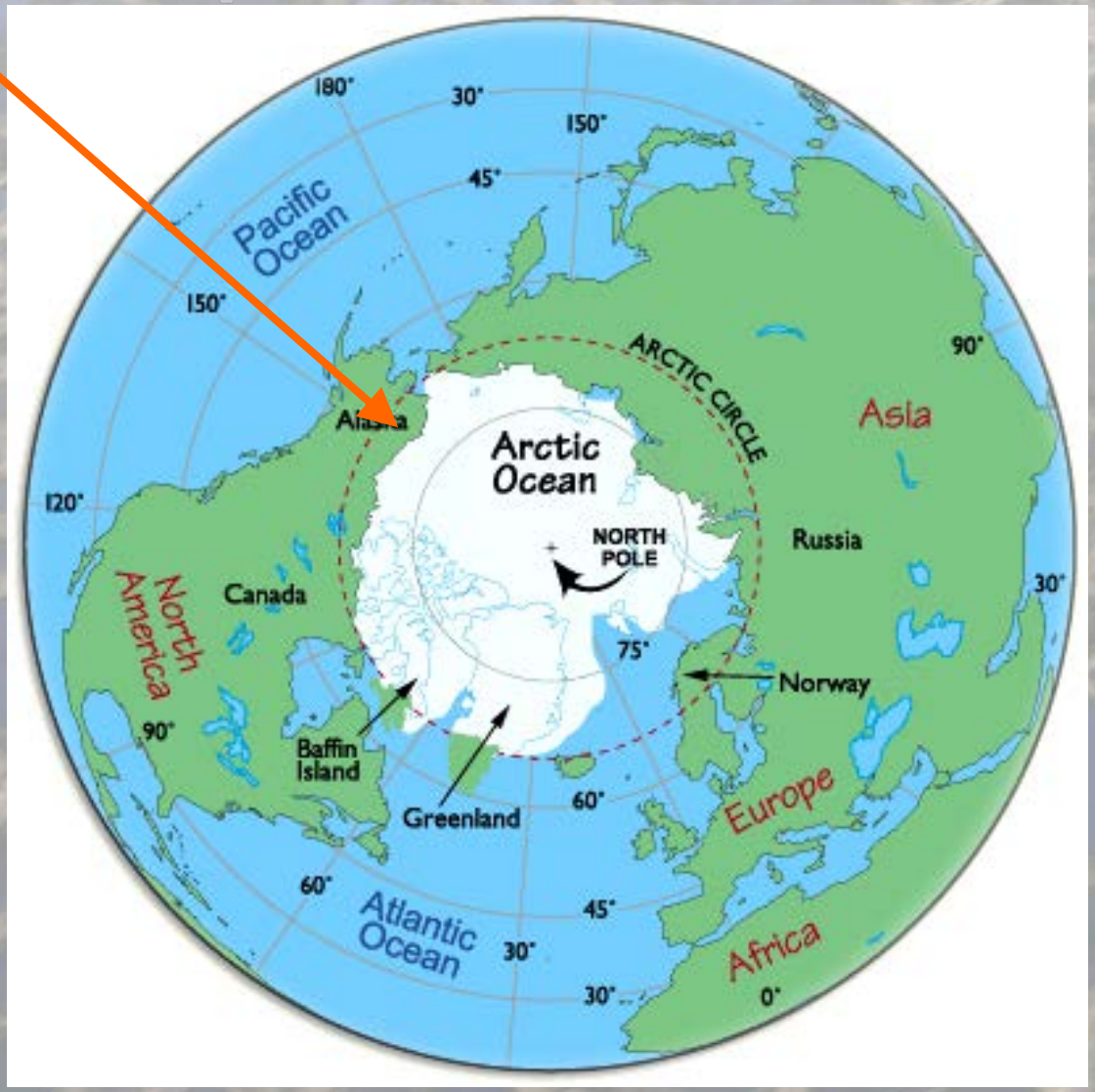
Expansion of southerly distributed species in the arctic in response to warming

Jennifer Liebig
Robert Hollister
Jeremy May
GVSU Biology Department

Abstract:

High latitude regions have experience and are expected to experience the most profound climate change. Here we examine the response of plant species to experimental warming at four sites in northernmost Alaska. The experiment was established between 1994 and 1996, and this study presents data collected in 2007 and 2008. Plant cover was sampled using a point frame method. Previous studies have found that when compared to the control plots, the warmed plots show an increase in the cover of vascular plants. This study examines the differences between plants species classified into four different regional zones published by Steven Young (1971). We found that species in Zone 4, the zone with the southernmost northern limit, always showed an increased cover in warmed plots, while the relative cover of species from the other zones varied among sites. The trend is that warmed plots show an increased in cover of more southerly species, which supports the prevailing wisdom.

Climate Change: Impacts on the Arctic



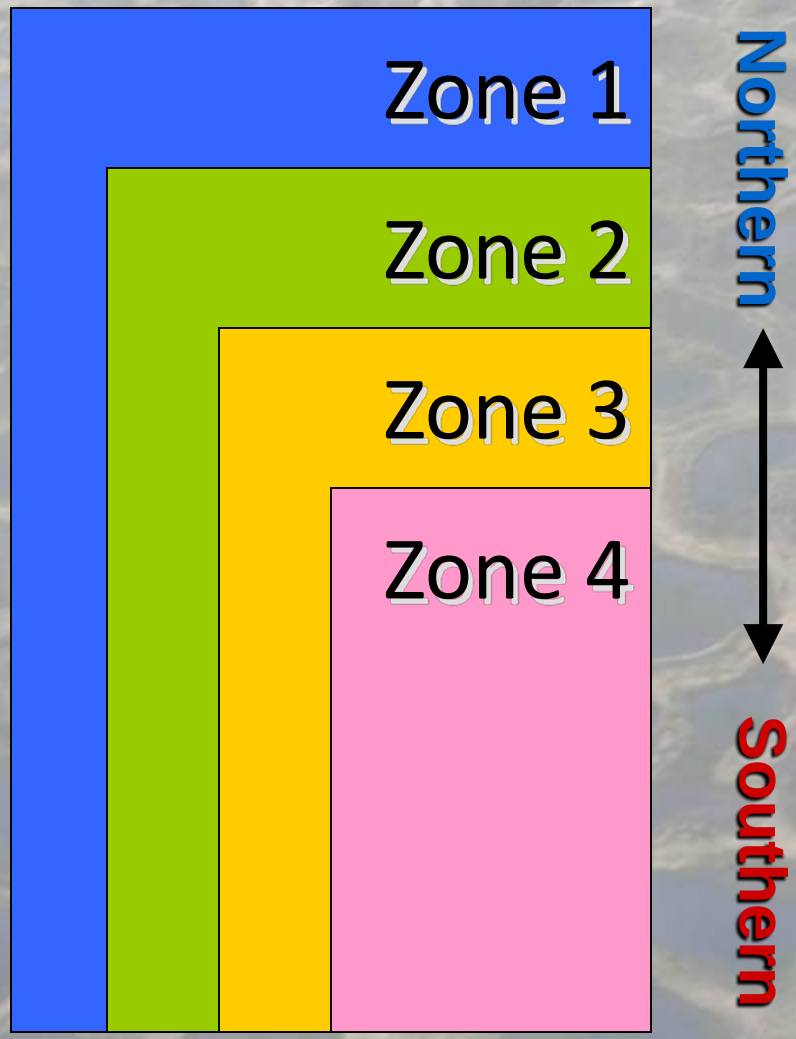
Expected Trends

N = Northern species

S = Southern species

Steven B Young (1971)

Used observations of vegetation on St. Lawrence Island to establish a zonation scheme of four zones based on the northern limits of species.



Zones:

1

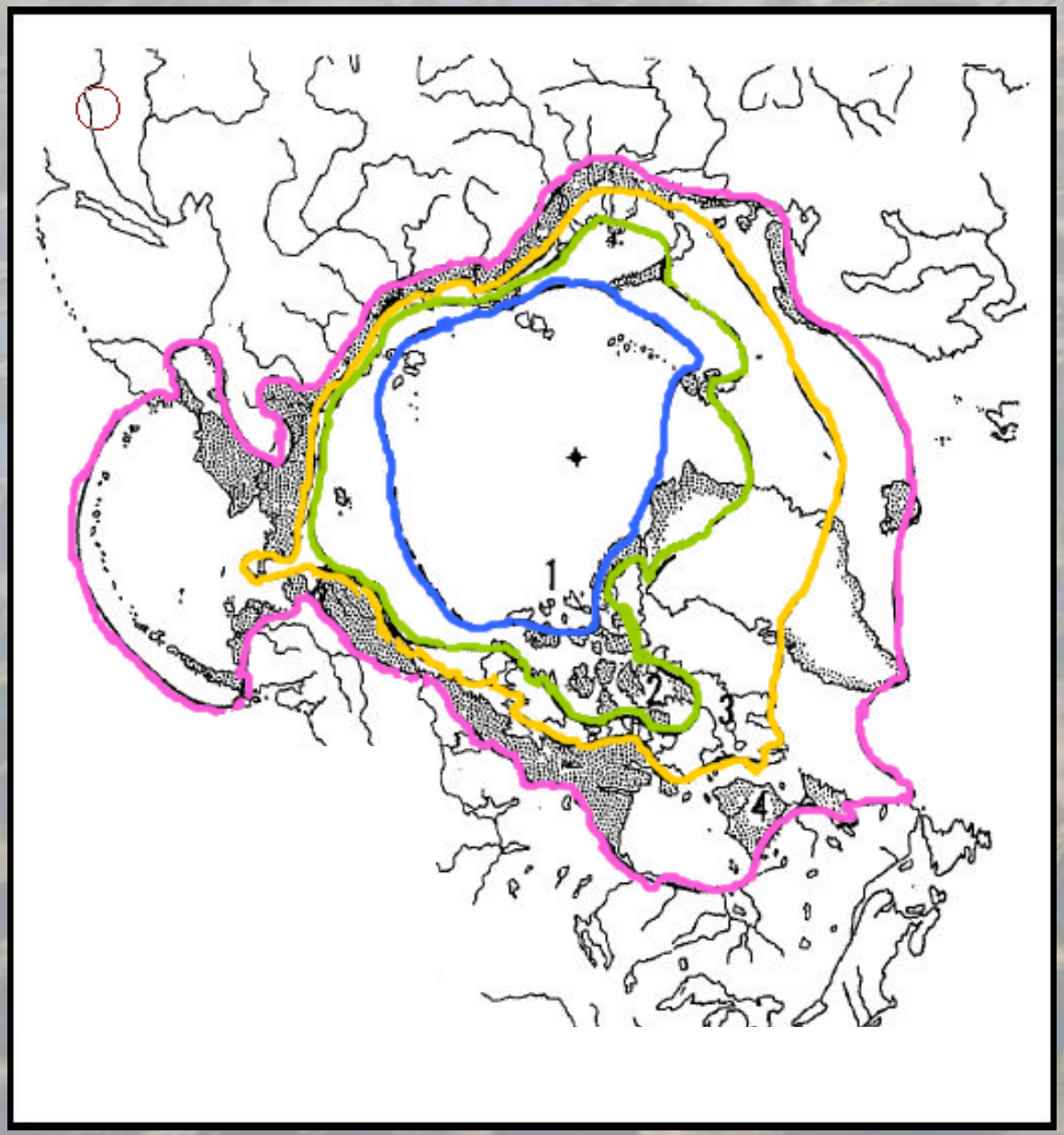
2

3

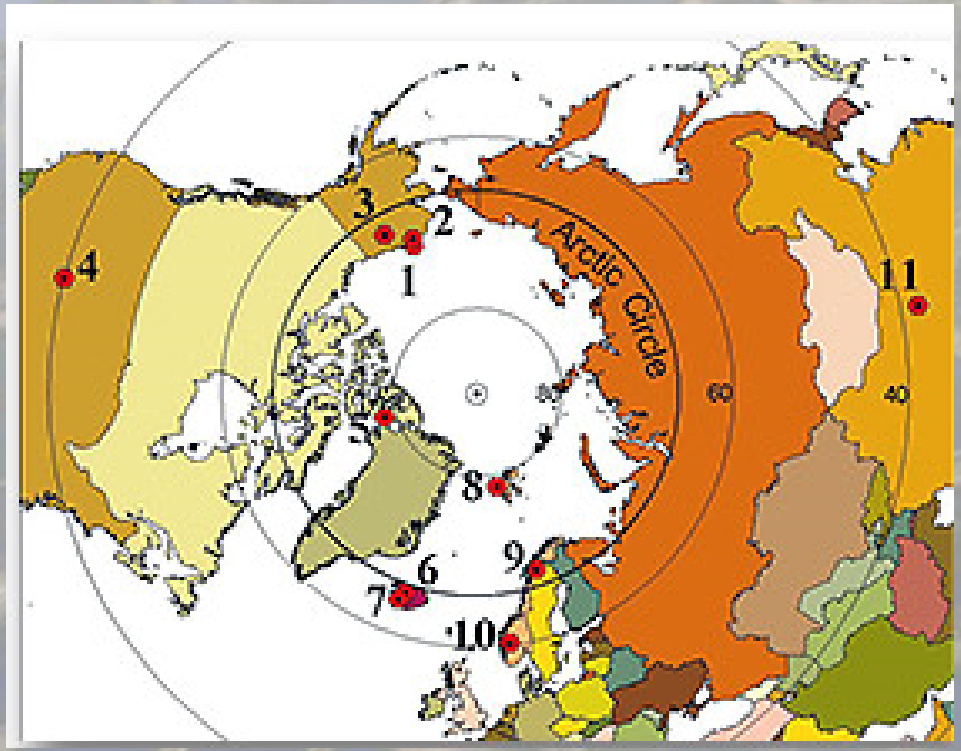
4

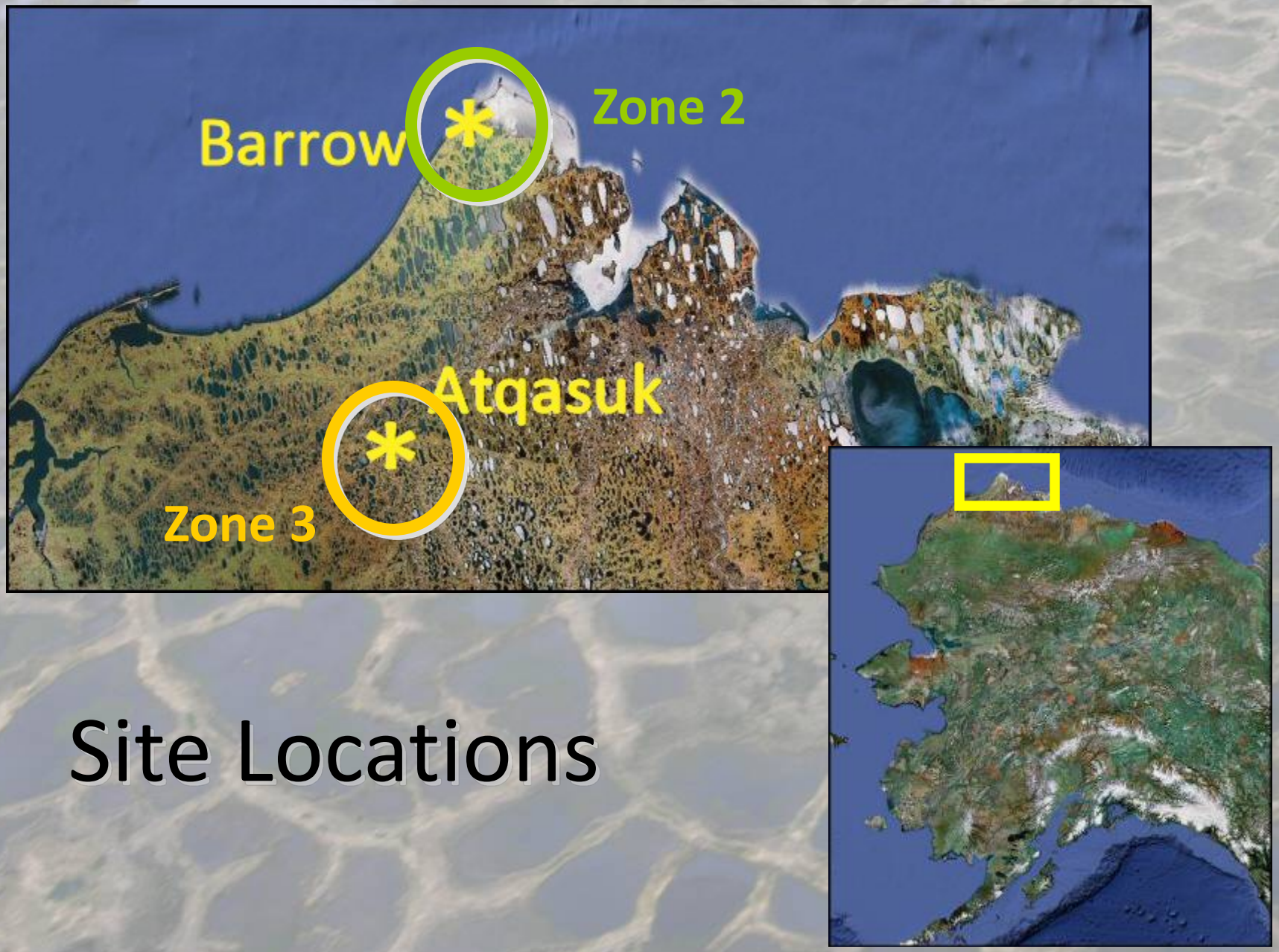
Northern

Southern

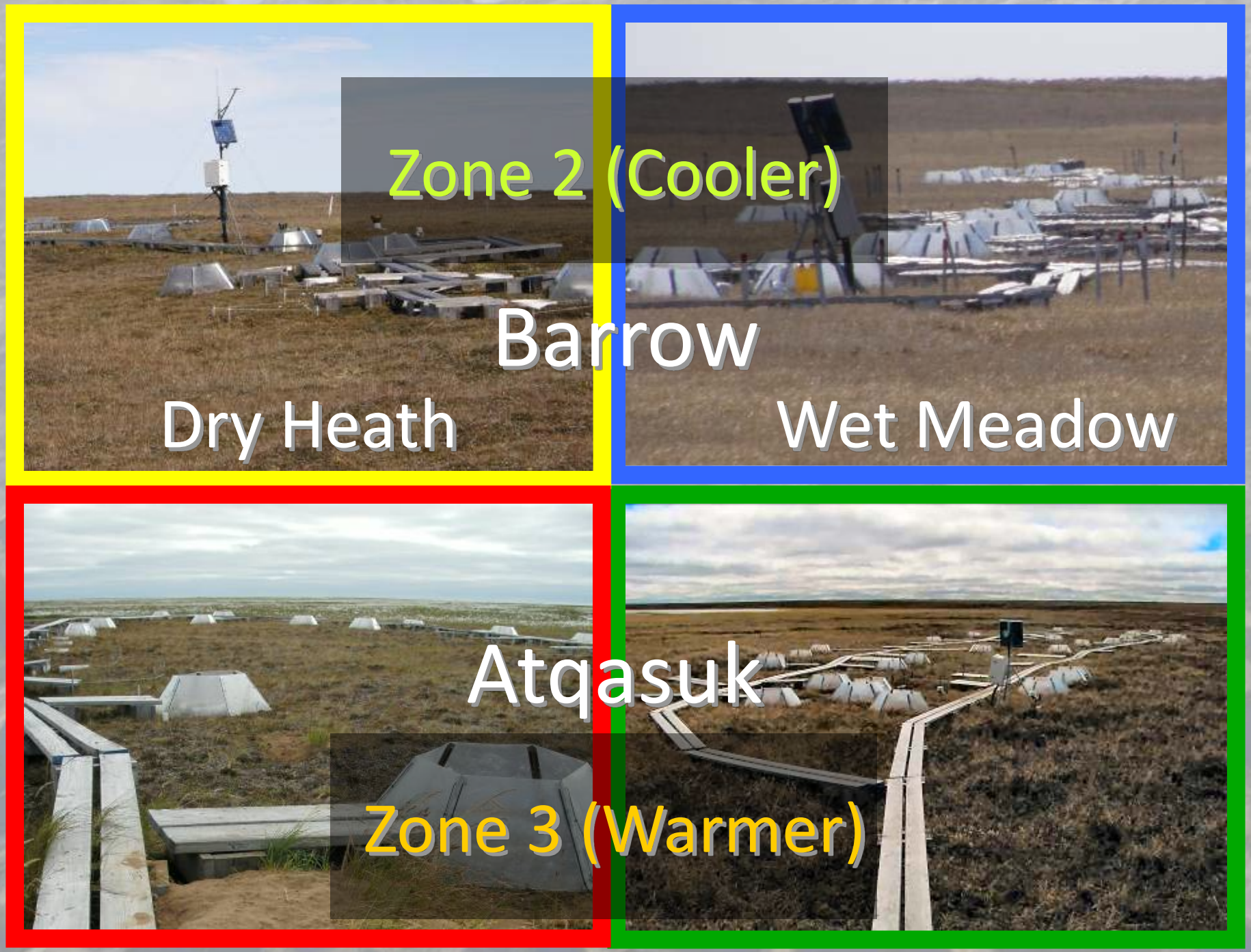


International Tundra Experiment



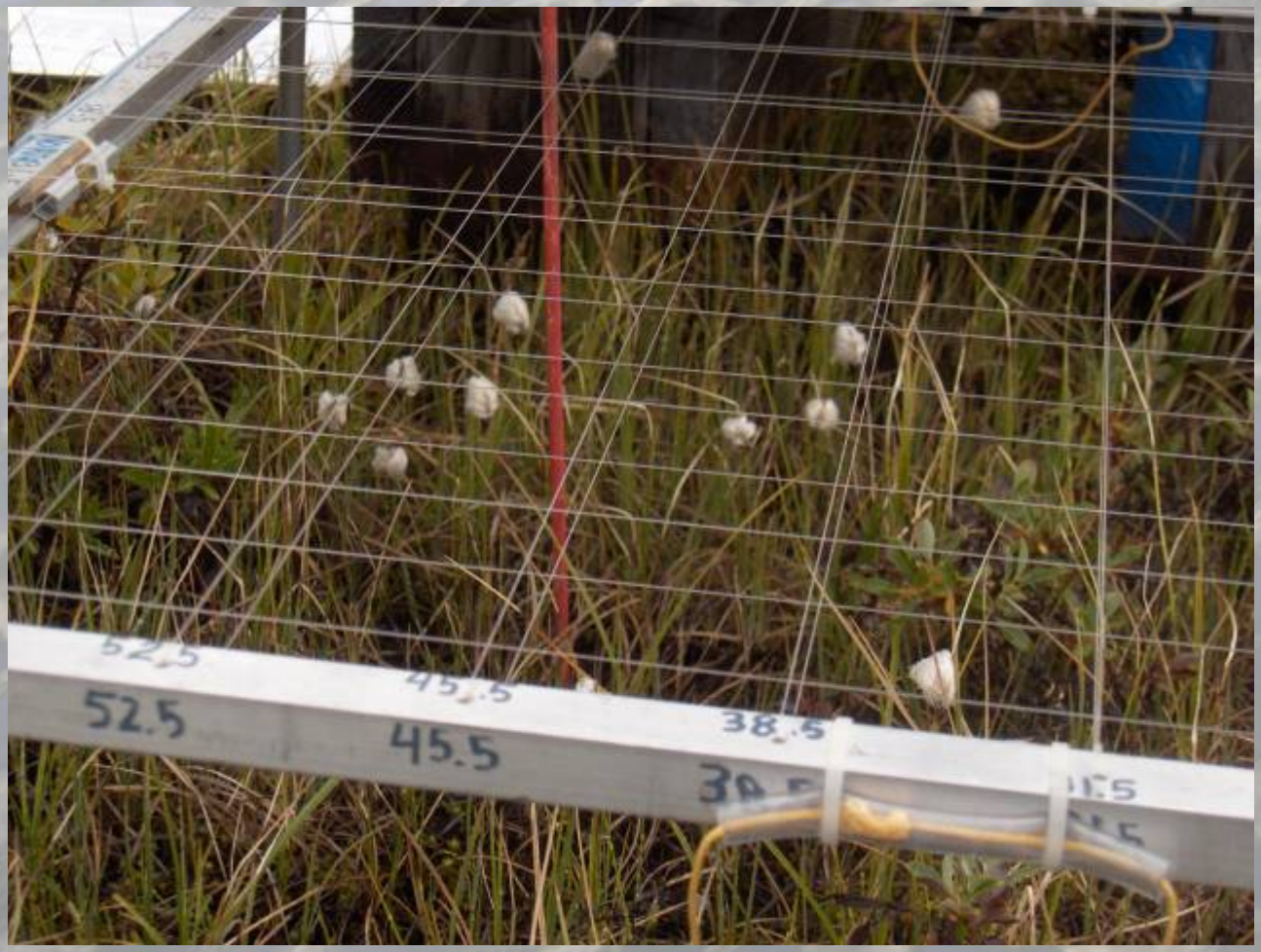


Site Locations

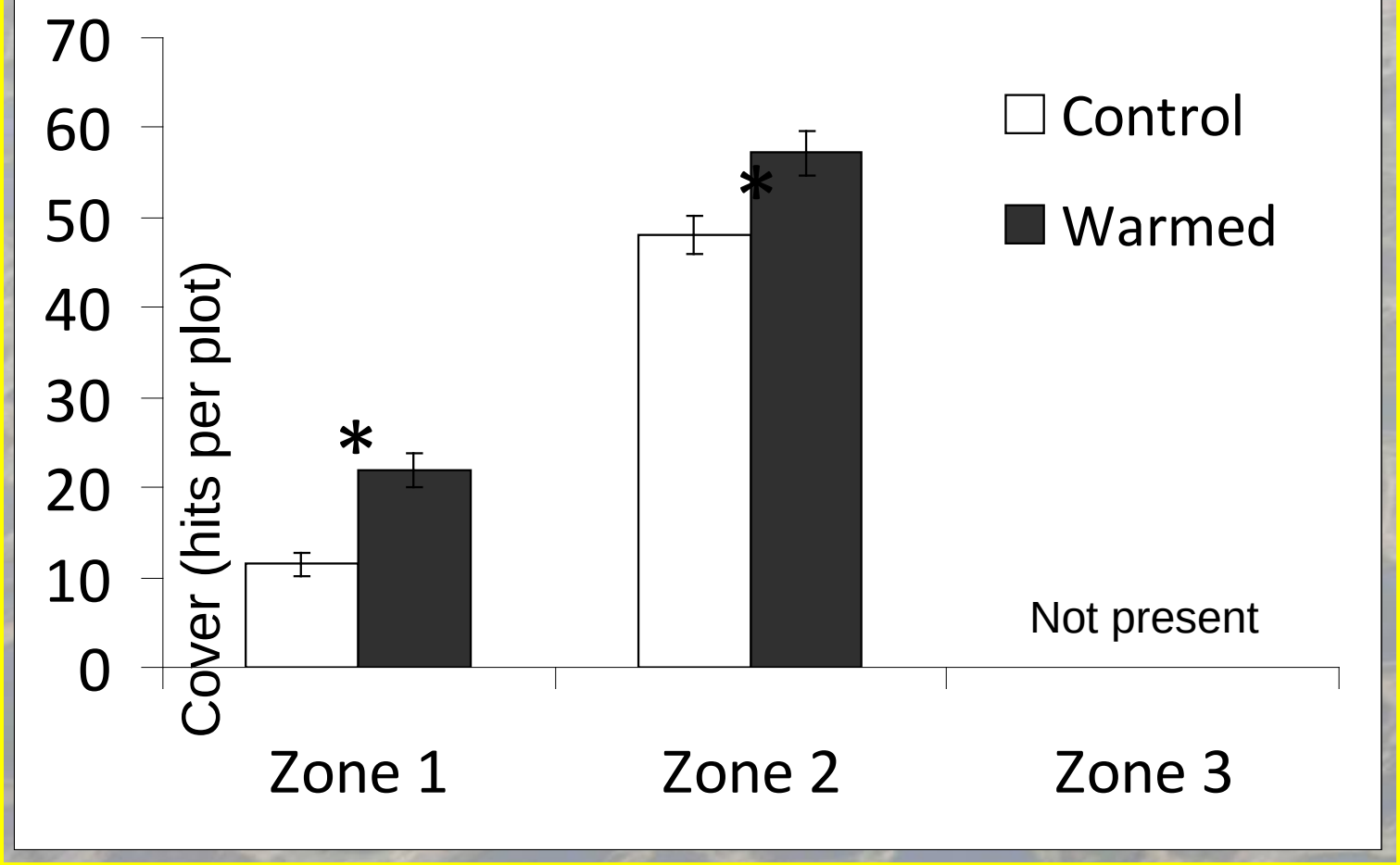

Zone 2 (Cooler)
Barrow
Dry Heath
Wet Meadow
Atqasuk
Zone 3 (Warmer)

Warming Treatment

Point frame data collection

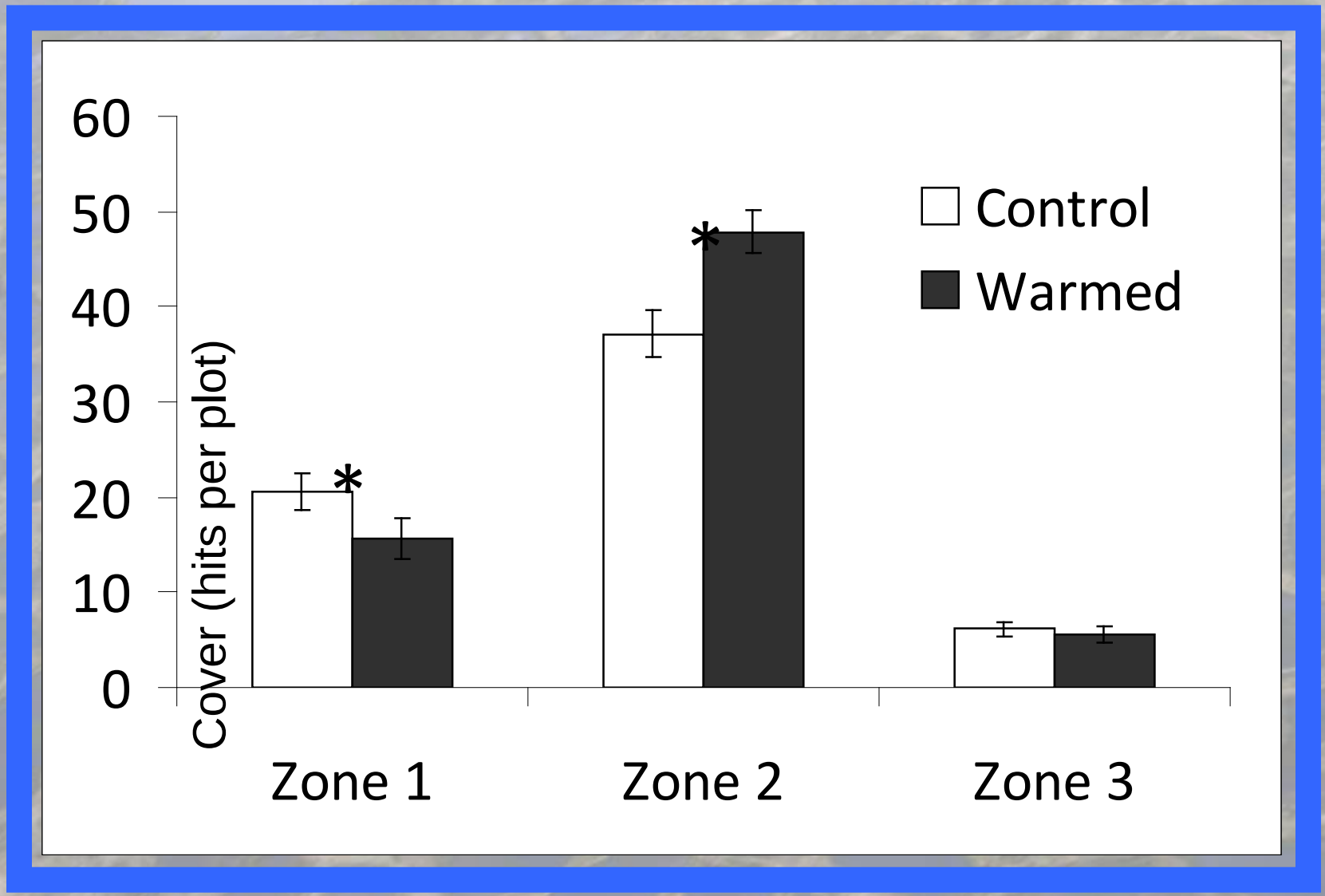


Barrow Dry



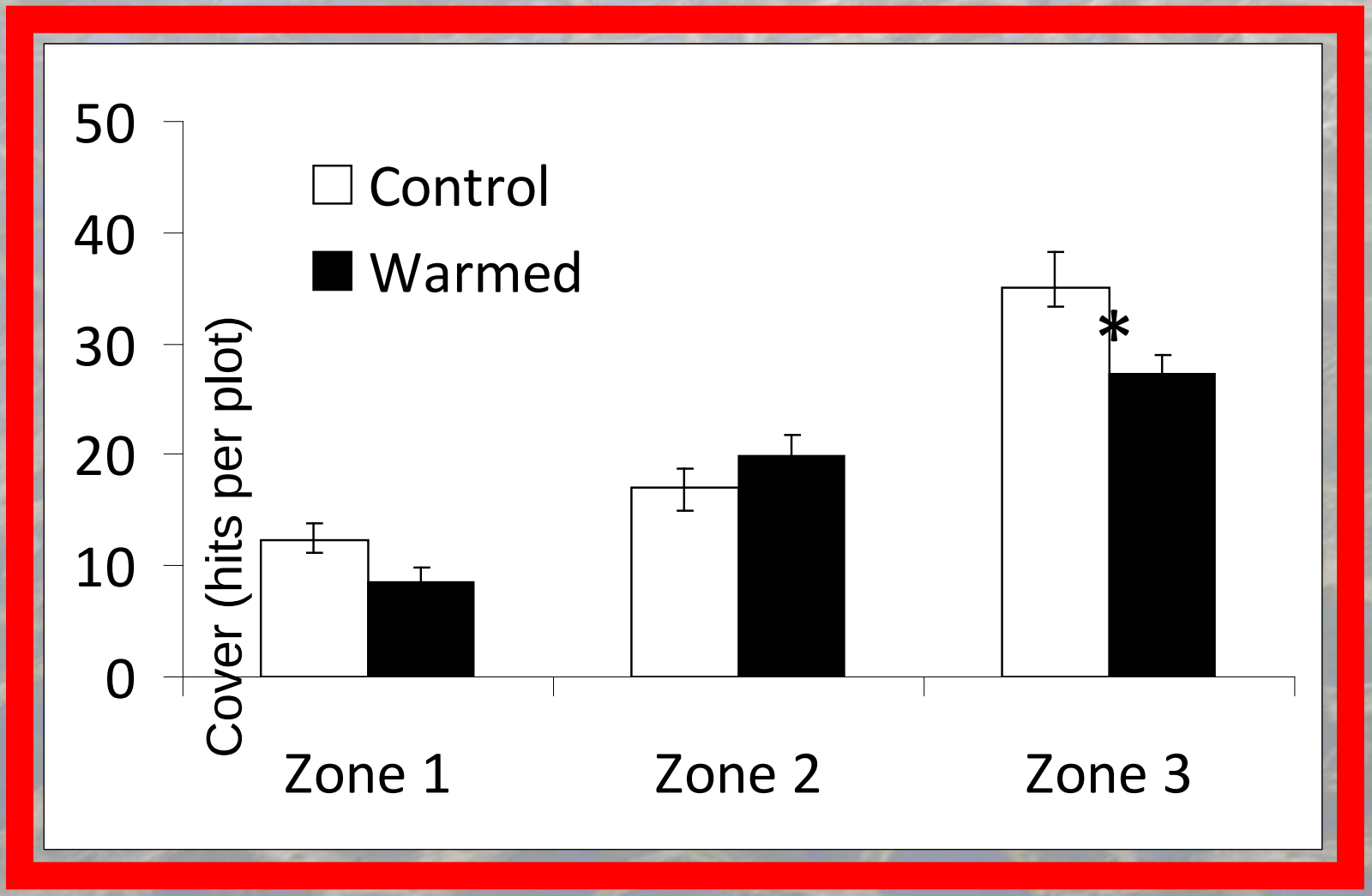
Northern ⟷ Southern

Barrow Wet



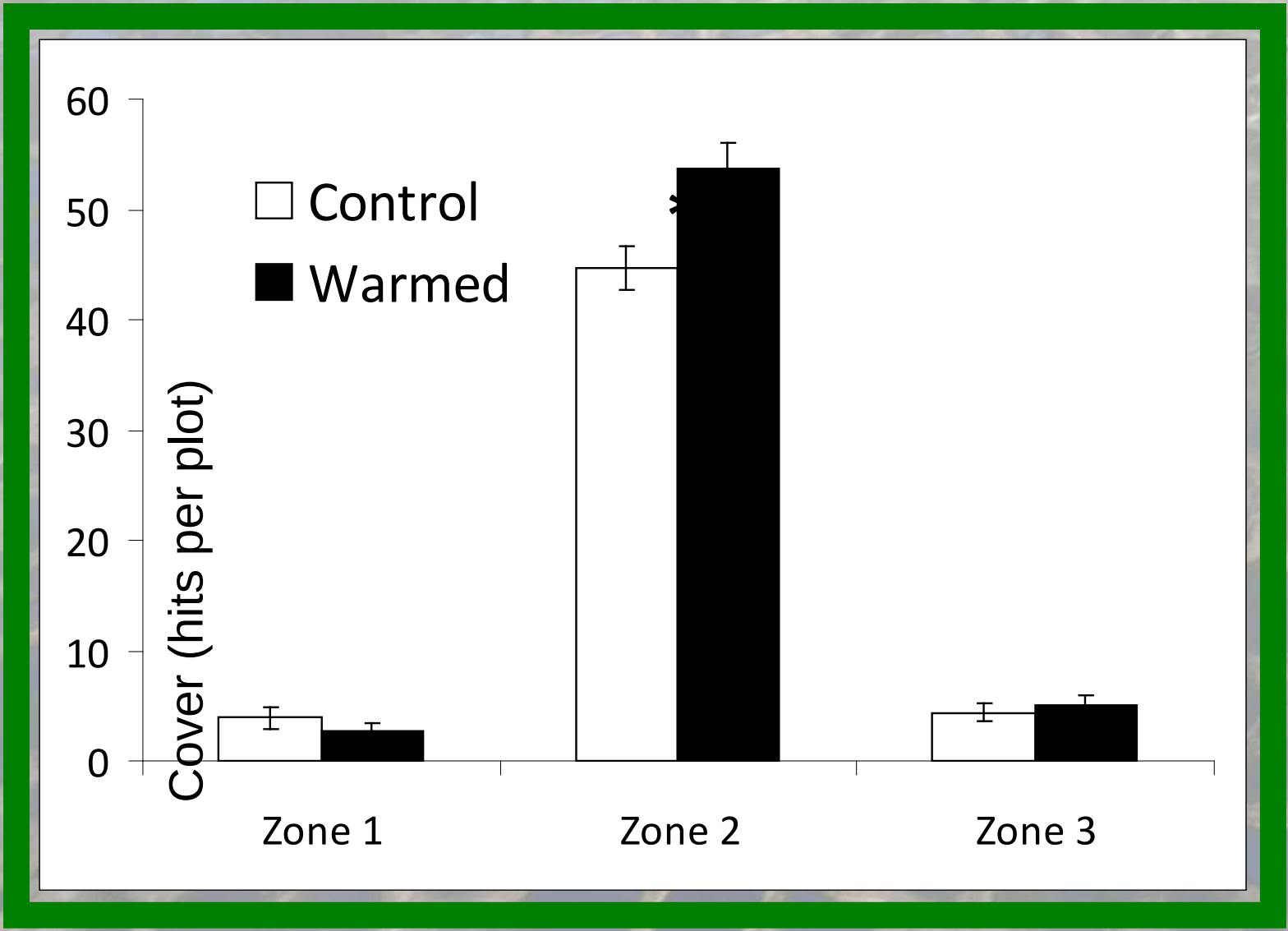
Northern ⟷ Southern

Atqasuk Dry



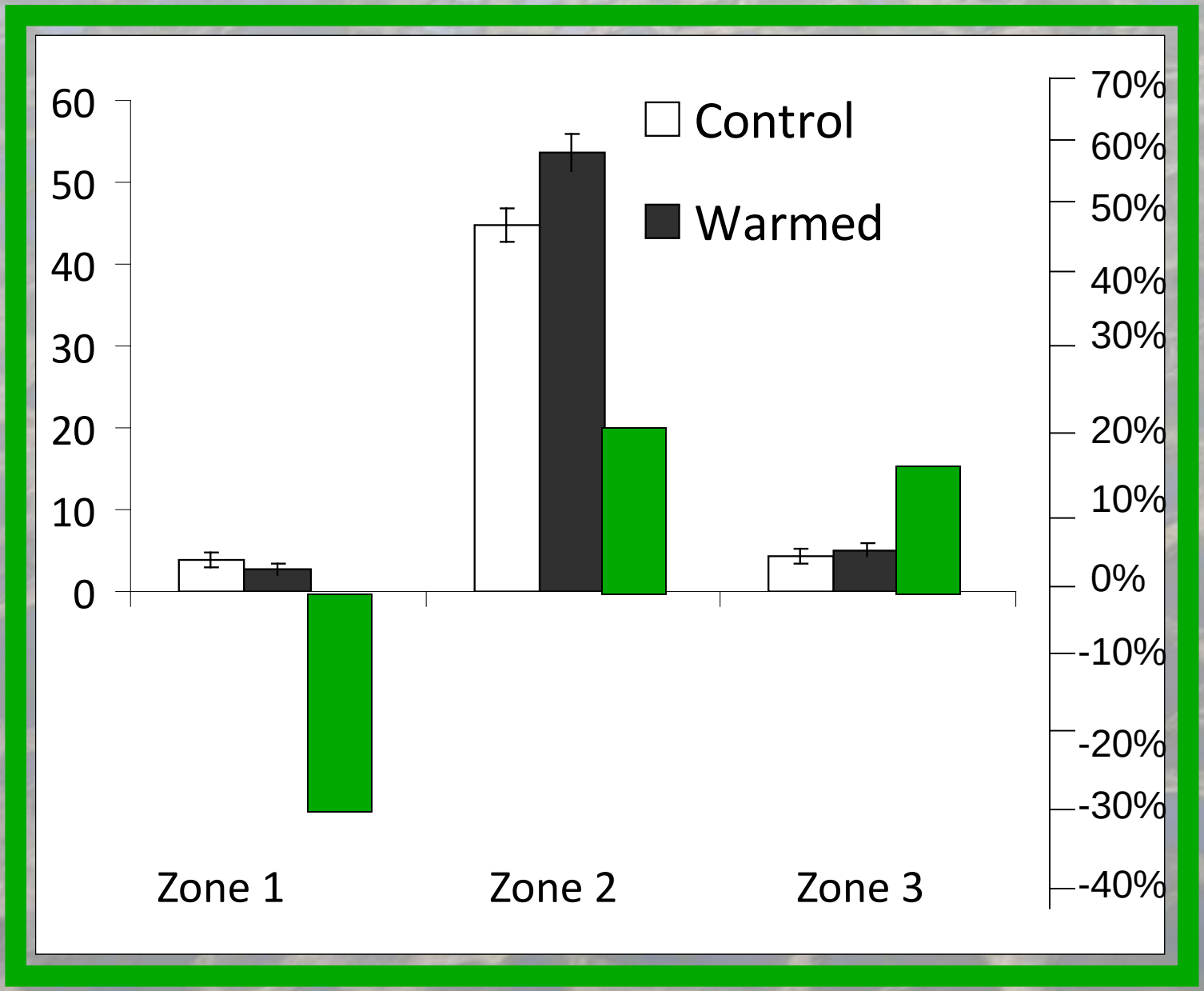
Northern ⟷ Southern

Atqasuk Wet

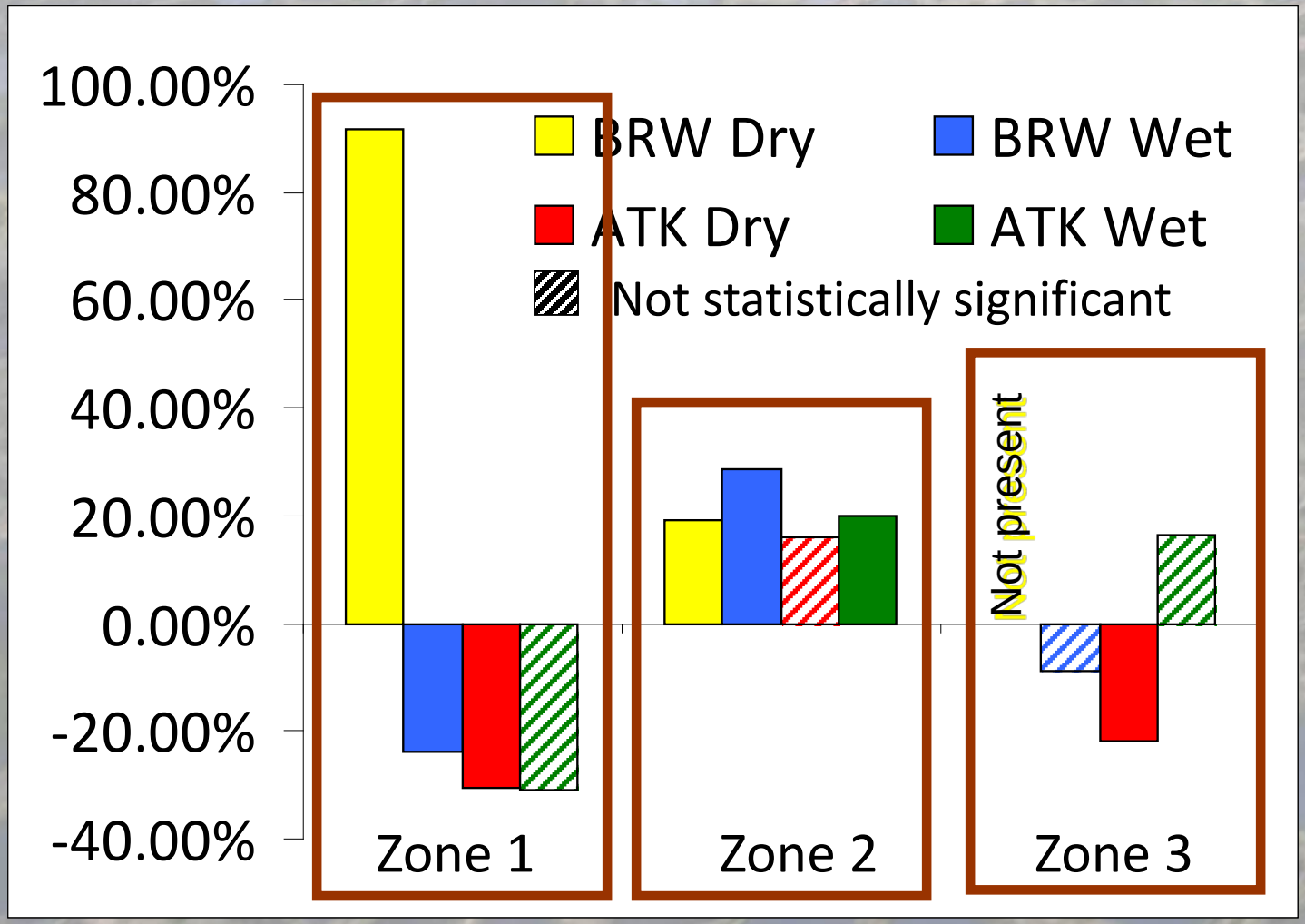


Northern ⟷ Southern

Atqasuk Wet


60
50
40
30
20
10
0
Control
Warmed
70%
60%
50%
40%
30%
20%
10%
0%
-10%
-20%
-30%
-40%
Zone 1
Zone 2
Zone 3

Percent Change



Zone 1 species show decrease when in competition with Zone 2

Zone 2 species show an increase in cover in warmed plots

Zone 3 species are poorly represented and show mixed results

Northern ⟷ Southern

Summary

- Vegetation responded to warming
- Young's zonation scheme is a useful classification tool- the zones are reasonable and behave differently from each other
- Zone 1's performance was poor
- Zone 2 did well in the warmed environment
- Zone 3 is poorly represented in the sites and showed mixed results

References

Edlund, S. A. & Alt, B. T. 1989. Regional congruence of vegetation and summer climate patterns in the Queen Elizabeth Islands, Northwest Territories, Canada. *Arctic* 42 (1): 3-23.

Gould, W. A. & Walker, M. D. 1999. Plant communities and landscape diversity along a Canadian Arctic river. *Journal of Vegetation Science* 10 (4): 537-548.

Hollister, R.D., P.J. Webber, F.E. Nelson, and C.E. Tweedie. 2006. Soil thaw and temperature response to air warming varies by plant community: Results from an open-top chamber experiment in northern Alaska. *Arctic Antarctic and Alpine Research* 38(2):206-215.

Hollister, R.D., P.J. Webber, and C. Bay. 2005. Plant response to temperature in northern Alaska: Implications for predicting vegetation change. *Ecology* 86(6): 1562-1570.

Walker, M.D., C.H. Wahren, R.D. Hollister, G.H.R. Henry, L.E. Ahlquist, J.M. Alatalo, M.S. Bret-Harte, M.P. Calef, T.V. Callaghan, A.B. Carroll, H.E. Epstein, I.S. Jónsdóttir, J.A. Klein, B. Magnússon, U. Molau, S.F. Oberbauer, S.P. Rewa, C.H. Robinson, G.R. Shaver, K.N. Suding, C.C. Thompson, A. Tolvanen, Ø. Totland, P.L. Turner, C.E. Tweedie, P.J. Webber, and P.A. Wookey. 2006. Plant Community Responses to Experimental Warming Across the Tundra Biome. *Proceedings of the National Academy of Science of the United States of America (PNAS)* 103(5): 1342-1346.

Walker, D. A., Raynolds, M. K., Daniëls, F. J. A.,Einarsson, E., Elvebakk, A., Gould, W. A., Katenin, A. E., Kholod, S. S., Markon, C. J., Melnikov, E. S., Moskalenko, N. G., Talbot, S. S., Yurtsev, B. A. & the CAVM Team 2005. The Circumpolar Arctic Vegetation Map. – *Journal of Vegetation Science* 16 (3): 267-282.

Young, S.B. 1971. The vascular flora of St. Lawrence Island with special reference to floristic zontation in the arctic regions. *Contributions from the Gray Herbarium of Harvard University* 201: 11-115.

Acknowledgements

Thanks to the members of the Arctic Ecology Program in 2007-2008: Jeremy May, Robert Slider, Jean Marie Galang, Amanda Snyder, and Michael Lothshutz.

Thanks to the National Science Foundation for funding and the Barrow Arctic Science Consortium for providing logistics in Alaska.