Changes in Plant Canopy Structure in Response to Warming

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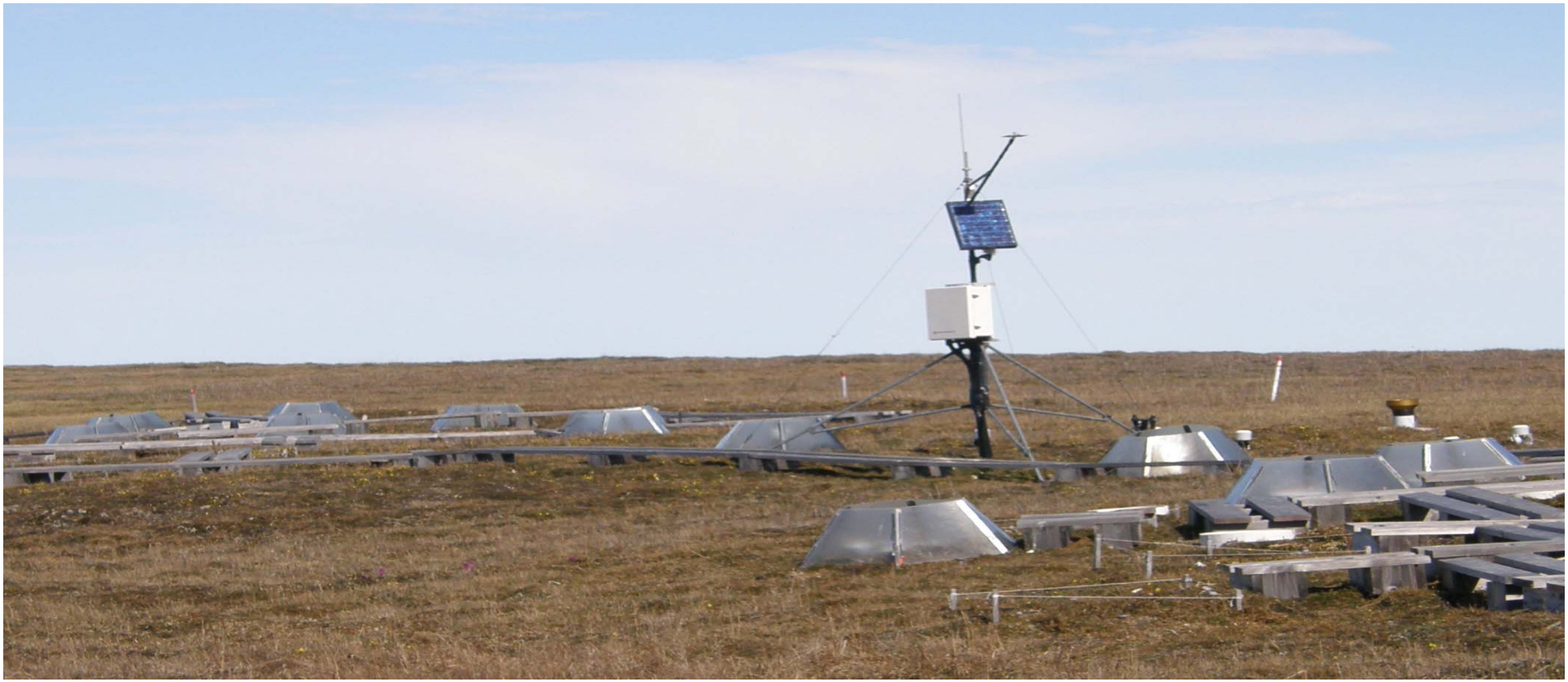
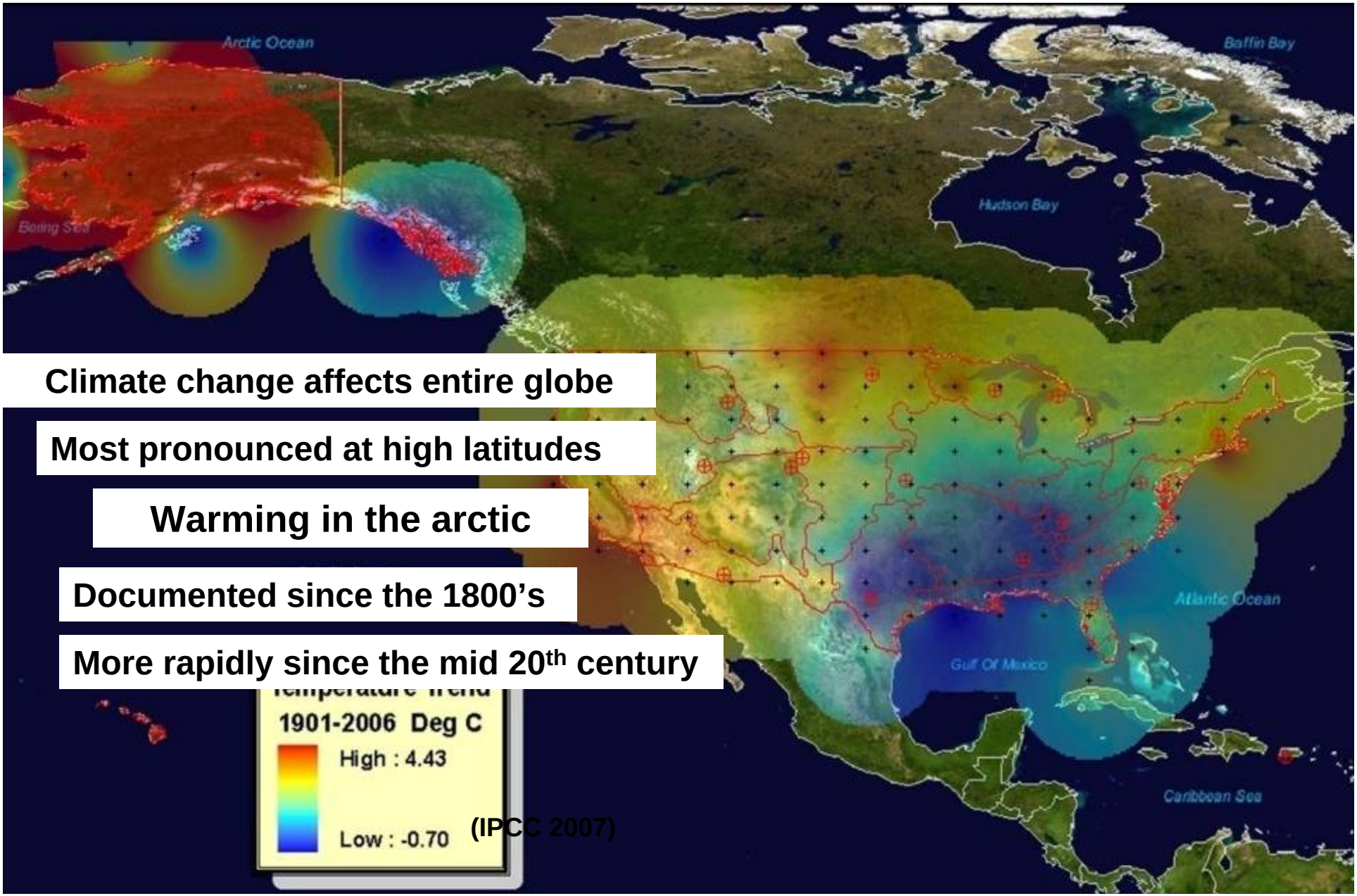


Climate Change and the Arctic



Climate change affects entire globe

Most pronounced at high latitudes

Warming in the arctic

Documented since the 1800's

More rapidly since the mid 20th century

(IPCC 2007)

Effects of Warming on Tundra Plants

Even small variations in the environment effect community function

Reproductive effort, growth rates, and nutrient cycling

(Chapin and Shaver, 1985)

Responses to warming are often within one growing season

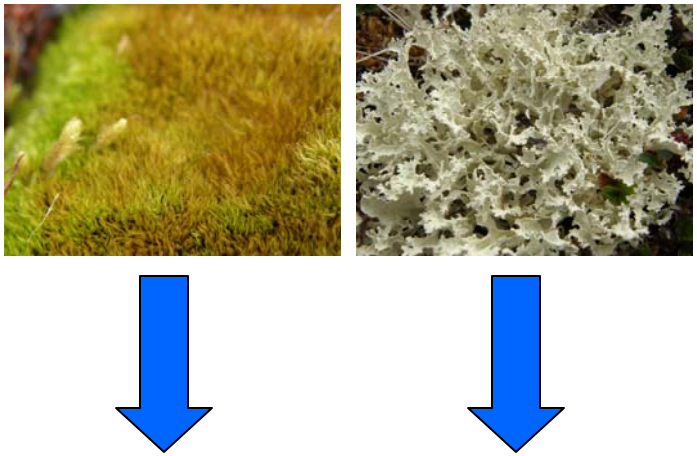
Graminoids and Shrubs often show the most increased growth

(Arft et al, 1999; Hobie and Chapin, 1998)

Increased growth of these taller strata shifts competitive advantage

Bryophytes and lichens become light deficient and decline in abundance

(Epstein et al, 2004; Wahren et al 2004)



Hypotheses

1. Increase in overall canopy heights for each site with warming

2. All individual functional groups would increase in height with warming

3. Community dynamics will shift to a more closed canopy

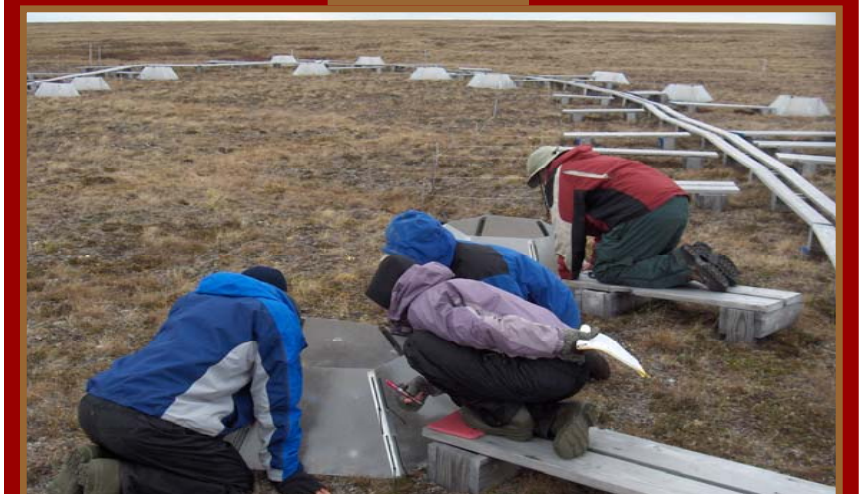
Site Locations

Barrow

DRY

WET

Atqasuk



Site Setup and Warming

24 Warmed and 24 Control plots

All plots are $1m^2$

Open-Top Chambers (OTC)

Light enters and traps heat in

Established between 1994-96

International Tundra Experiment (ITEX)

Point Frame Method

Summers of 2007-08

Same 2 weeks each year

Point Frame Grid

-75cm by 75cm

-100 points

Measurements

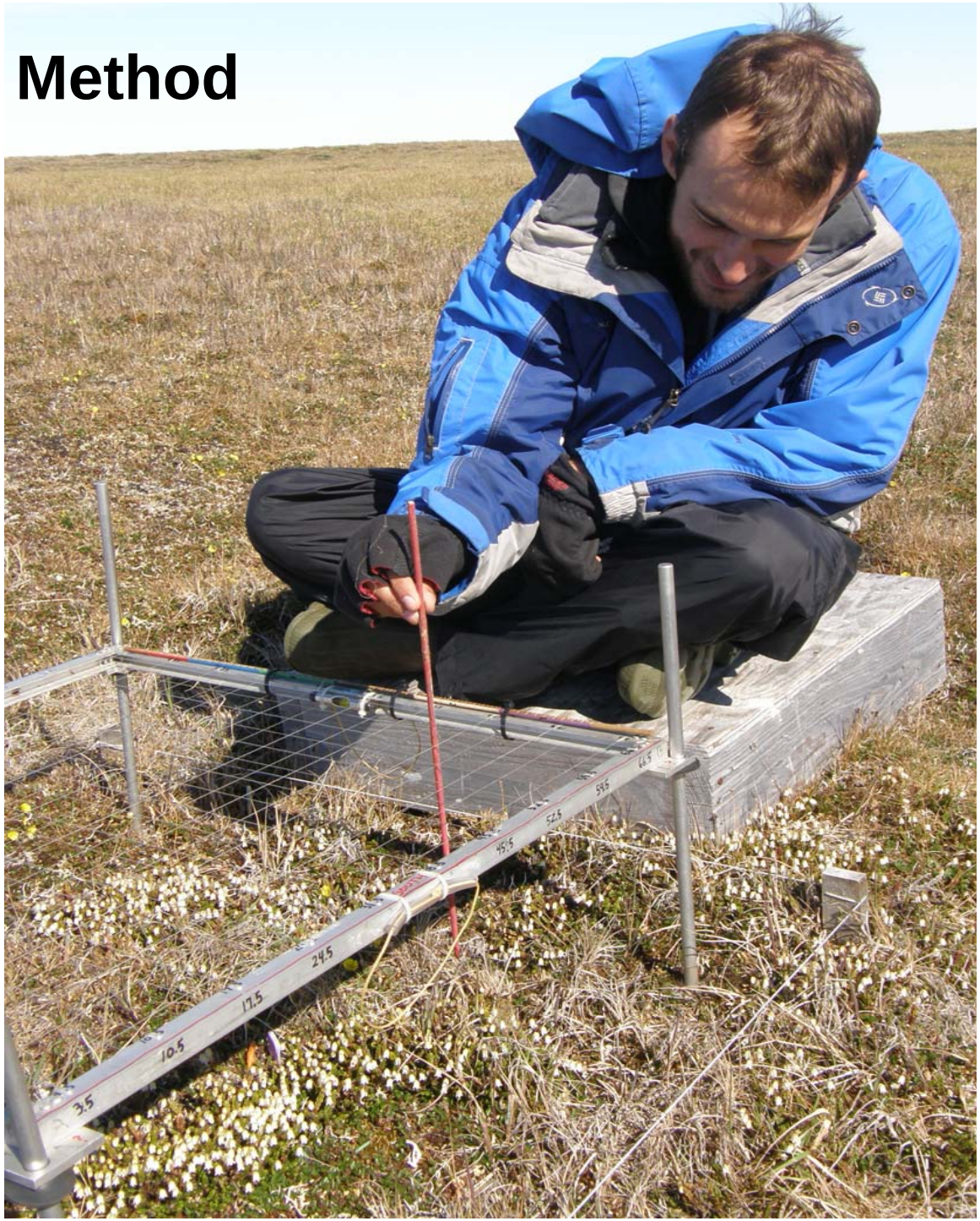
-At each point

Species

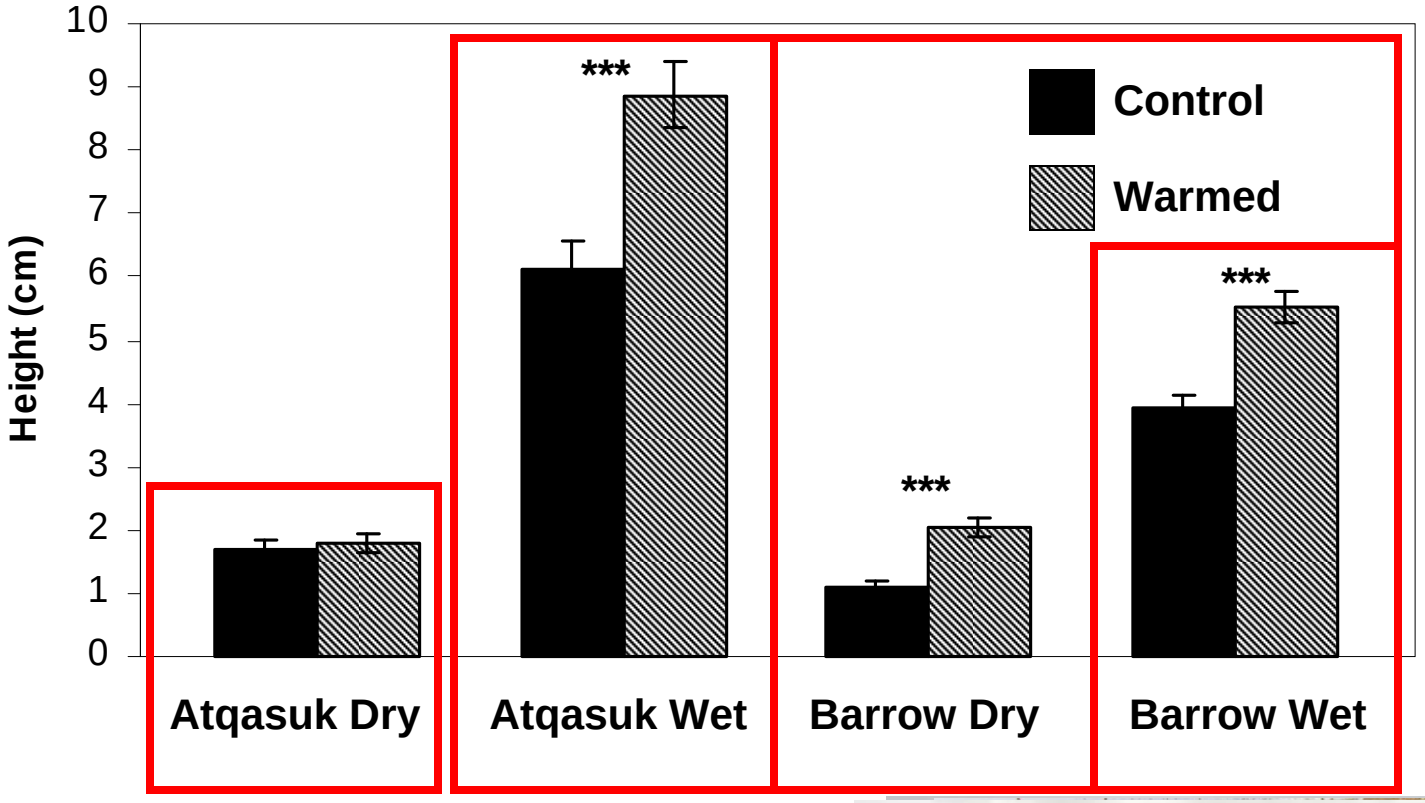
Live/Dead Status

Height

(Hollister et al, 2005)



Canopy Height By Site

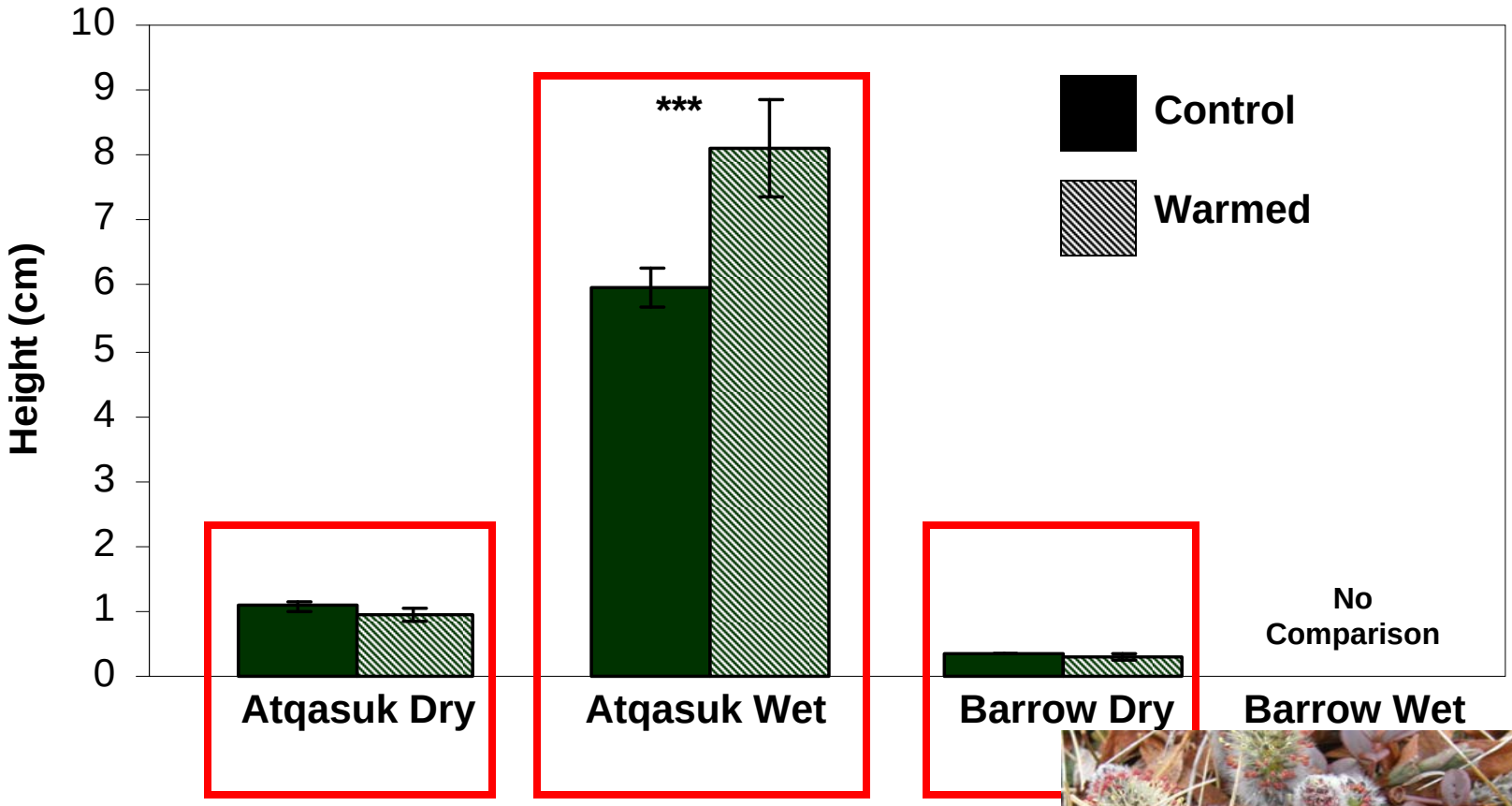


No change in the Atqasuk Dry Site p=0.540

Taller canopy for all other sites All p<0.0001

Wet sites increased the most

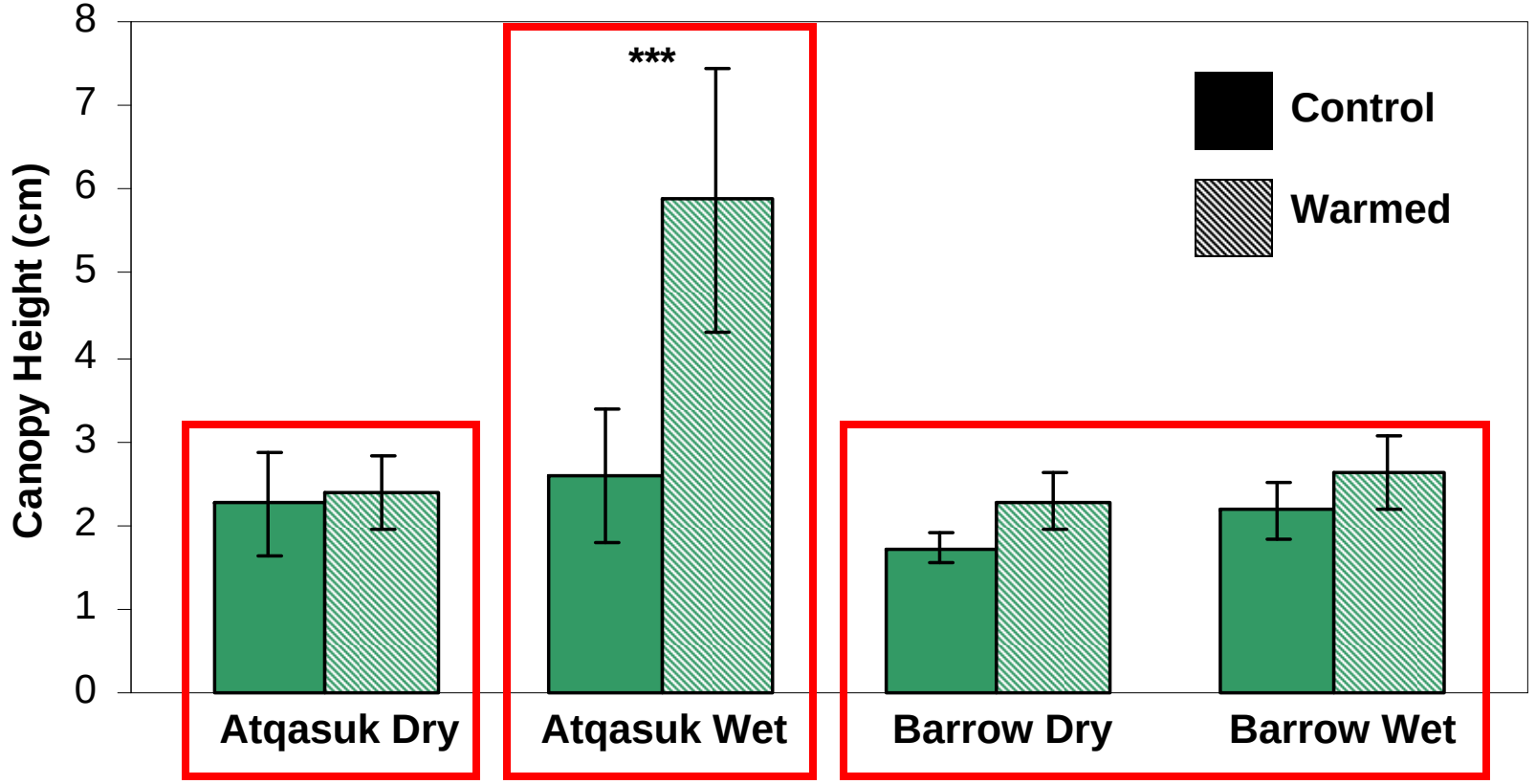
Shrub Height



No change in Dry Sites Both p>0.28

Taller Shrubs in the Atqasuk Wet Site p=0.011

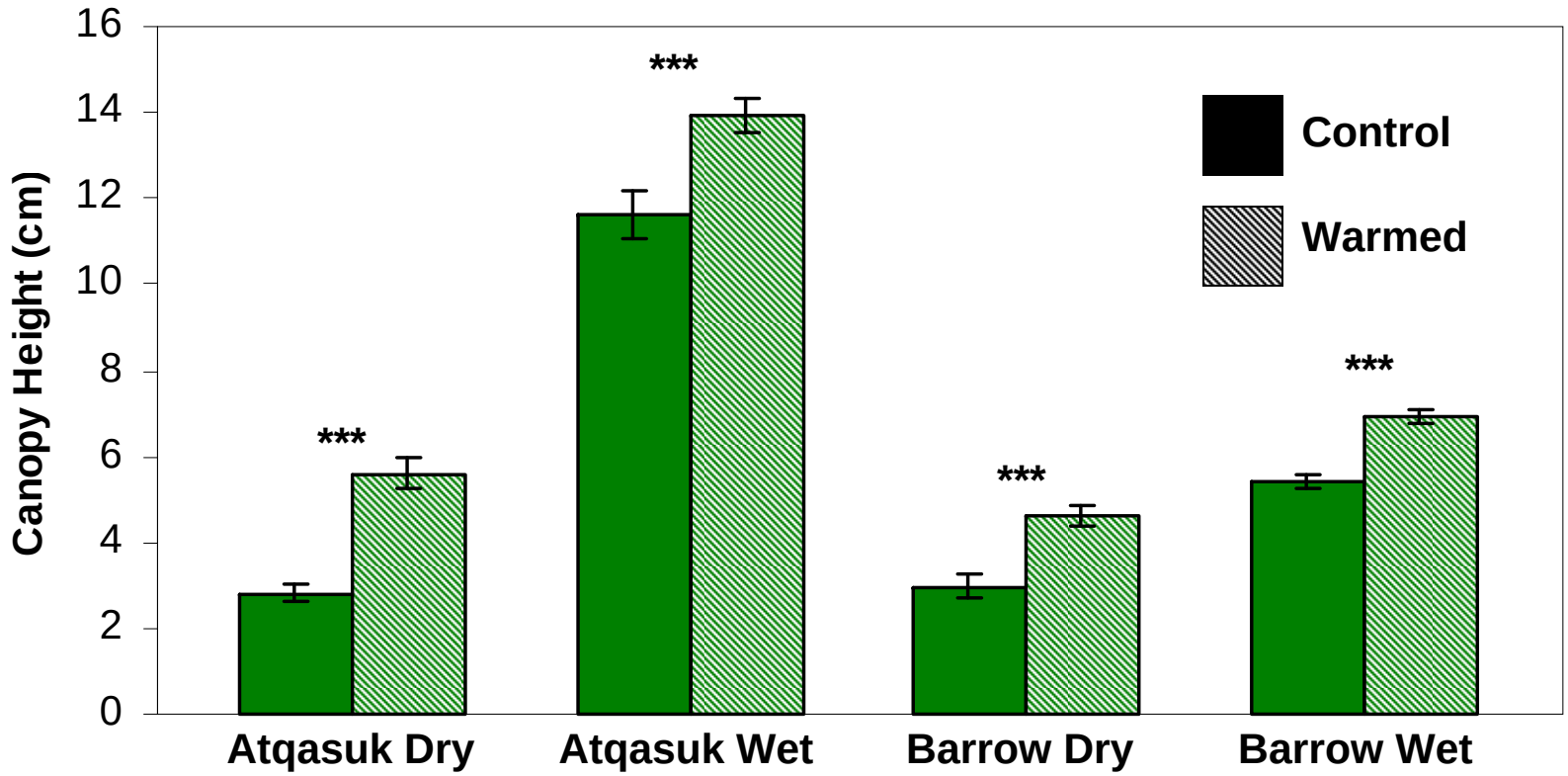
Forb Height



Forbs were taller in Atqasuk Wet Site p=0.011

Other sites had an increasing trends All p>0.141

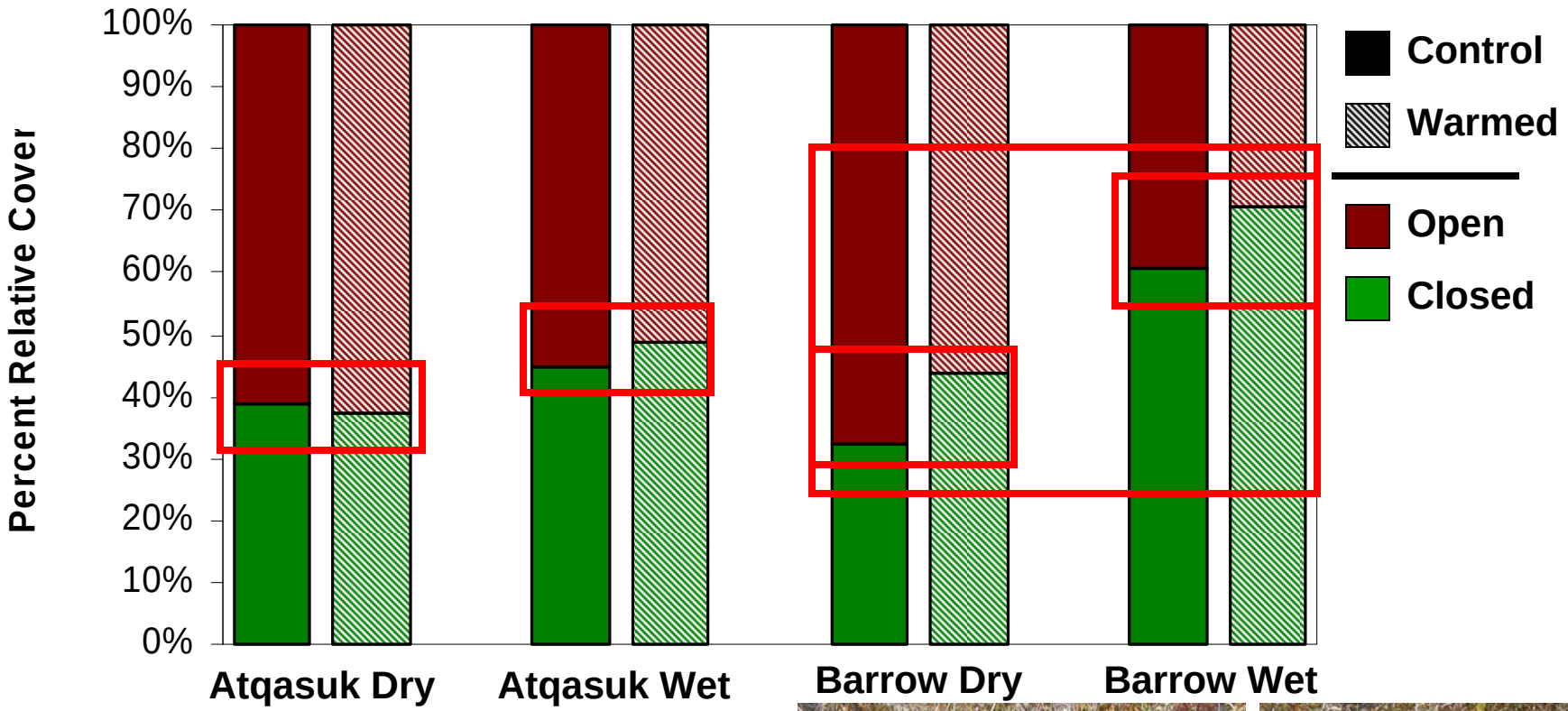
Graminoid Height



Graminoids were taller All p<0.02

Graminoids most influential driving Canopy Height (shown before)

Canopy Openness

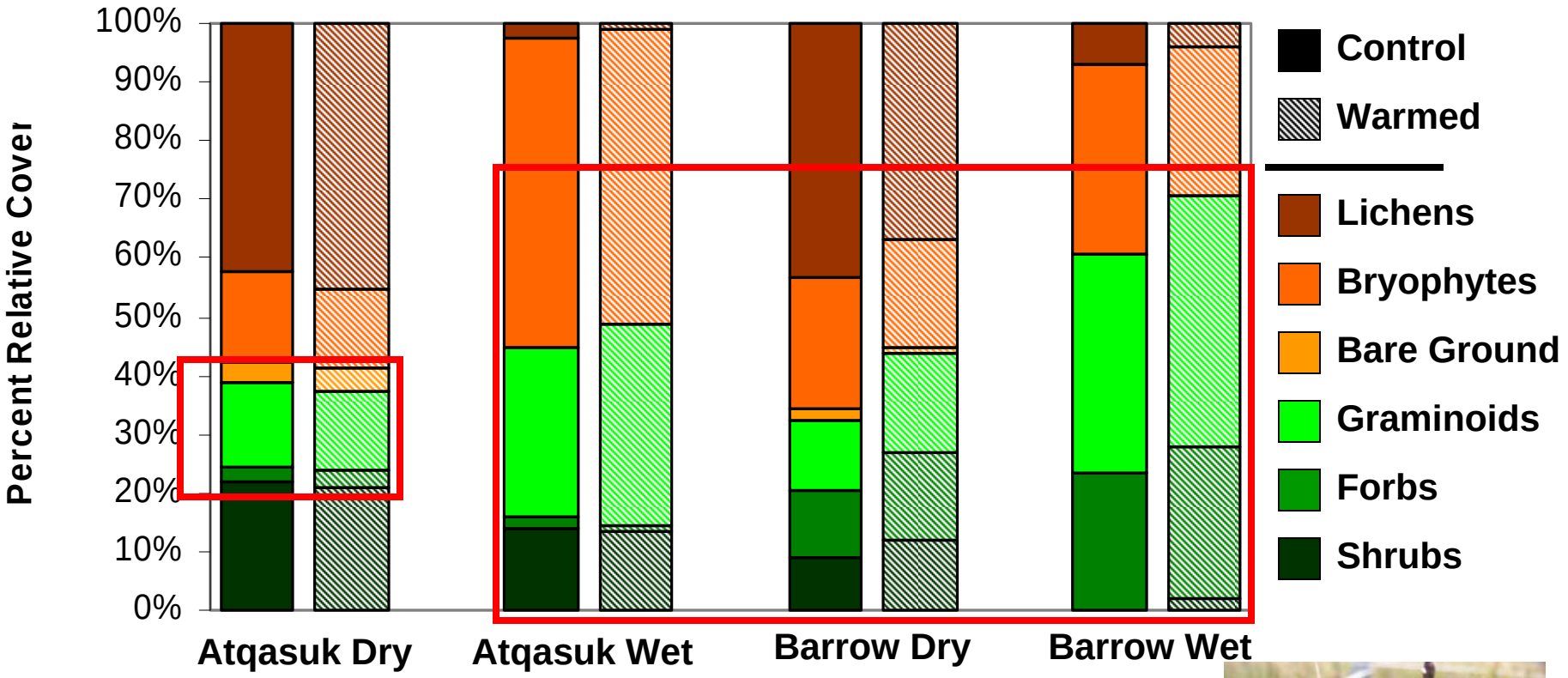


No change in Atqasuk Dry Site

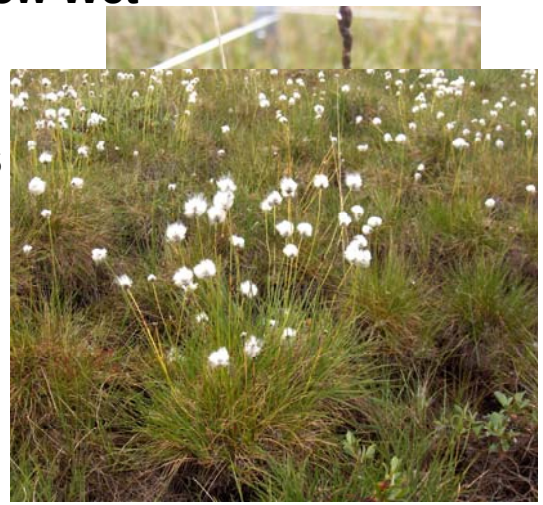
Other sites had more closed canopies

Barrow sites changed the most

Canopy Openness By Growth Form



Atqasuk Dry canopy opened due to a loss of graminoids



Other sites canopies closed

due to spread of graminoids and shrubs

Conclusion

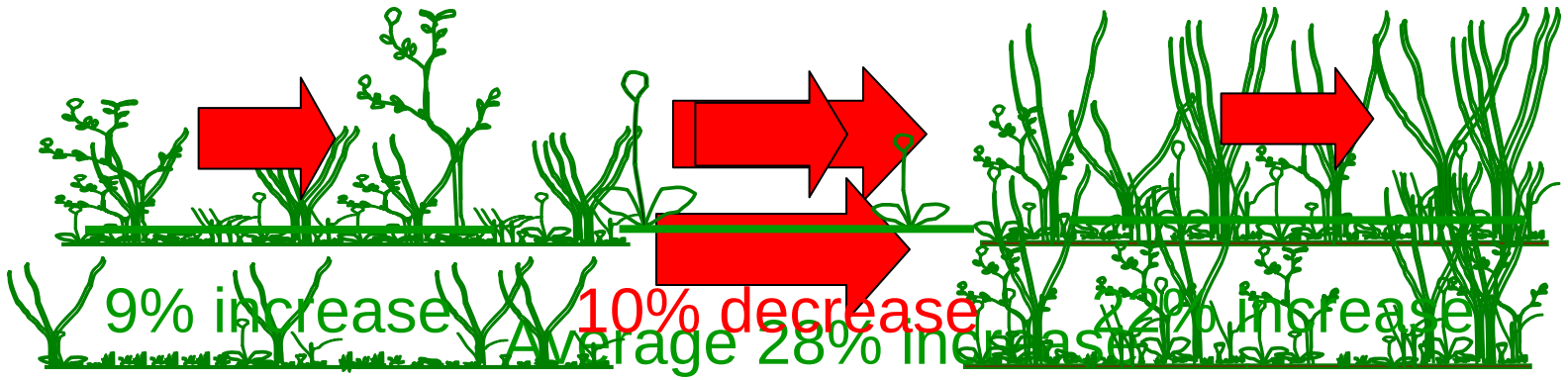
Warming caused:

Overall increase in canopy height

Most growth forms were taller

Overall closing of canopies

-Shrubs **-Forbs** **-Graminoids**



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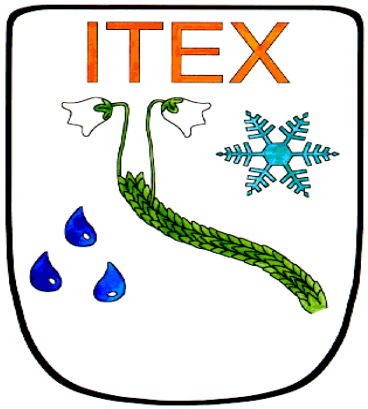

References

Arft, A.; M. Walker; J. Gurevitch, et al. 1999. “Responses of Tundra Plants to Experimental Warming: Meta-Analysis of the International Tundra Experiment”. *Ecological Monographs*. 69 (4). 491-511.

Chapin III, F. Stuart; and Gaius R. Shaver. 1985. “Individualistic Growth response of Tundra Plant Species to Environmental Manipulations in the Field”. *Ecology*. 66 (2). 564-576.

Epstein, Howard E.; Monika P. Calef; Marilyn D. Walker, et al. 2004. “Detecting changes in arctic tundra plant communities in response to decadal time scales”. *Global Change Biology*. 10 (8). 1325-1334.

Hobbie, Sarah E.; and Stuart Chapin III. 1998. “The response of Tundra Plant Biomass, Aboveground Production, Nitrogen and CO2 Flux to Experimental Warming.” *Ecology*. 79 (5). 1526-1544.

Hollister, Robert D.; Patrick J. Webber; Craig E. Tweedie. 2005. “The response of Alaskan arctic tundra to experimental warming: differences between short and long term responses”. *Global Change Biology*. 11. 525-536.

IPCC. 2007. Climate Change 2007. The Scientific Basis. Contribution of Working Group II to the Third Assessment Report on the Intergovernmental Panel on Climate Change. Cambridge University Press. Cambridge, United Kingdom. Pp 230.

Wahren, C.-H. A.; M. D. Walker; M. S. Bret- Harte. 2005. “Vegetation responses in Alaskan arctic tundra after 8 years of a summer warming and winter snow Manipulation experiment”. *Global Change Biology*. 11 (4) 537-552.

Questions?