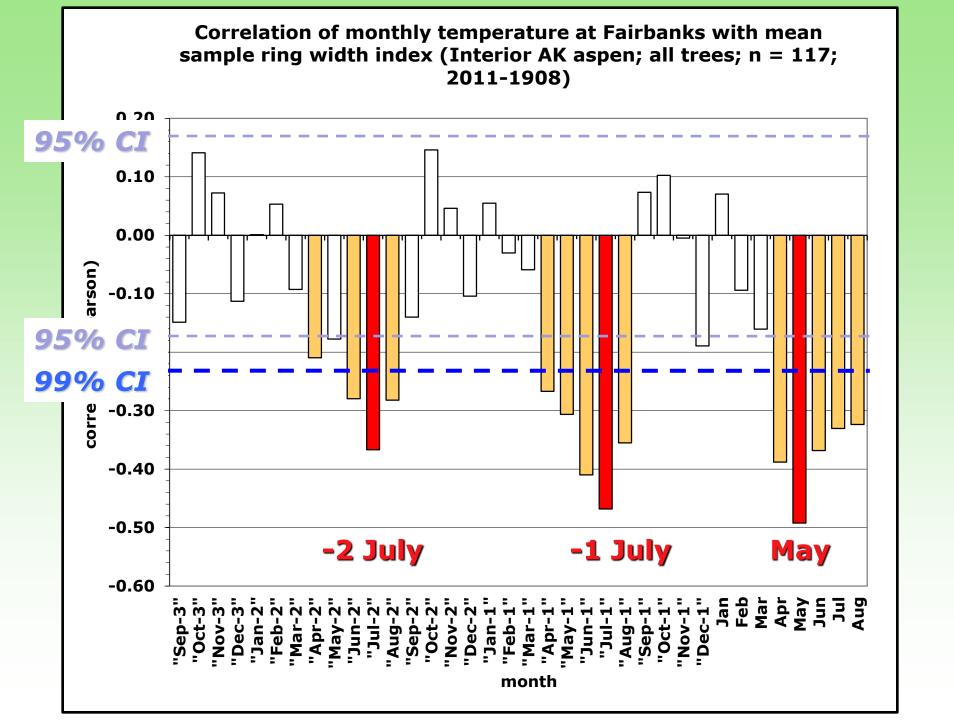
"white ring" in aspen



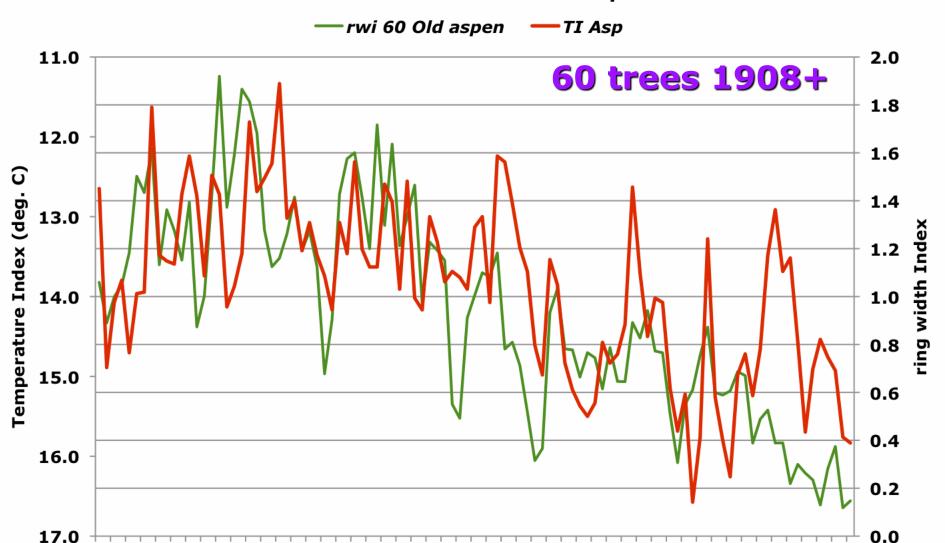








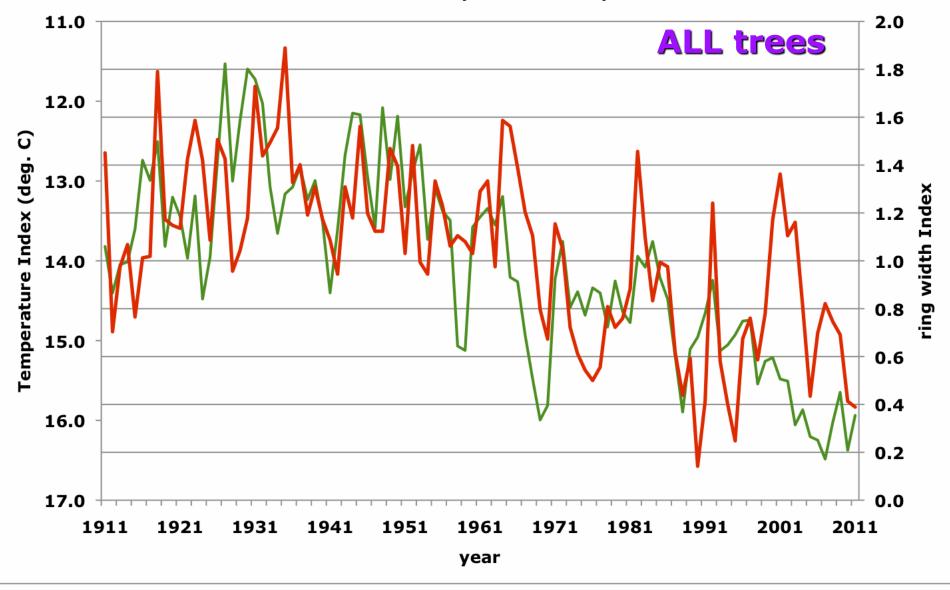
Growth of Interior Alaska Aspen



year

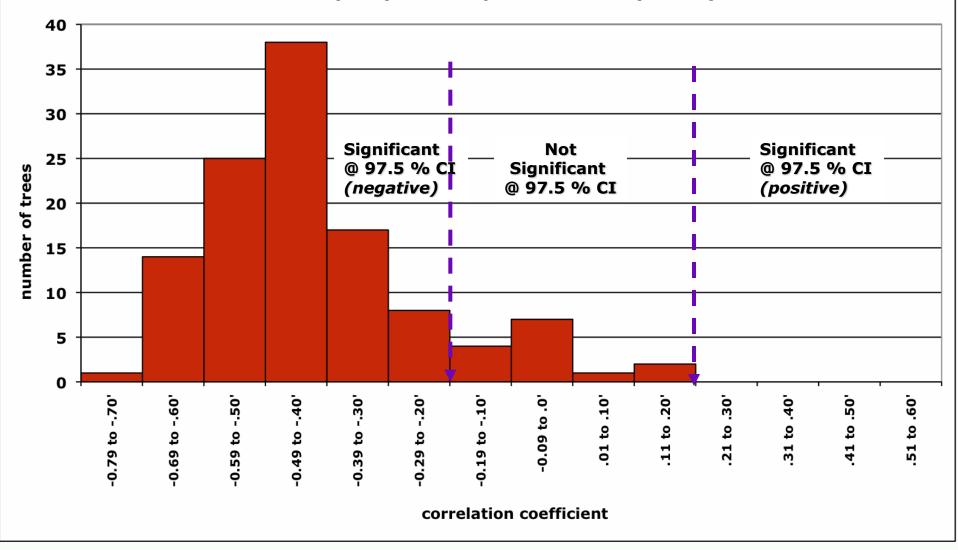
Growth of Interior Alaska Aspen

—rwi 117 aspen —TI Asp

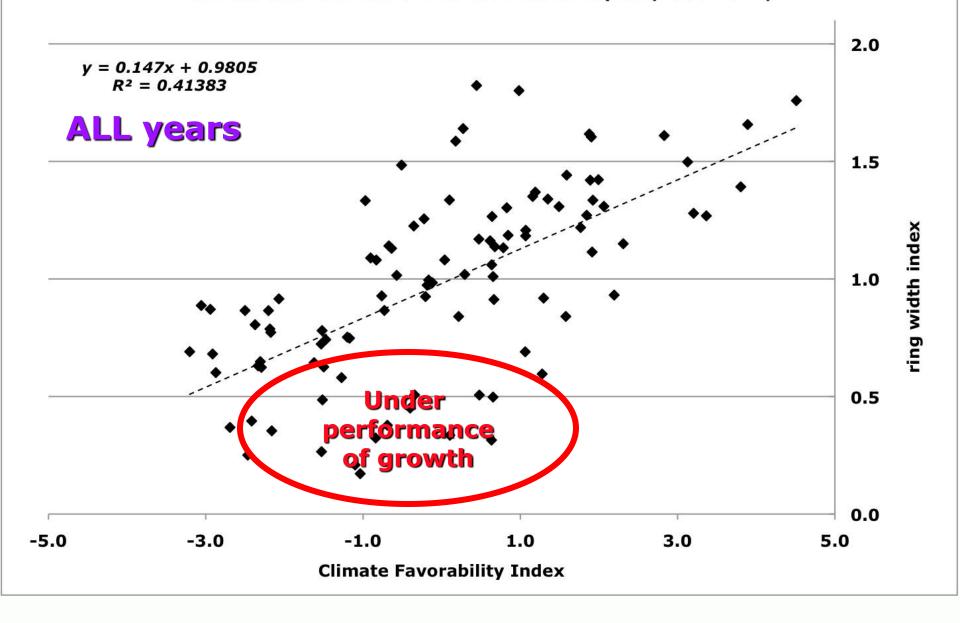


Growth of Interior Alaska Aspen rwi All 117 aspen ---CFI aspen 2.2 5.5 1.8 Temperature Index (deg. C) 3.5 ring width Index 1.4 1.5 1.0 -0.5 0.6 -2.5 2001 2011 1911 1921 1931 1941 1951 1961 1971 1981 1991 year

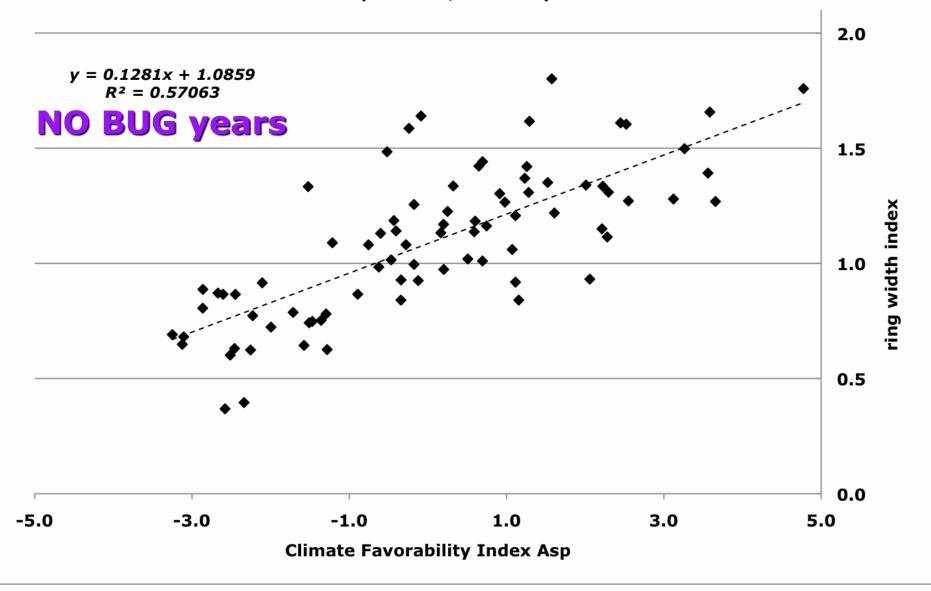
All Aspen Distribution of individual tree correlation with 3yrMay/Jul Temperature INDX (n=117)



Climate and Growth of Interior Alaska Aspen (1906-2011)

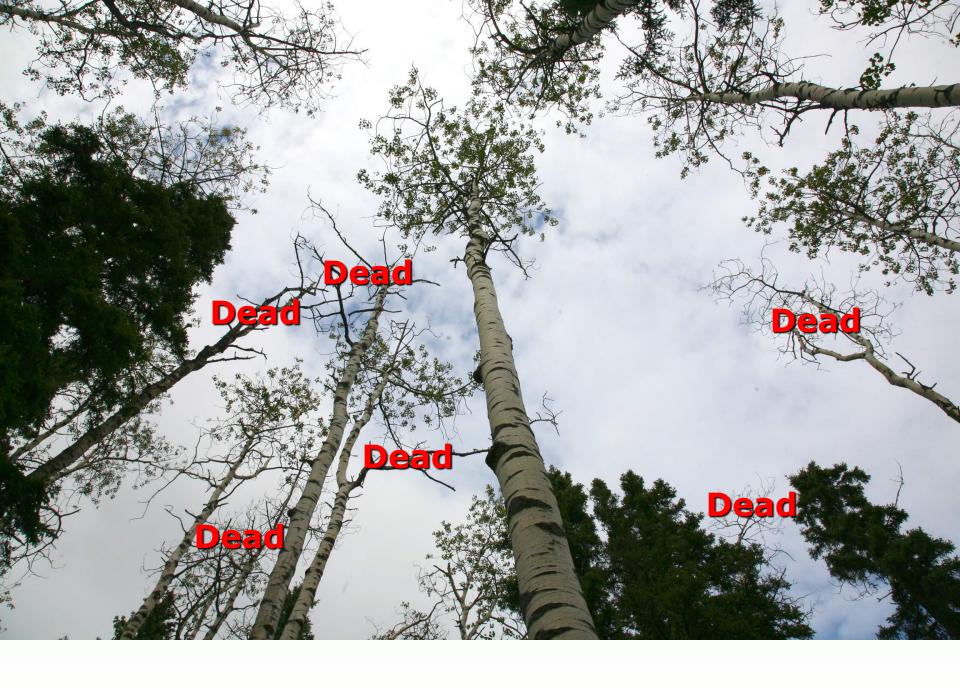


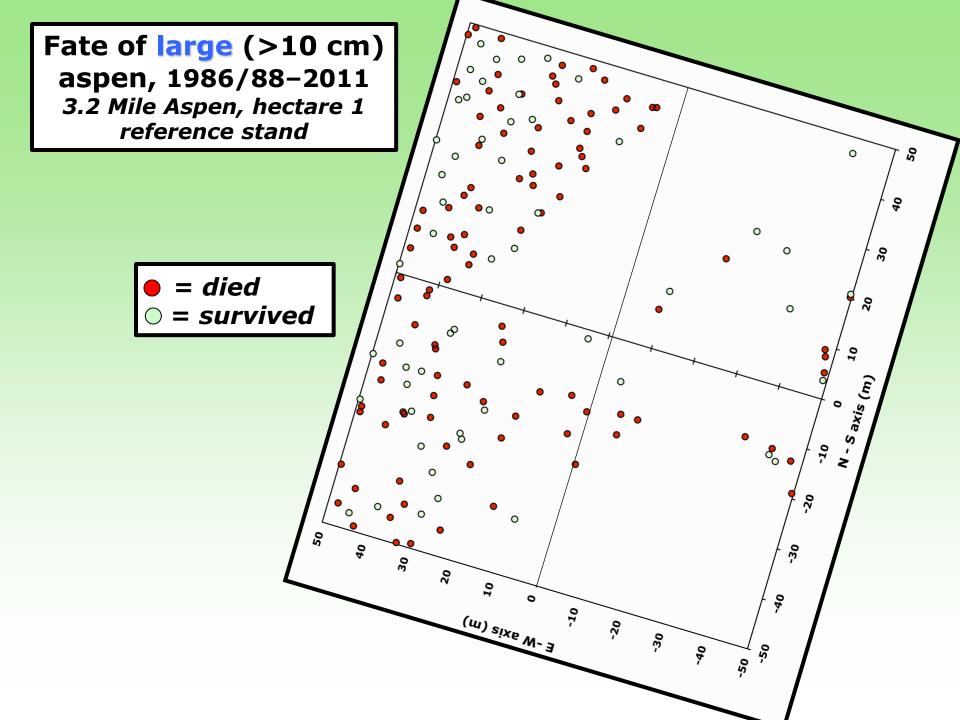
Climate and Growth of Interior Alaska Aspen 1906-97 (no 1927, 1966-69)

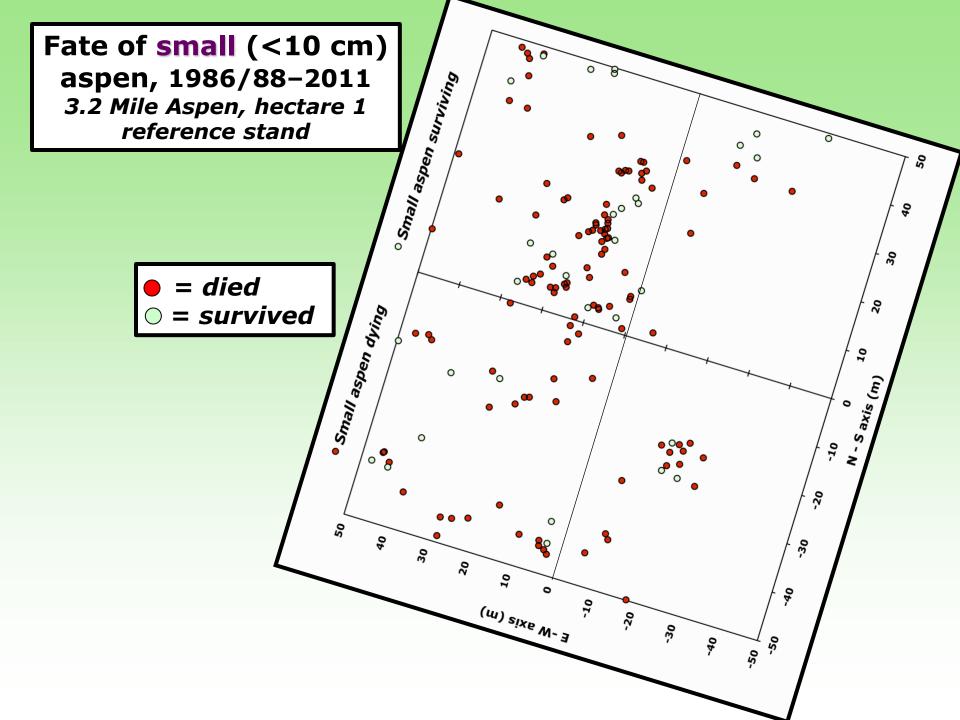


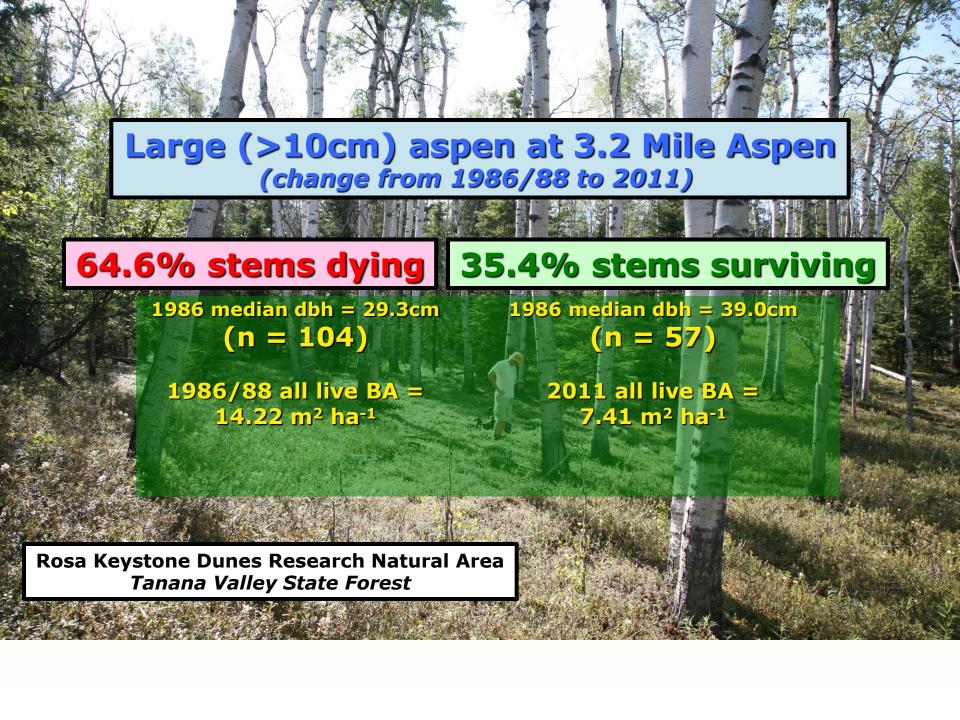
3.2 Mile Aspen reference stand – hectare 1 (132A) (Bonanza Creek Experimental Forest Unit BNZ LTER)











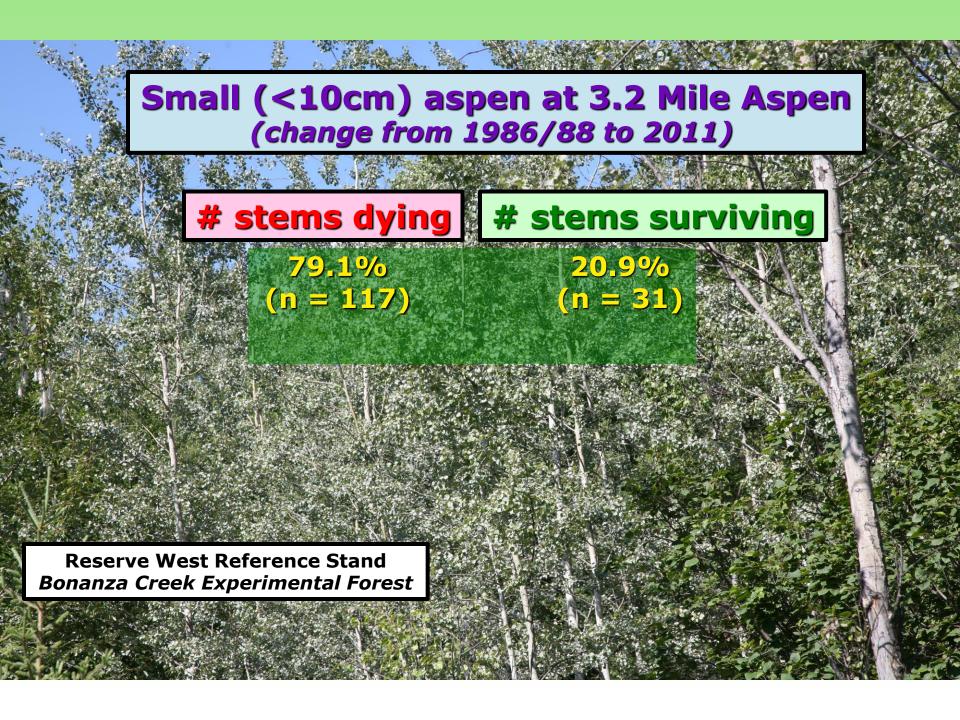


Photo point 132A100UP

1993



Photo point 132A100UP

2007

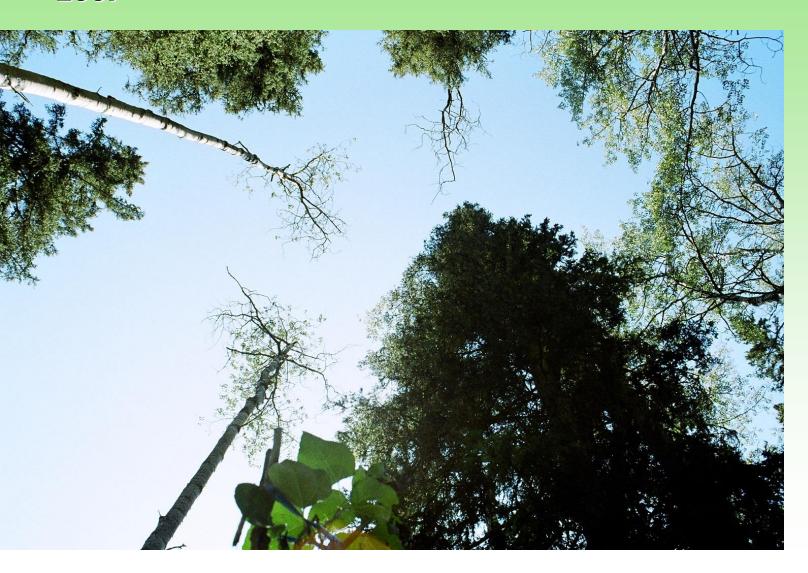


Photo point 132A100UP 2010

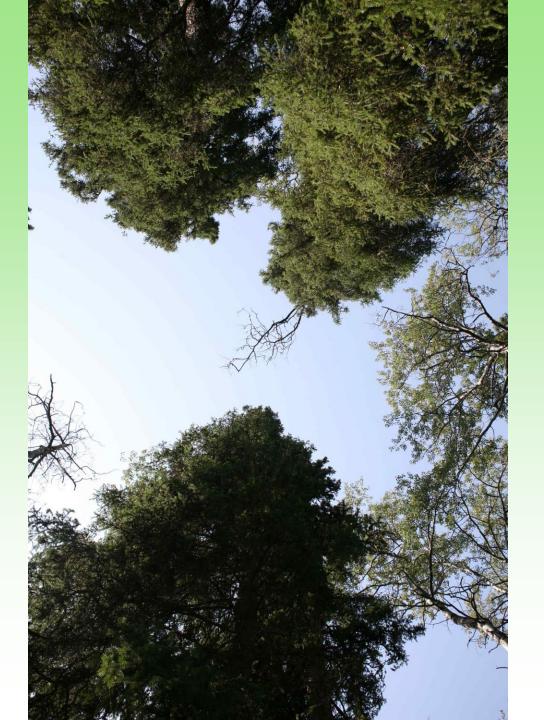


Photo point 132A100UP 2012

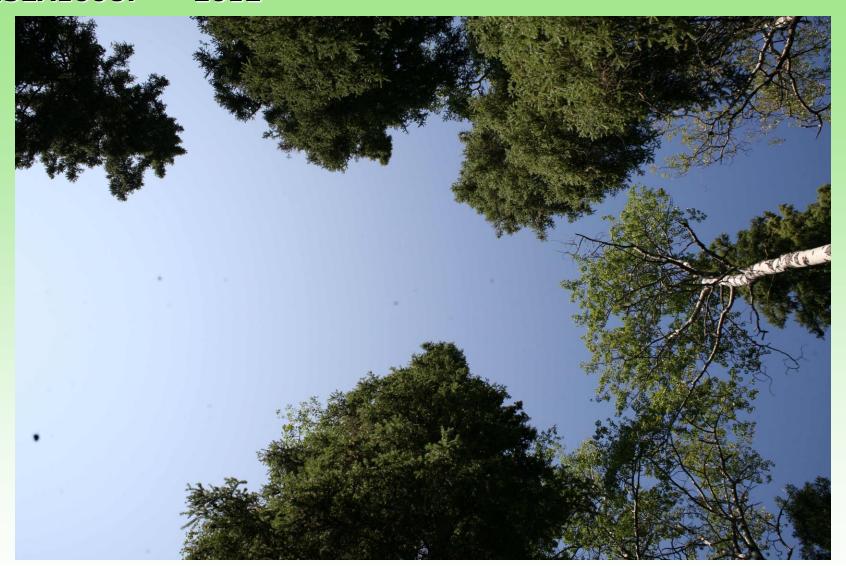
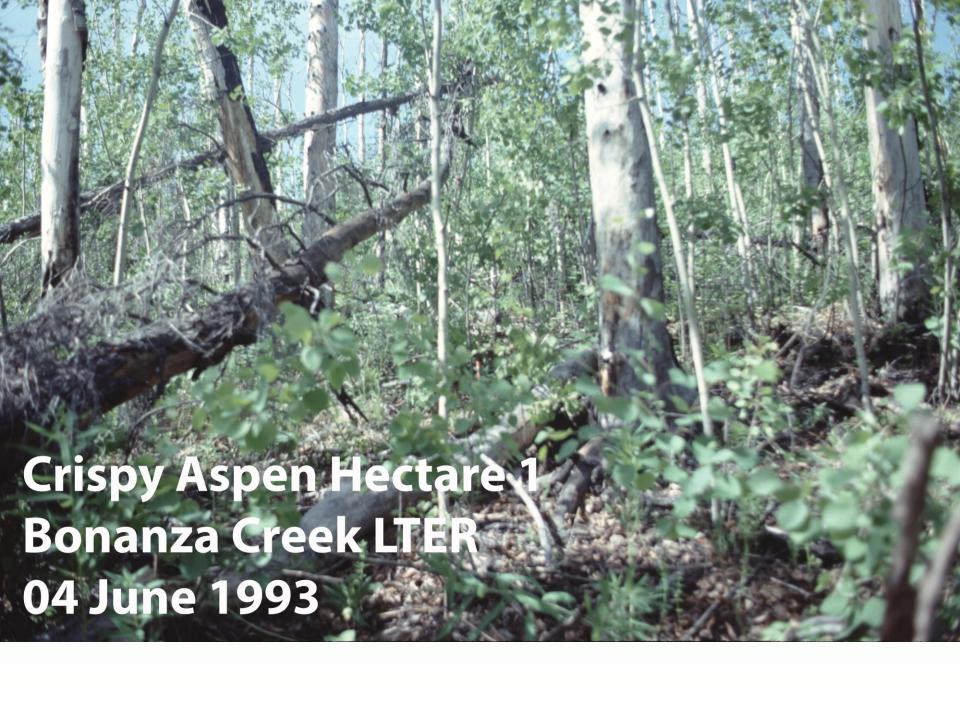
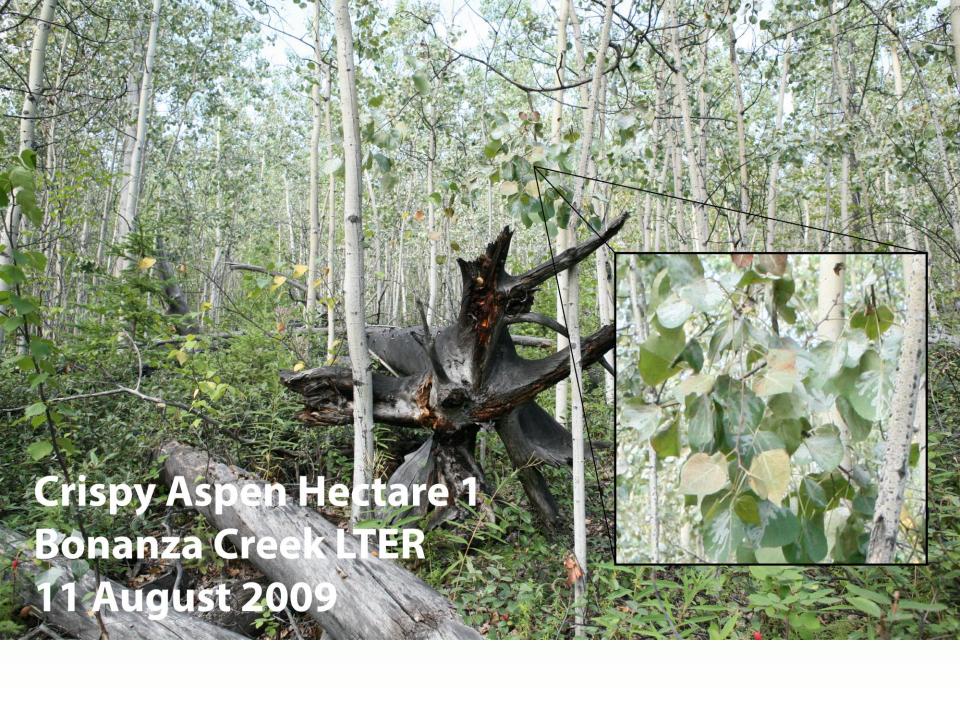
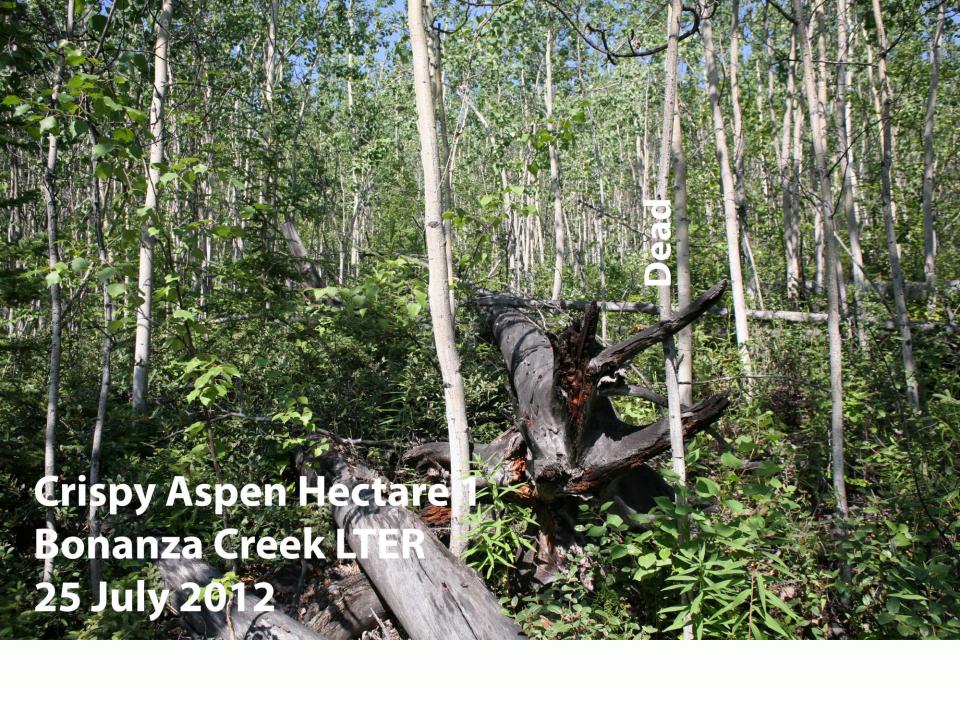


Photo point 132A100UP 2013

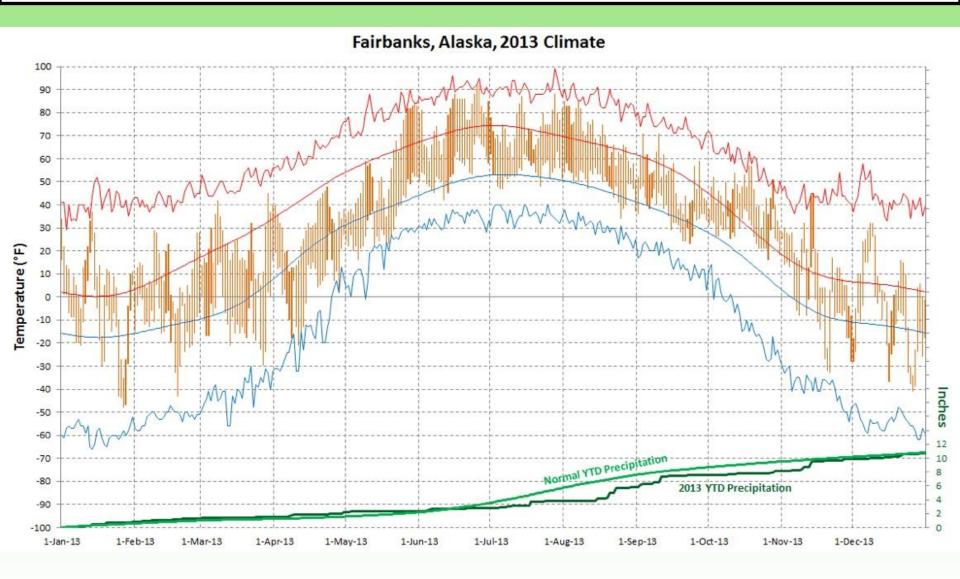








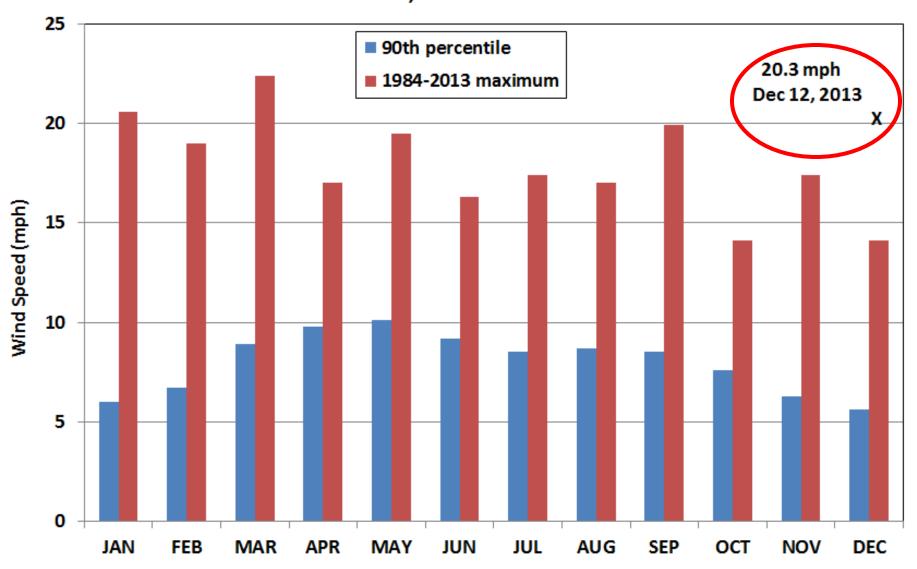
Calendar 2013: way below and way above normal



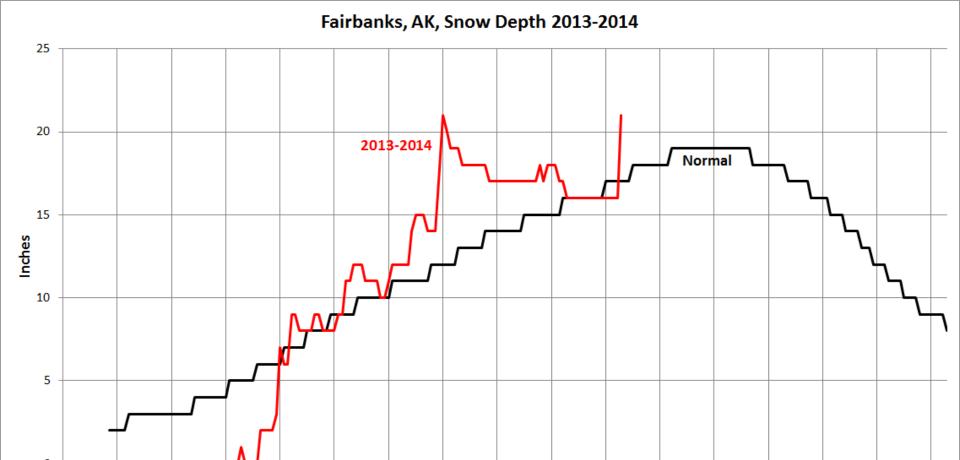
Source: http://ak-wx.blogspot.com

Annual Maximum Wind Speed (mph) Fairbanks, AK GHCN data Source: http://ak-wx.blogspot.com 70 ---1-minute average 60 2-minute average 5-second average ---Peak gust 50 Wind Speed (mph) 40 30 20 2013: Record wind - by fall 10 0 1998 2006 2002

Monthly Maximum and 90th Percentile of Daily Average Wind Speed Fairbanks, AK 1984-2013



Source: http://ak-wx.blogspot.com



Snow Depth ∼ normal

27-Apr

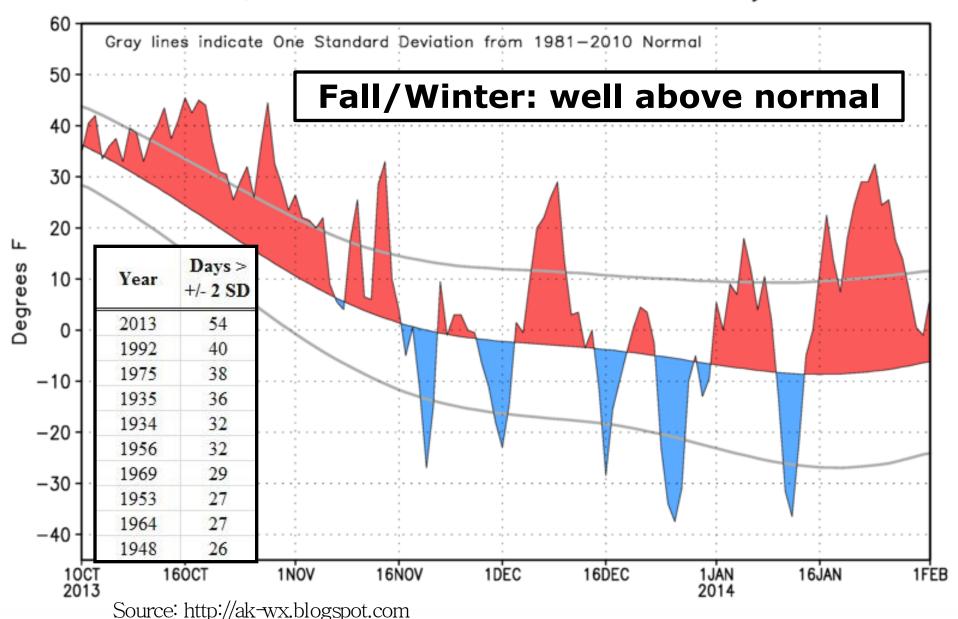
13-Apr

Source: http://ak-wx.blogspot.com

27-Oct

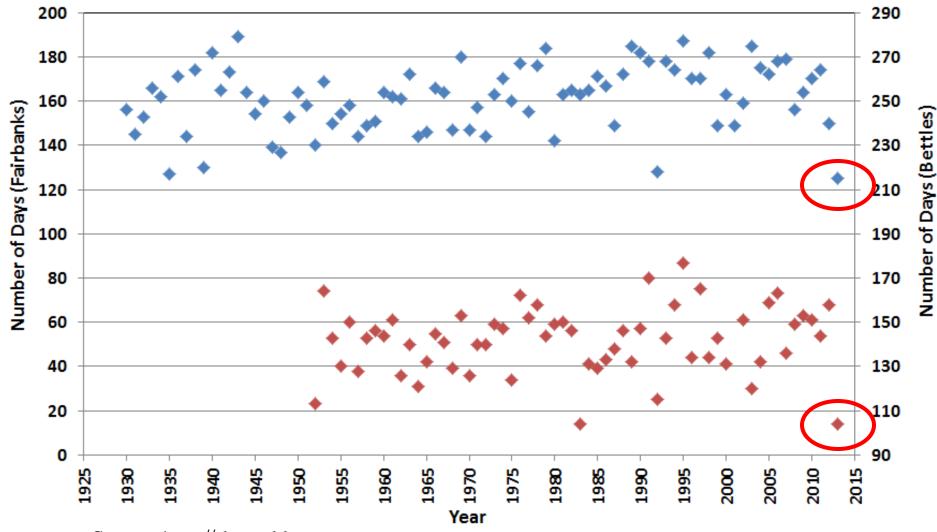
10-Nov

Daily Mean Temperature (°F)
Fairbanks, AK 1 October 2013 — 1 February 2014

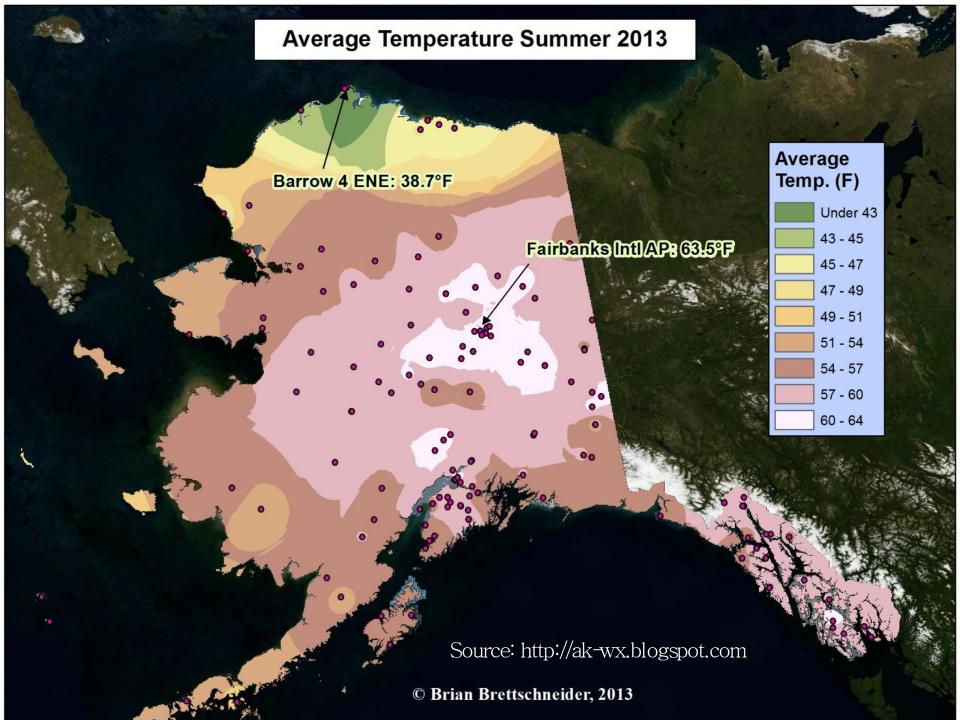


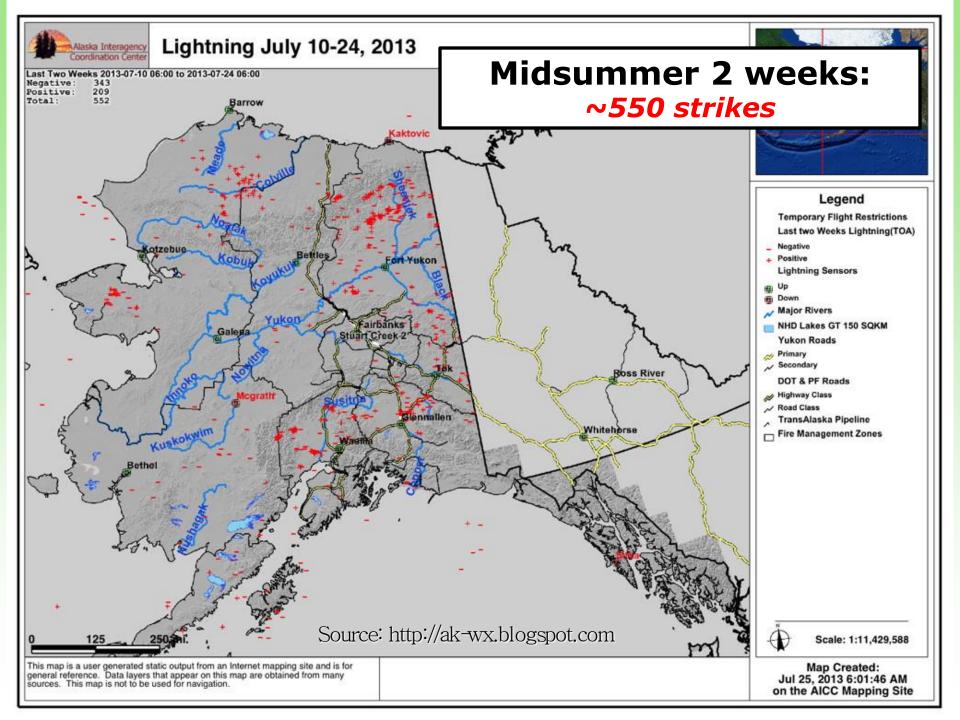
Length of Continuous Summer Thaw Season (Daily Mean Temp > 32 °F)

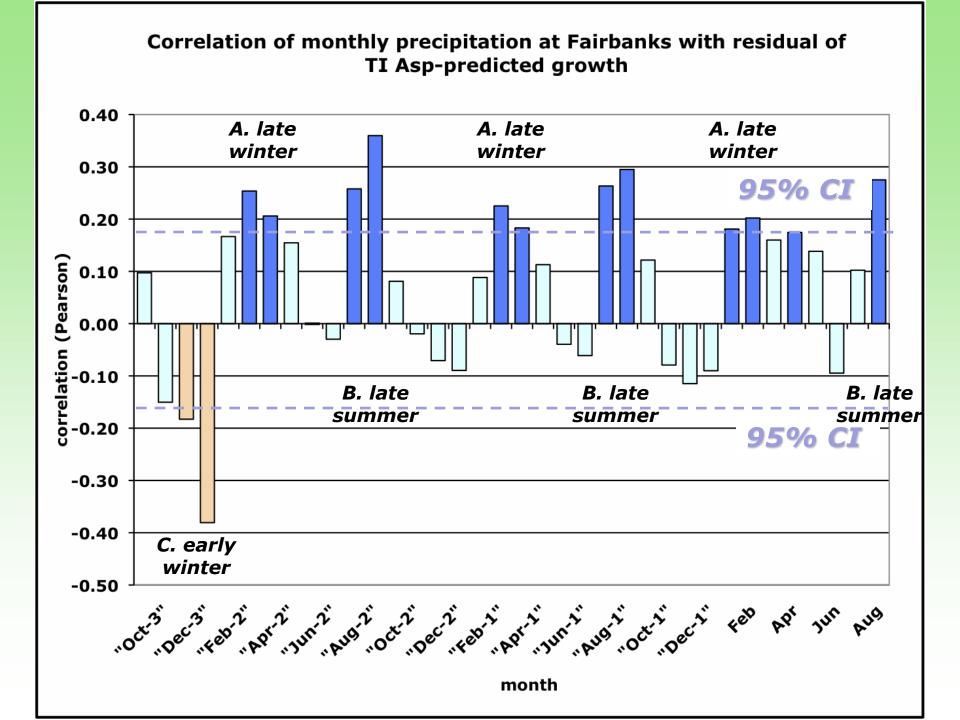
Fairbanks, AK (left axis, blue) 1930-2013 Bettles, AK (right axis, red) 1952-2013



Source: http://ak-wx.blogspot.com







Temperature Index (TI)

- mean of MMT for May, -1Jul, -2Jul
- negatively correlated with rwi

Supplemental Precipitation Index (SPI)

- constr. from 14 (of 36) months total precip.
- selection based on correl w/ rt-bp @95%CI
- 12 positive, 2 negative correl. w/ rt-bp
- $SPI = (M_1 + M_2 ... M_{12}) (M_{13} + M_{14})$
- positively correlated with rwi

Climate Favorability Index (CFI)

- *CFI* = *SPI TI*
- positively correlated with rwi

Each black dot = climate data from a weather station within the entire North American distribution of aspen

