The Impacts of Experimental Warming on Phenology and Growth of *Carex aquatilis-stans* in Northern Alaska

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Introduction

High latitudes are expected to show the earliest and greatest response to global climate change. Air temperature has been increasing in the Arctic at much faster rates than the rest of the globe (IPCC 2007). Arctic plants are adapted to severe conditions in this region and a small change in climate could alter communities. These changes could impact plant productivity and community composition in Arctic regions (Elmendorf et al. 2012). The International Tundra Experiment (ITEX) uses a warming treatment to examine how plants respond to changing temperatures. Generally, previous studies have indicated that Arctic plants respond to warming by increasing growth and reproduction (Hollister et al. 2005). This study looks at how the Arctic sedge, *Carex aquatilis-stans* (**Figure 10**), has responded to experimental warming between two sites in Northern Alaska.

Methods

Sites were established at Barrow in 1994 and Atqasuk in 1996. Atqasuk is located approximately 60 miles south of Barrow (**Figure 1**). Atqasuk is generally 4°C warmer than Barrow during the summer. Each site contains 24 experimental plots and 24 control plots. The experimental plots (1m²) were warmed 1°C to 3°C using fiberglass open-top chambers (**Figure 2**). Data on *Carex aquatilis-stans* were collected in each control and experimental plot containing the species over various years, during the growing season, which is from mid June to late August. Data for this study were from seasonal measurements (inflorescence height and leaf length) and phenologic timing (first flower).

Statistics were completed using R version 2.15.0. Analysis included 2 way ANOVAS, T-tests and Linear Regressions.

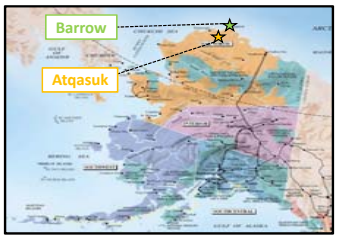

Figure 1. Location of study sites in Barrow and Atqasuk, Alaska.

Figure 2. Open top chambers passively warm experimental plots 1-3°C

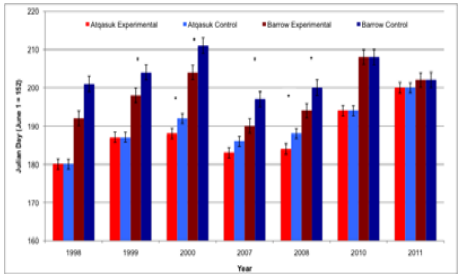

Figure 3. Date of first flowering day each year at both sites.

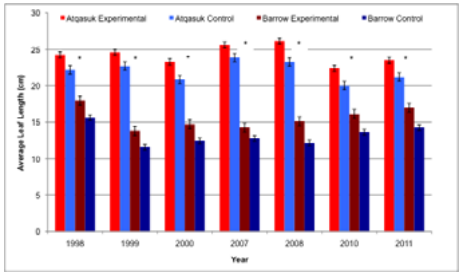

Figure 4. Average leaf length at each site each year.

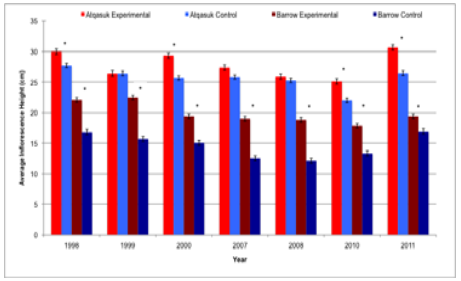

Figure 5. Average inflorescence height at each site each year.

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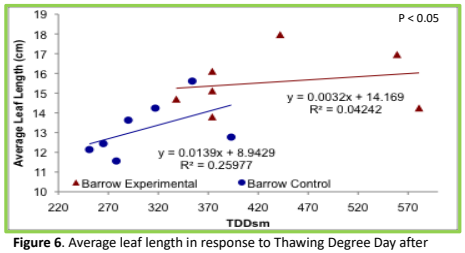

Figure 6. Average leaf length in response to Thawing Degree Day after snow melt at Barrow wet.

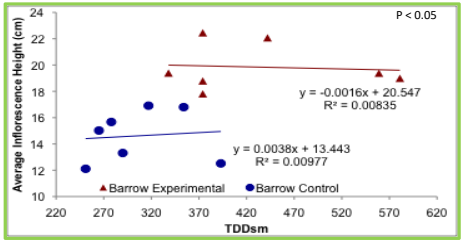

Figure 7. Average inflorescence height in response to Thawing Degree Day after first snow melt at Barrow wet.

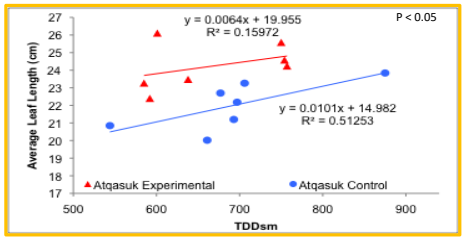

Figure 8. Average leaf length in response to Thawing Degree Day after first snow melt at Atqasuk wet.

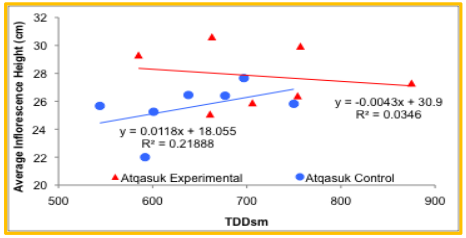

Figure 9. Average inflorescence height in response to Thawing Degree Day after snow melt at Atqasuk wet.

Figure 10. *Carex aquatilis-stans* photographs from Barrow, Alaska.

Results

The time of first flowering of *Carex aquatilis-stans* changed at the Barrow wet site but not at the Atqasuk wet site (**Figure 3**). At Barrow wet, *Carex aquatilis-stans* flowered significantly earlier in warmed versus control plots in 1998, 1999, 2000, 2007 and 2008. At Atqasuk wet, *Carex aquatilis-stans* flowered significantly earlier on warmed plots in 2008. The average leaf length of *Carex aquatilis-stans* changed significantly each year from 1998 to 2011 (**Figure 4**). Average leaf lengths were longer in warmed versus control plots each year. Average leaf lengths were significantly longer at Atqasuk wet compared to Barrow wet. At both sites, with both treatments included, there was a significant positive linear relationship between thawing degree day from snow melt and average leaf length of *Carex aquatilis-stans* (**Figure 6 and 8**). The average inflorescence height of *Carex aquatilis-stans* is also changing (**Figure 5**). At Barrow wet, the average inflorescence height was significantly different between treatments each year from 1998 to 2011. At Atqasuk wet, there was a significant difference between treatments in 1998, 2000, 2010, and 2011. Average inflorescence heights of *Carex aquatilis-stans* were significantly different between Atqasuk wet and Barrow wet. At Barrow wet there was a negative linear relationship between thawing degree day from snow melt and average inflorescence height on warmed plots, but a positive linear relationship on control plots (**Figure 7**). The same trend is shown at Atqasuk wet (**Figure 9**). However, regressions for each treatment are not significant at either site.

Discussion

The results of this study indicate that *Carex aquatilis-stans* is flowering earlier in the growing season at Barrow wet due to increased warming and longer growing seasons. There was no change at Atqasuk wet, possibly due to the timing of data collection during the field season. *Carex aquatilis-stans* leaves also grew longer and inflorescences were taller on experimental versus control plots at both sites. This indicates the treatment effect is working at Barrow and Atqasuk. There was also a significant positive linear relationship at both sites with average leaf length versus thawing degree day after snow melt and a significant negative linear relationship at Barrow wet with average inflorescence height. This indicates that experimental warming is impacting growth at both sites, as *Carex aquatilis-stans* is likely allocating more resources towards leaf growth instead of reproduction, as a result. There was not a significant relationship at Atqasuk wet, but there will likely be a significant relationship in the future. These changes, combined with earlier flowering, indicate that *Carex aquatilis-stans* will become an even more dominant sedge in the Arctic community due to future climate change.

Acknowledgements

Thank you to the National Science Foundation for project funding, UMIAQ and the Barrow Alaska Science Consortium for logistical support, ITEX researchers for help and support, and Grand Valley State University Arctic Ecology Program researchers for time and effort. Further thanks to Jenny Liebig and Kelseyann Kremers for help and guidance. Also, thank you to GVSU Office of Undergraduate Research and Scholarship and the International Arctic Research Center (IARC) for travel support.

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