Ecotypic variation in *Eriophorum vaginatum*: physiology and genetics.

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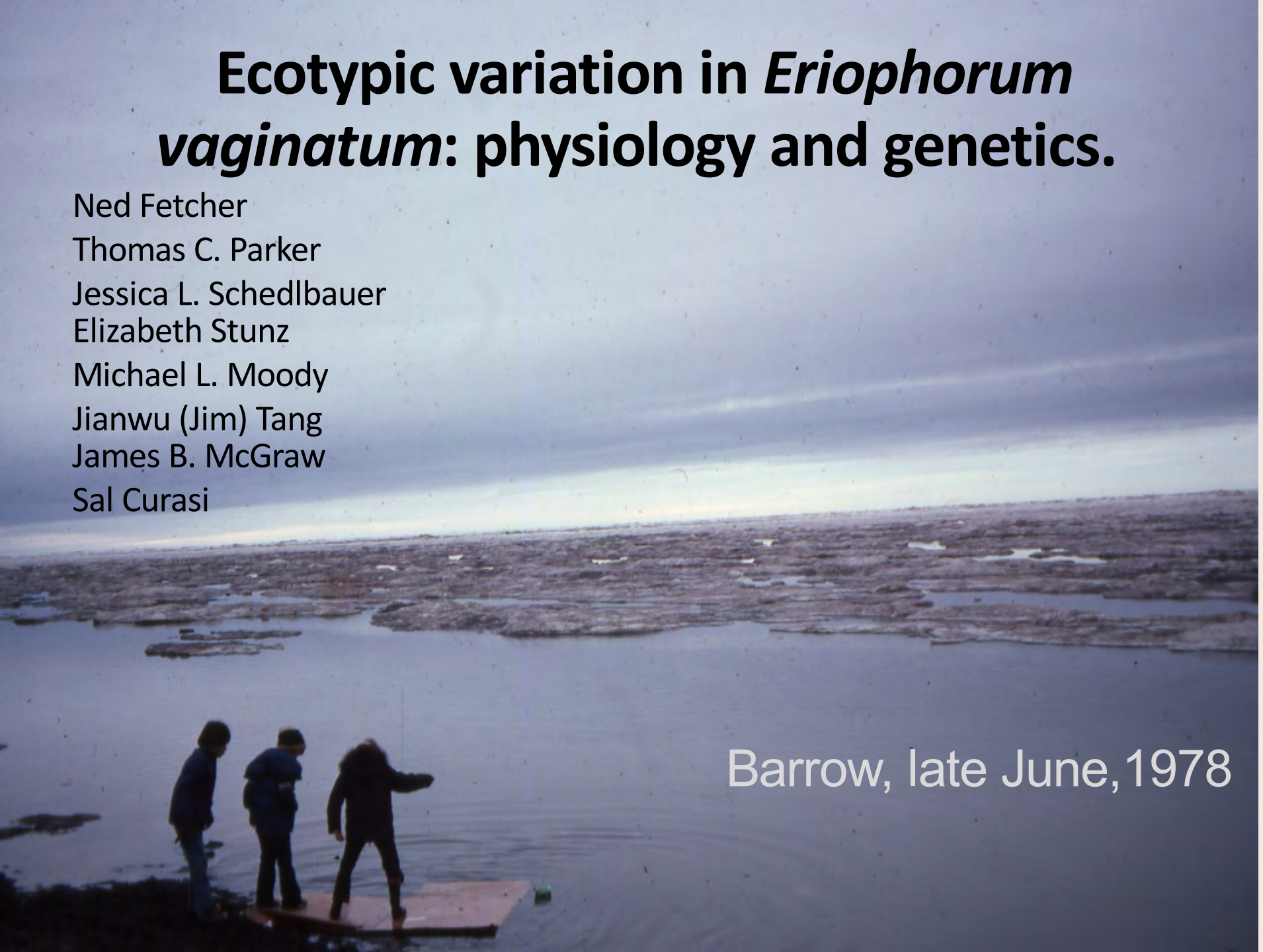


Barrow, late June,1978

1. *Eriophorum vaginatum* ecotypes
2. Phenological responses
3. Genetic analyses of ecotypes
4. What does ecotypic variation mean for ecosystems?

Ecotypes

- Locally adapted populations
  - Need to show genetic basis for difference in traits
    - Common garden
    - Reciprocal transplant
  - Need to show evidence for adaptation
    - Differences in fitness between populations that depends on the local environment
    - Fitness depends on survival and reproduction
    - Interaction between genotype and environment
    - Home site advantage

Dryas octapetala

Two Ecotypes

South of Brooks Range

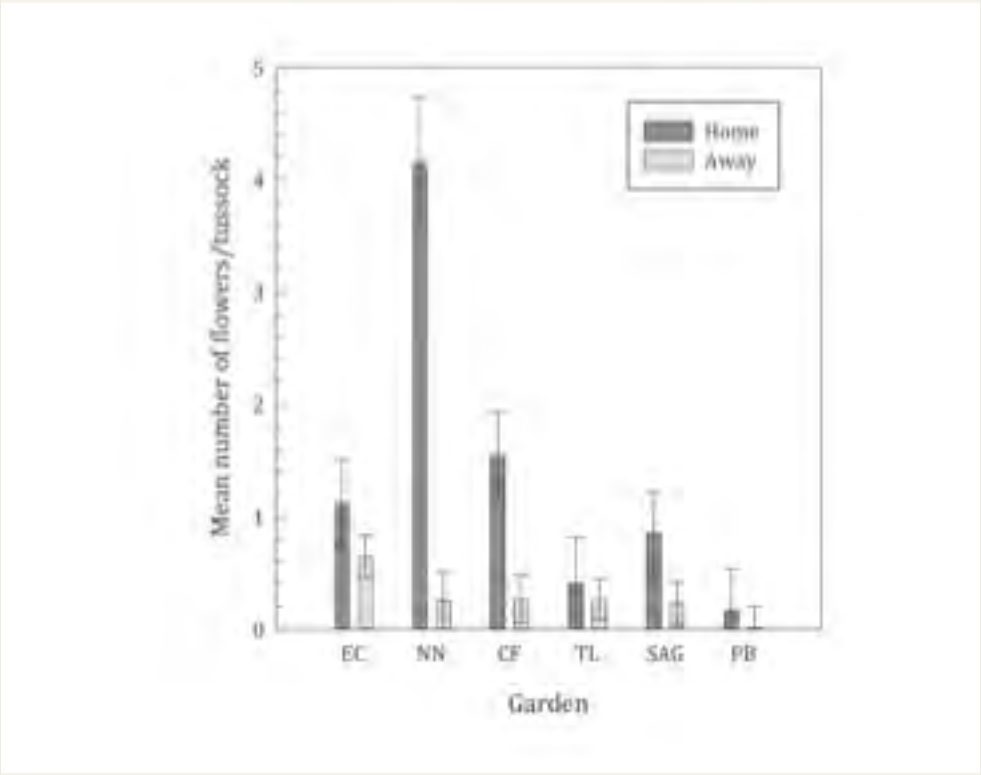
North of Brooks Range

Smaller, less moss cover

More disturbance from ice

Home-Site Advantage

Tussocks transplanted back into home sites tended to do better



Bennington et al. 2012 J. Ecology 100: 841

The *problem* of genetic specialization

If populations are generally genetically specialized to their local environments, what happens when the climate changes?

If turnover of individuals and migration are slow, will mean fitness decline as the climate warms?

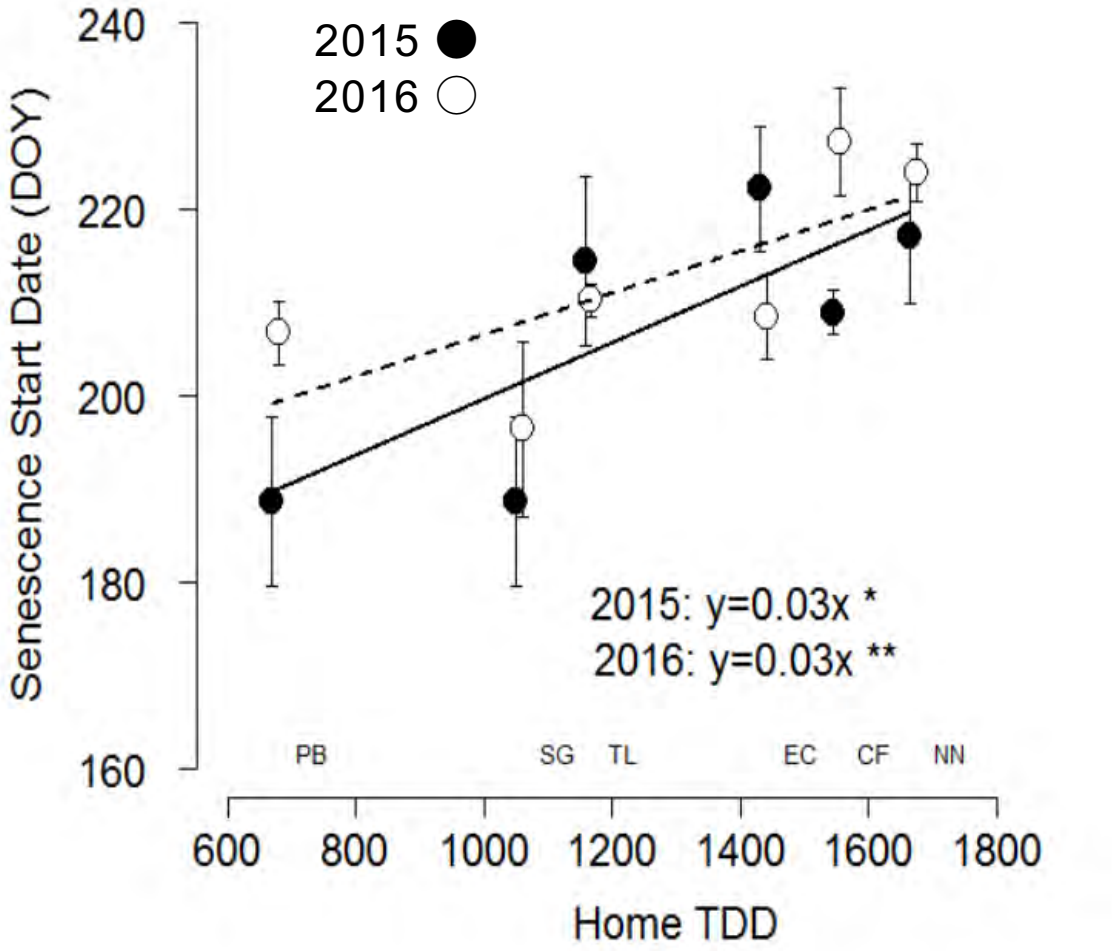
Adaptational Lag

Optima for tussock survival and tiller population growth rates are shifted northwards from present location of *E. vaginatum* populations

McGraw et al 2015 Global Change Biology 21: 3827

Phenology

Toolik tussock at Eagle Creek in mid-August, 1983



Timing of senescence depends on home site temperature

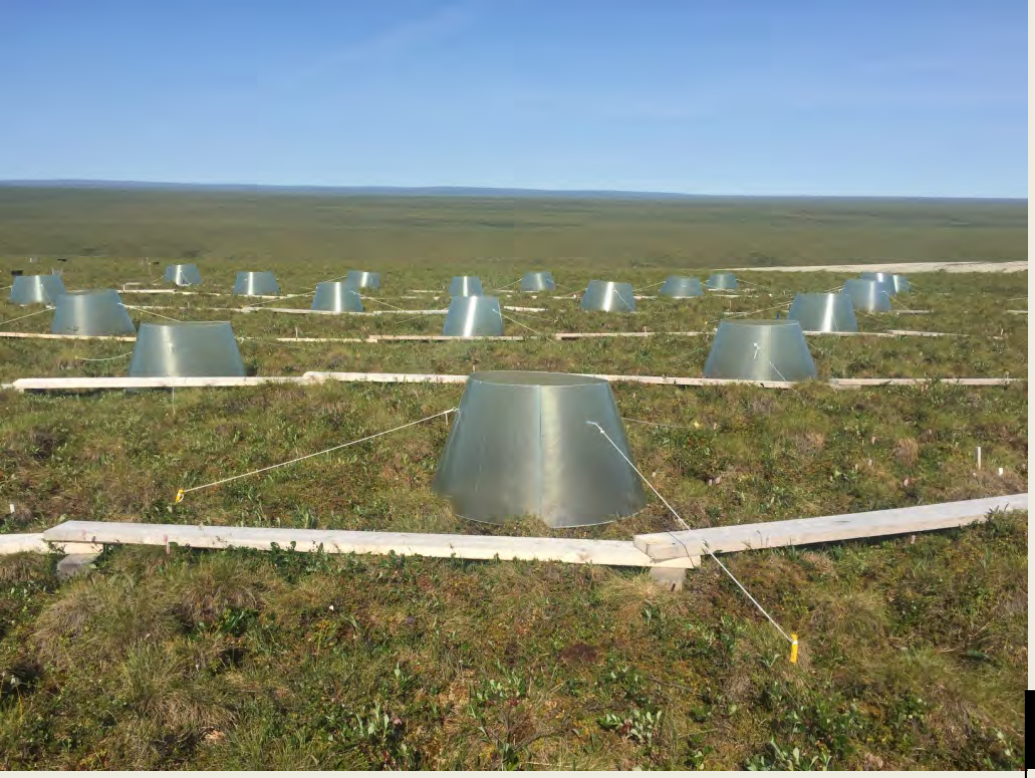
Parker et al. 2017 Ecology and Evolution 7:9775

New Transplant Garden 2014

- Three populations

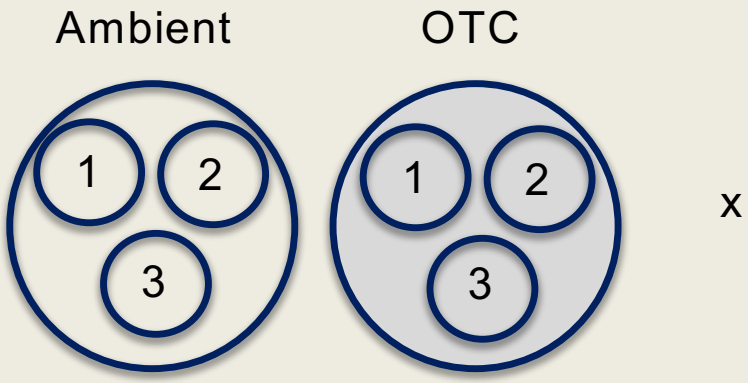
Thaw degree days

Prudhoe Bay	**672**
Sagwon	**912**
Toolik Lake	**1227**
Eagle Creek	**1451**
Coldfoot	**1615**
No Name Creek	**1890**



Warming with Open Top Chambers at Toolik Lake and Sagwon

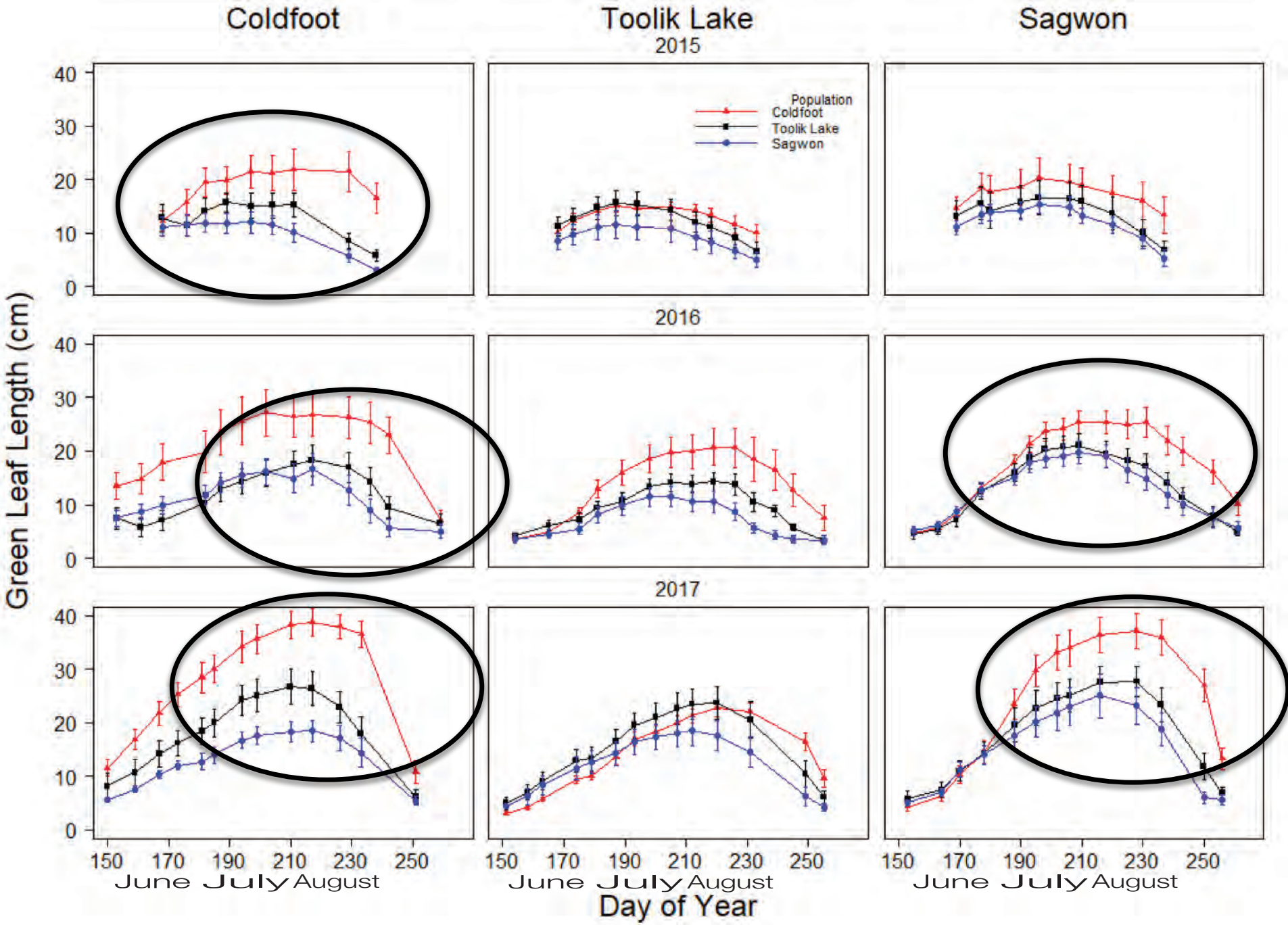
No OTC's at Coldfoot

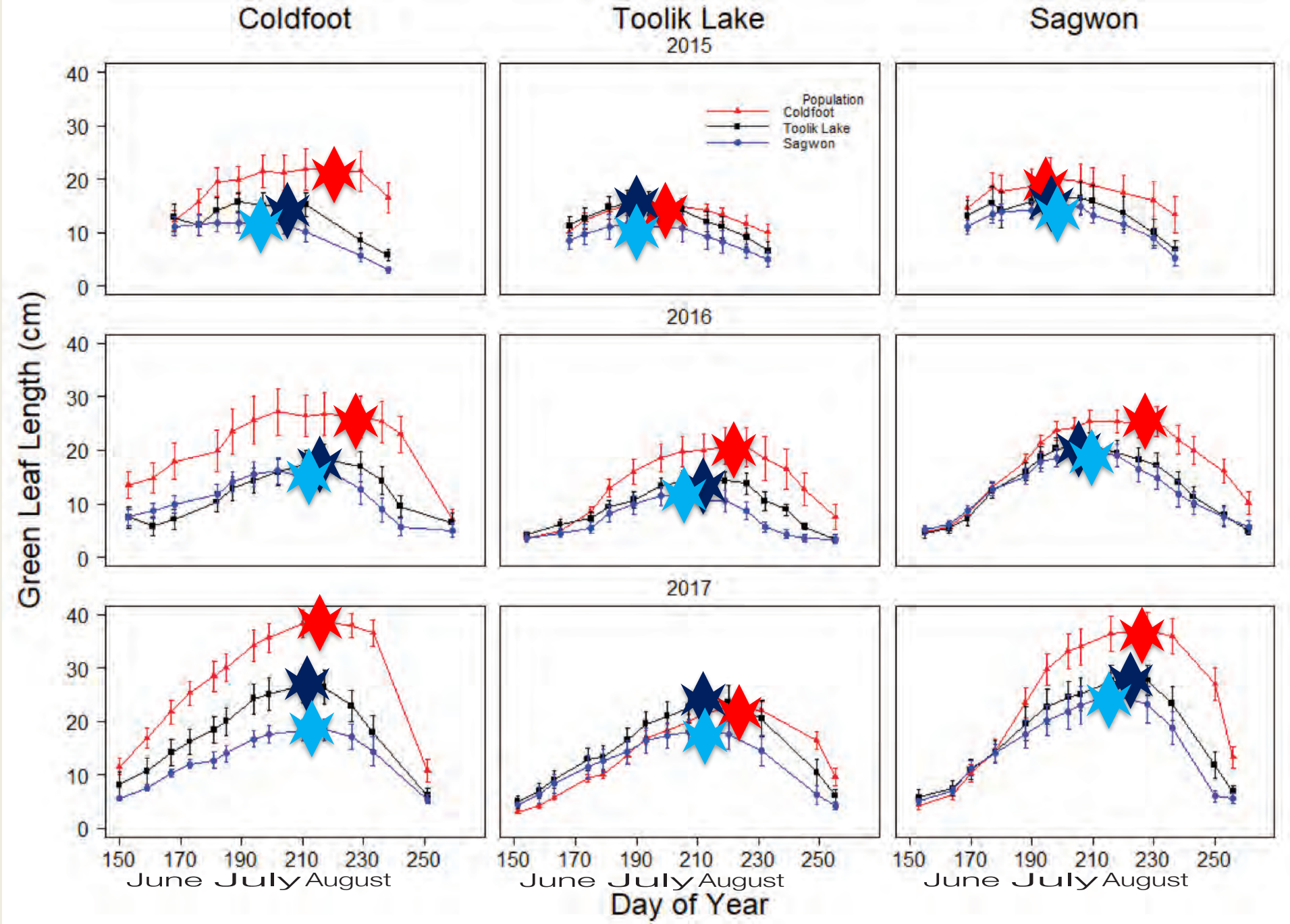


x

3 Populations x
10 Replicates/Population x
2.5 Gardens = 450 tussocks

	Ambient	OTC	Difference
Toolik Lake	Degrees C		
	9.2	11.0	1.8
	12.1	14.0	2.9
	8.6	9.6	1.0
Sagwon			
June	9.9	10.7	0.8
July	12.8	13.4	0.6
August	8.7	9.1	0.4


Coldfoot
Toolik Lake
Sagwon
2015
2016
2017
Population
Coldfoot
Toolik Lake
Sagwon
Green Leaf Length (cm)
0
10
20
30
40
150
170
190
210
230
250
June
July
August
Day of Year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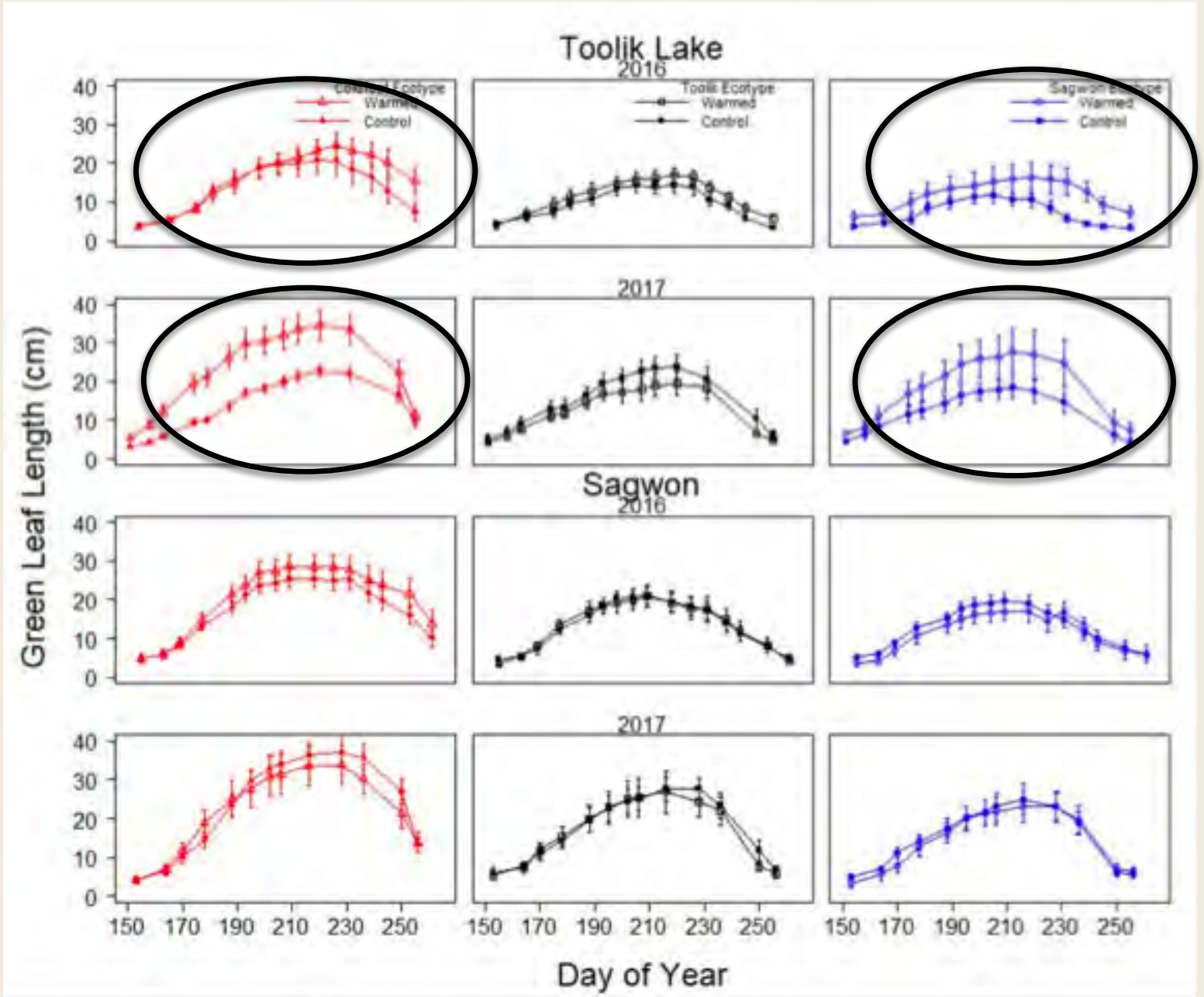
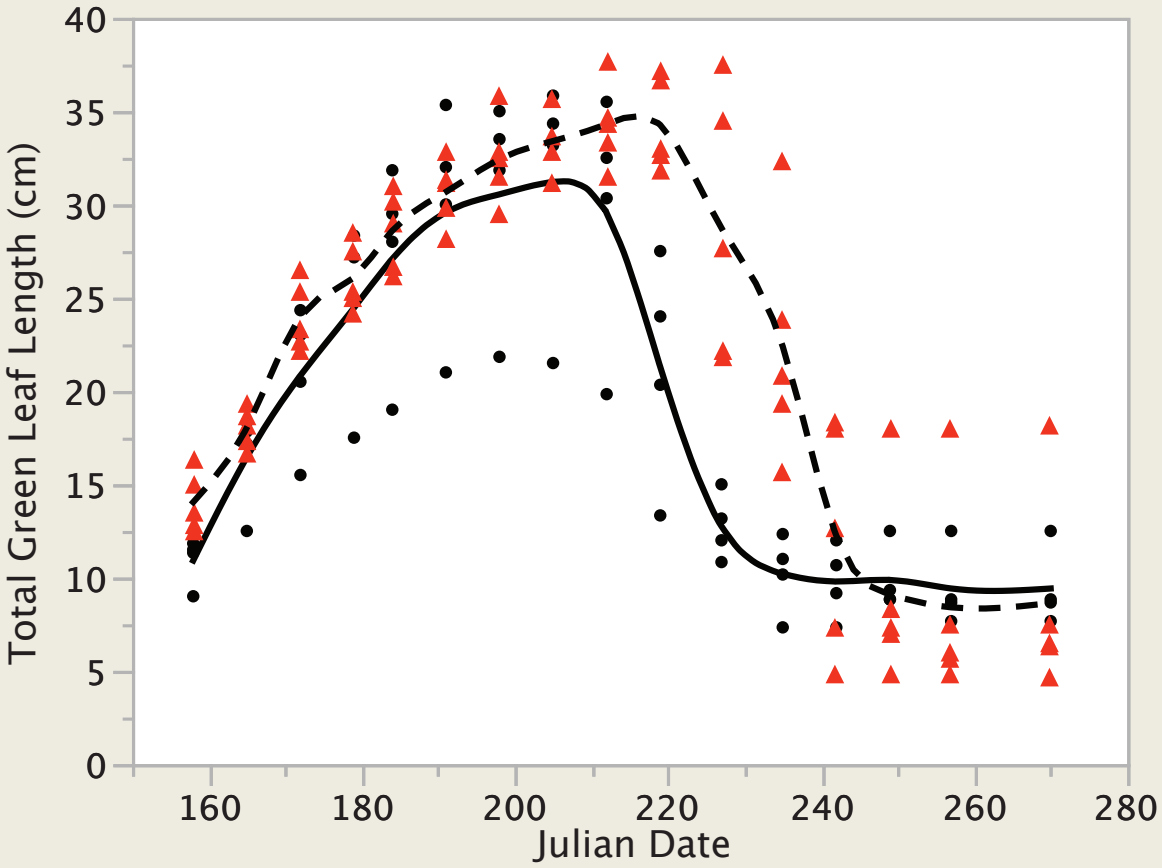
Response to Warming

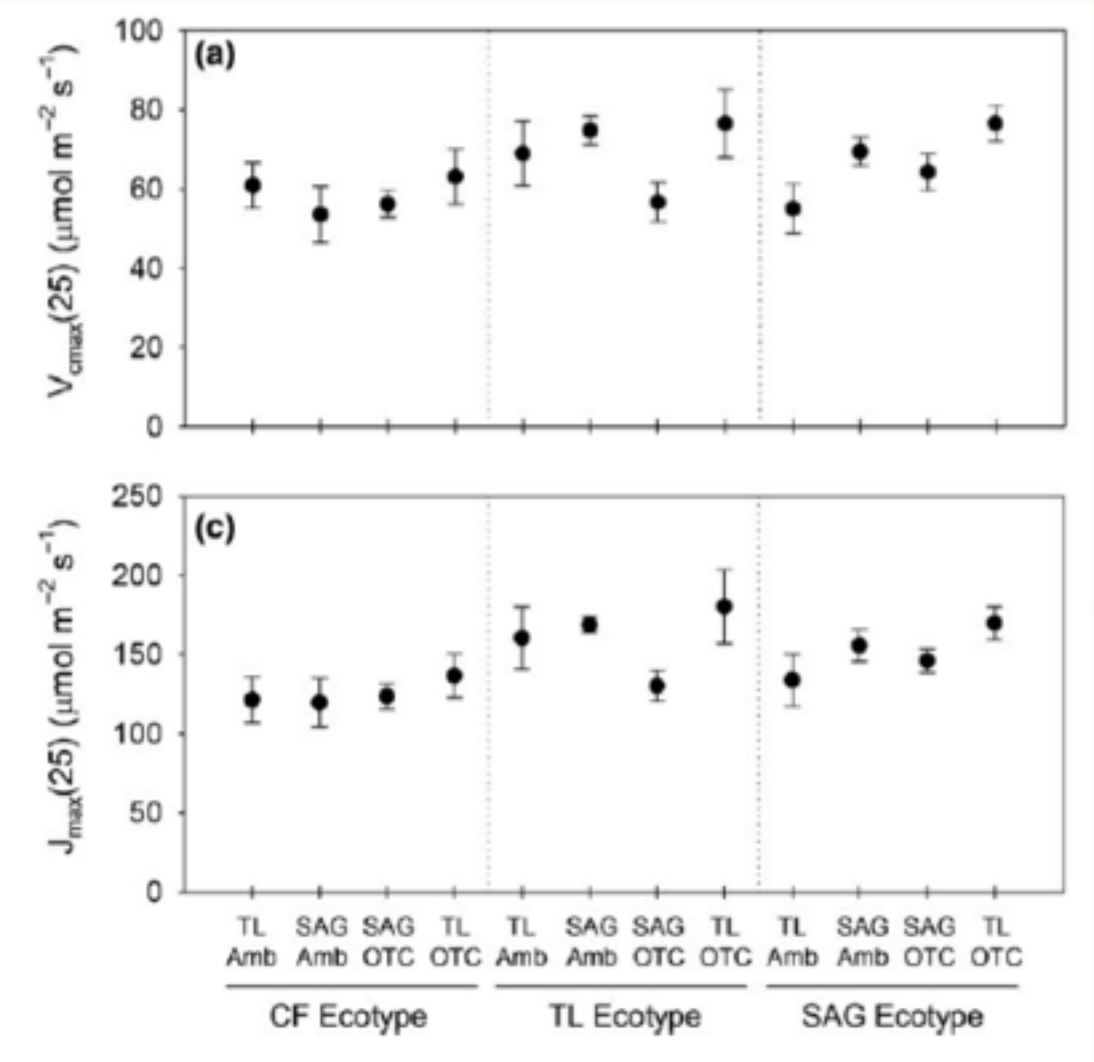


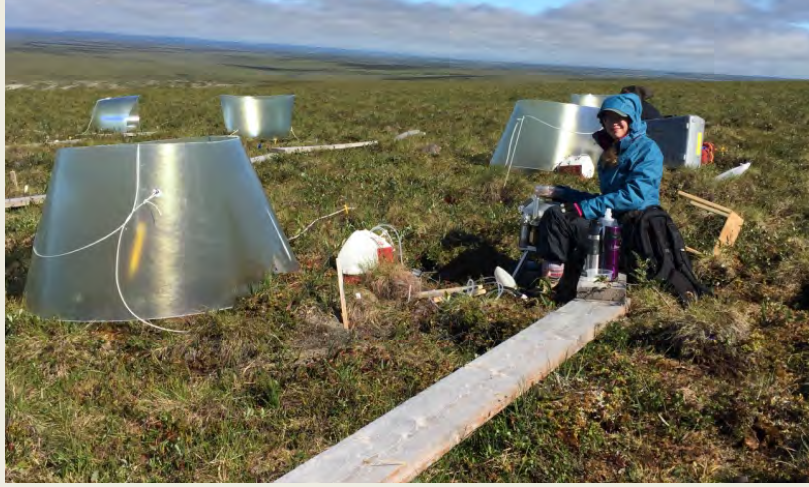
Growth Chamber Experiment

Temperature set to follow Toolik Lake climate
Control (red, dashed line) - Light set to follow Toolik Lake regime
Treatment (black, solid line) – Same except 3 hours of darkness



Temperature response of photosynthesis for Coldfoot, Toolik Lake and Sagwon ecotypes





Sagwon ecotype is most responsive to change in temperature; Coldfoot is the least

Vcmax (25) = Maximum rate of rubisco activity at 25 C
Jmax = Maximum rate of electron transport at 25 C

Schedlbauer et al. 2018. Ecology and Evolution 8:3711

Ecosystem Effects

- What are the potential effects of cottongrass ecotypes on Arctic ecosystems in a warming climate?

- As the climate warms, will the genetic background of the dominant species at a particular location make a difference?

- "If temperatures were to increase and growing seasons were to lengthen, it seems likely that site productivity in northern Alaska could be limited until ecotypes that show greater response to increases in temperature replace the present populations."
- Fetcher and Shaver. 1990. American Naturalist 136: 12

Conclusions

- Cottongrass ecotypes
  - Show increased fitness in home site
  - Some traits show results of natural selection
  - Differences in timing of senescence
- Three ecotypes so far
  - Northern, Southern, Eagle Creek
- Ecotypes respond differently to changes in latitude and to warming with OTC's
- If there is migration of alien ecotypes, could affect primary productivity
- If no migration, locally adapted ecotypes could lose fitness and decline

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