

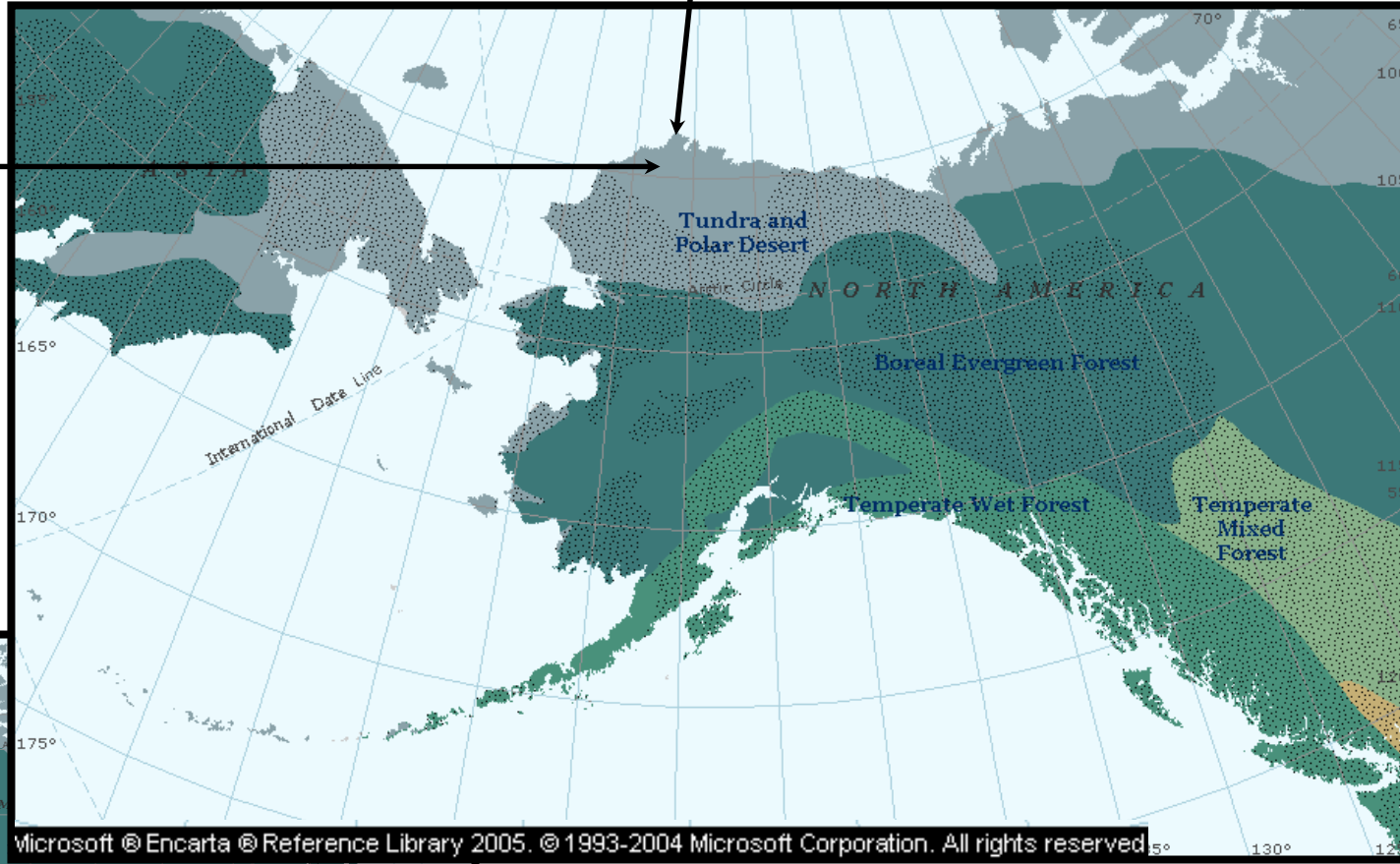
Plant responses to experimental and natural warming in Barrow and Atqasuk Alaska

Robert Slider
Robert Hollister

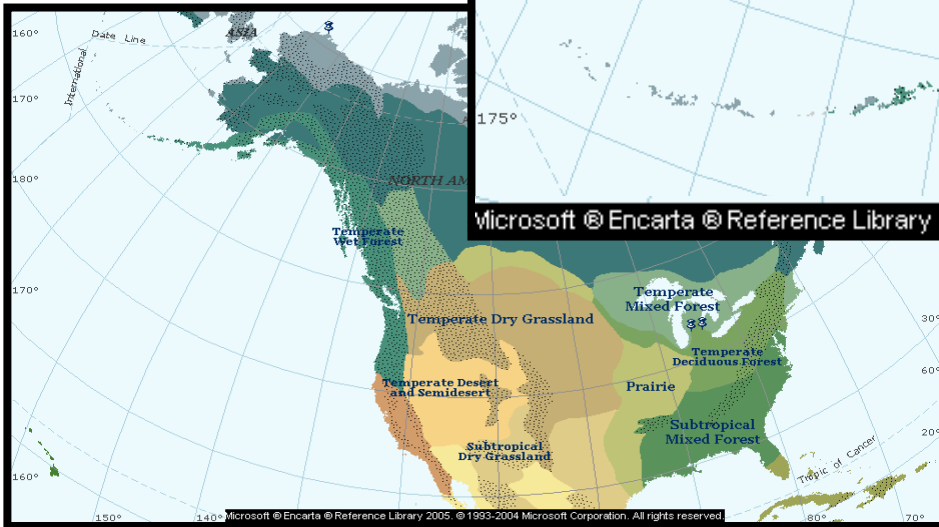


**Barrow 71°18'N
156°40'W**

**Atqasuk
70°29'N
157°25'W**



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Barrow

1994



1995

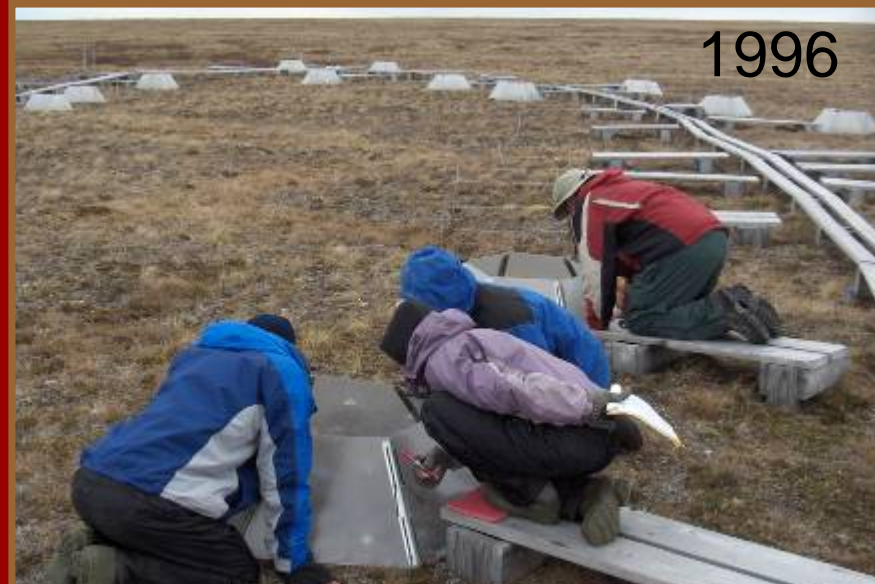


DRY

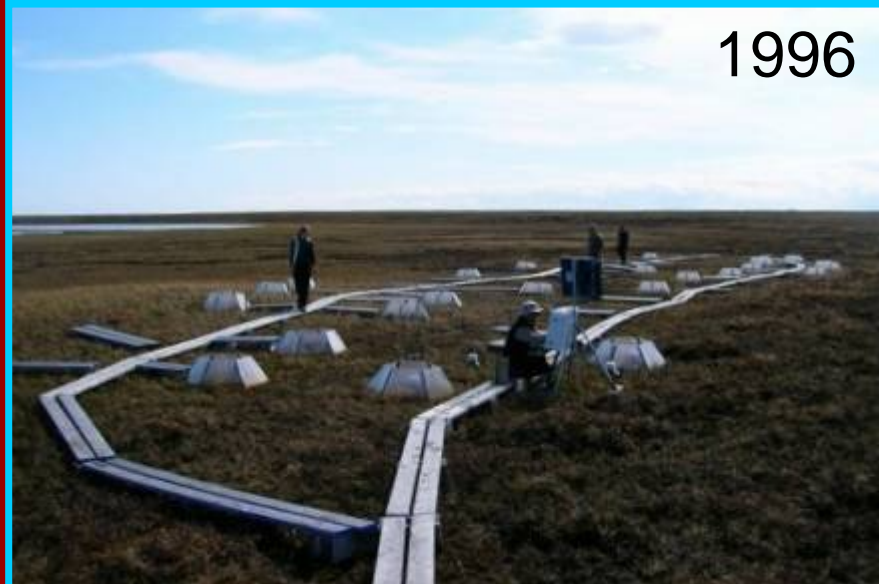
Atqasuk

WET

1996



1996



Study Goals

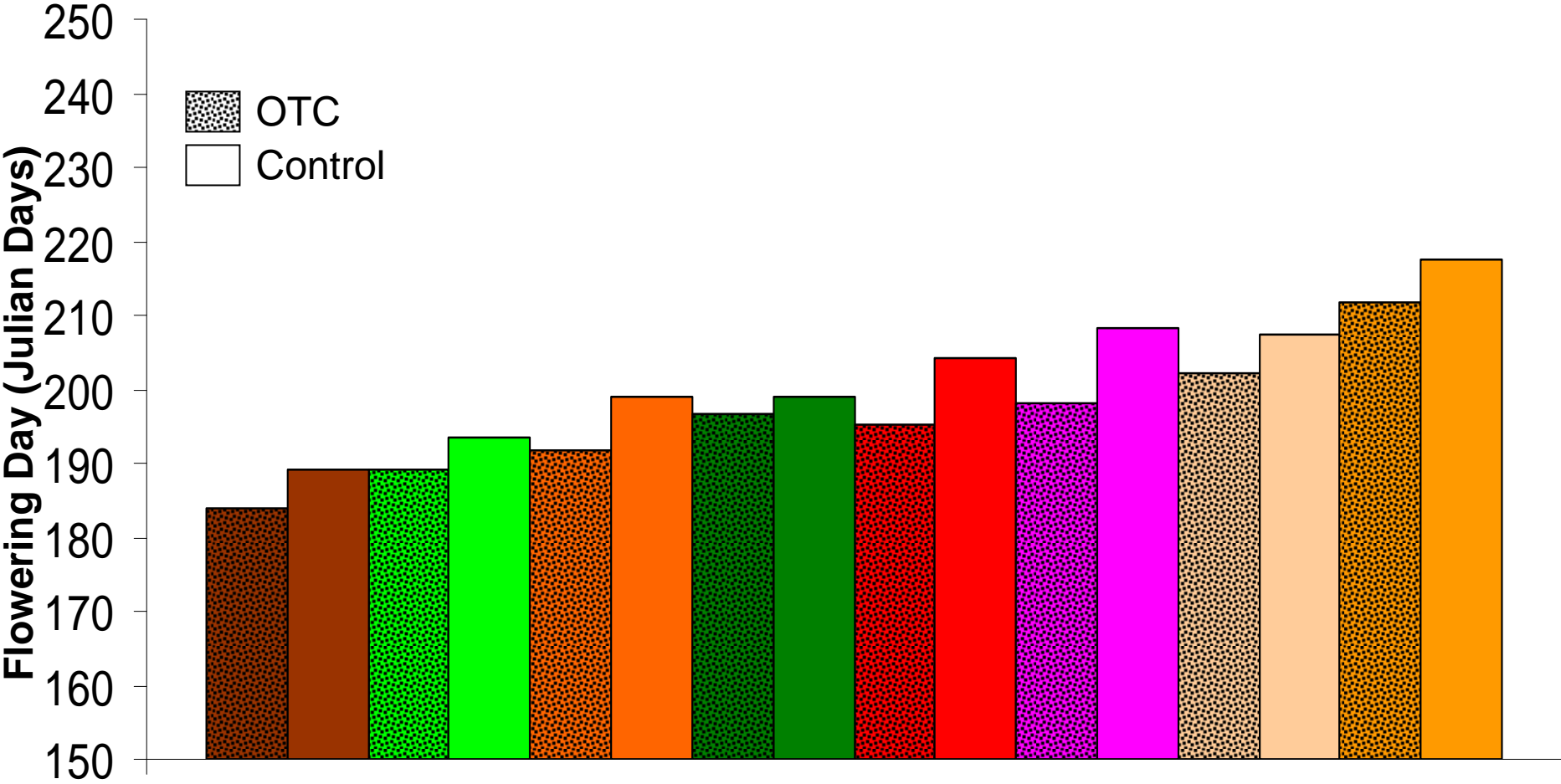
- Previous Findings of ITEX Studies
 - Earlier flowering with increase in temperature
 - Longer leaves with increase in temperature
- Compare to Temp. Trends in CTL's
 - Warmer years: earlier flowering?
 - Warmer years: longer leaves?



Methods

- Tallest leaf on reproductive individuals
 - Data from total season measurements
- First date of open flowering
 - Data from phenological observations
- Compared OTC to CTL
- Changes in temp correspond to trends between CTL & OTC's?
 - CTL's through time
 - Role of factors other than temperature?

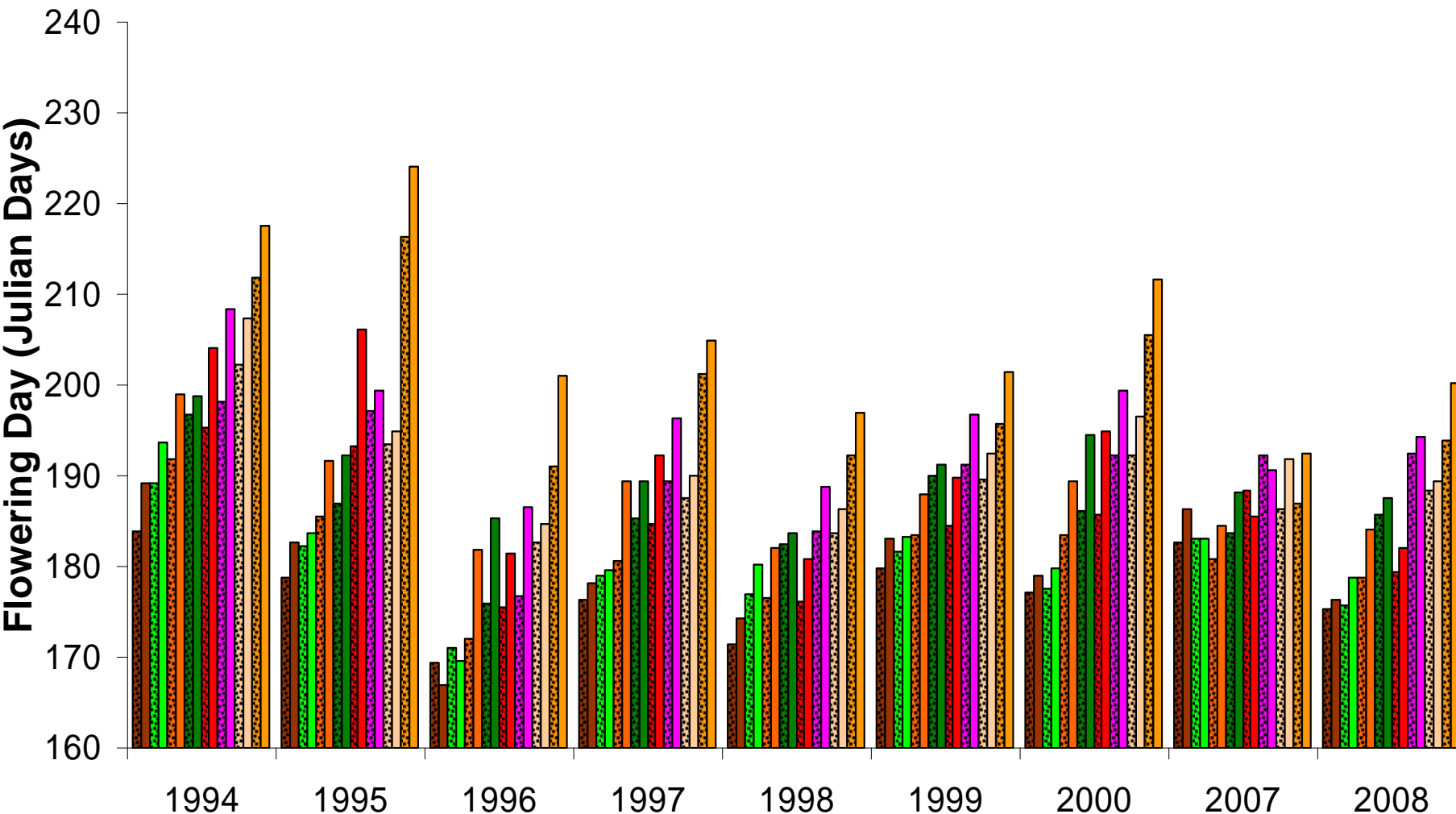
Barrow Dry



1994
Year

- Salix rotundifolia*
- Luzula arctica*
- Potentilla hyparctica*
- Luzula confusa*
- Cassiope tetragona*
- Papaver hultenii*
- Saxifraga punctata*
- Stellaria laeta*

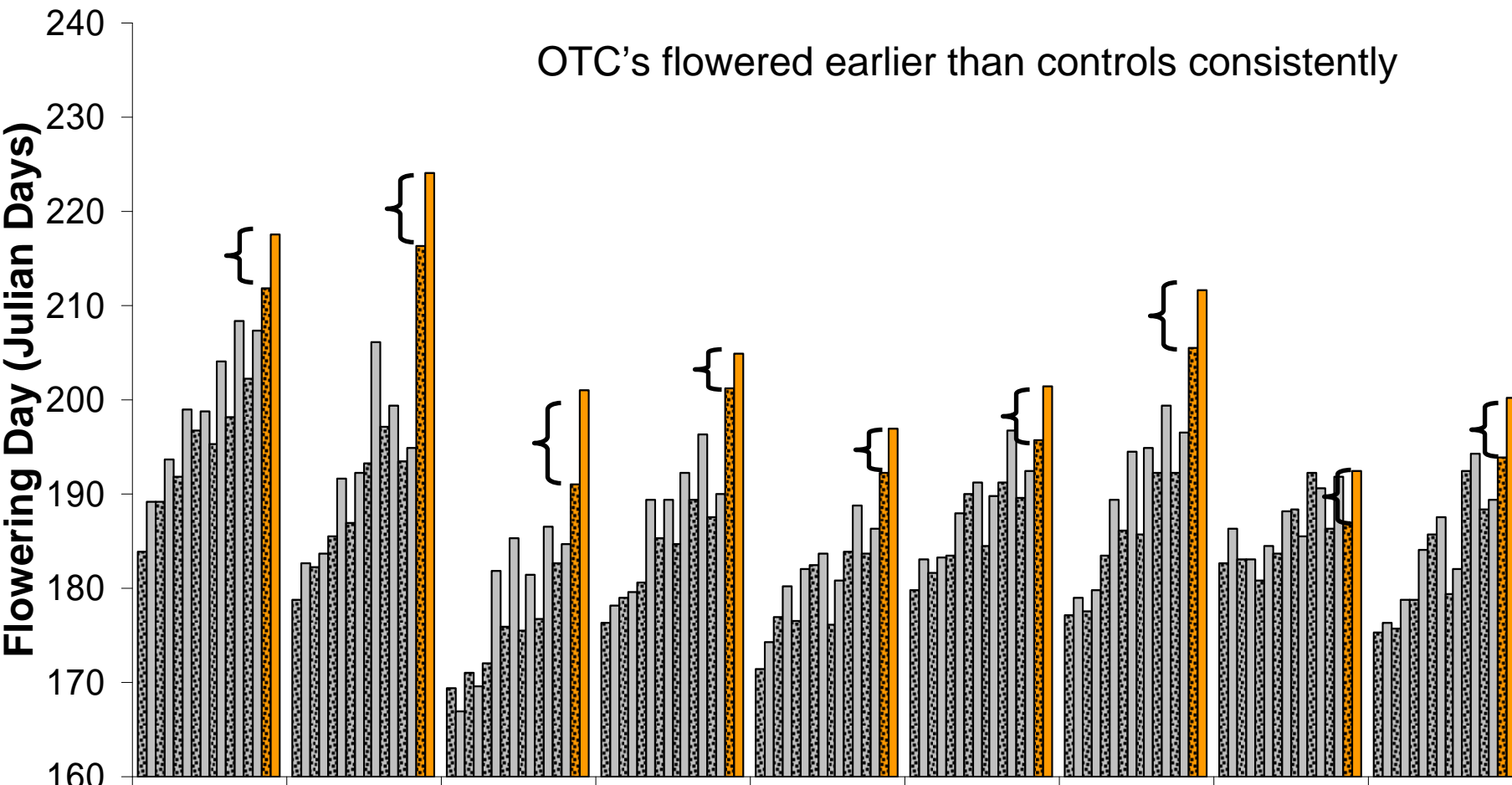
Barrow Dry



- Salix rotundifolia*
- Luzula arctica*
- Potentilla hyparctica*
- Luzula confusa*
- Cassiope tetragona*
- Papaver hultenii*
- Saxifraga punctata*
- Stellaria laeta*
- OTC
- Control

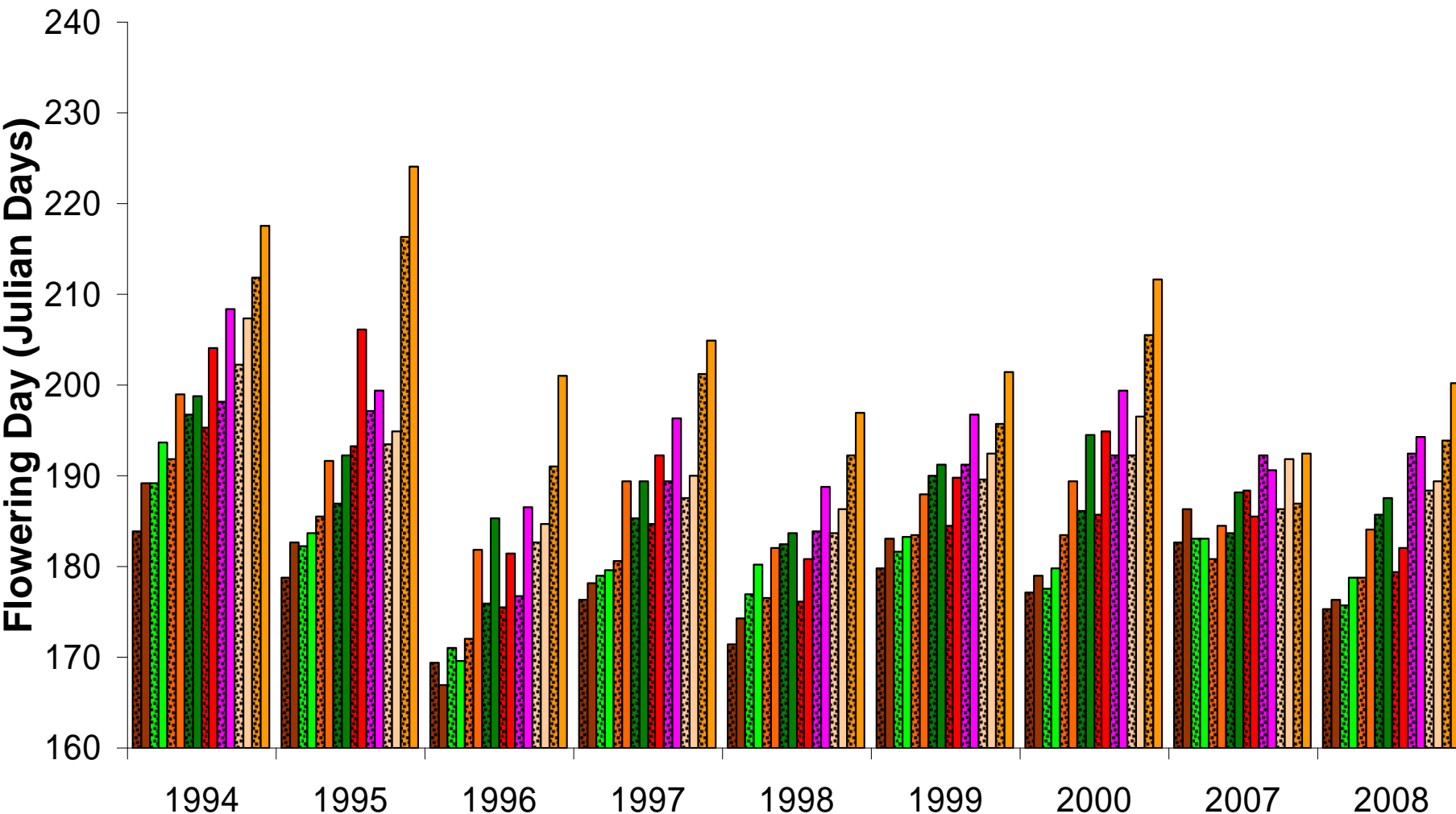
Barrow Dry

OTC's flowered earlier than controls consistently



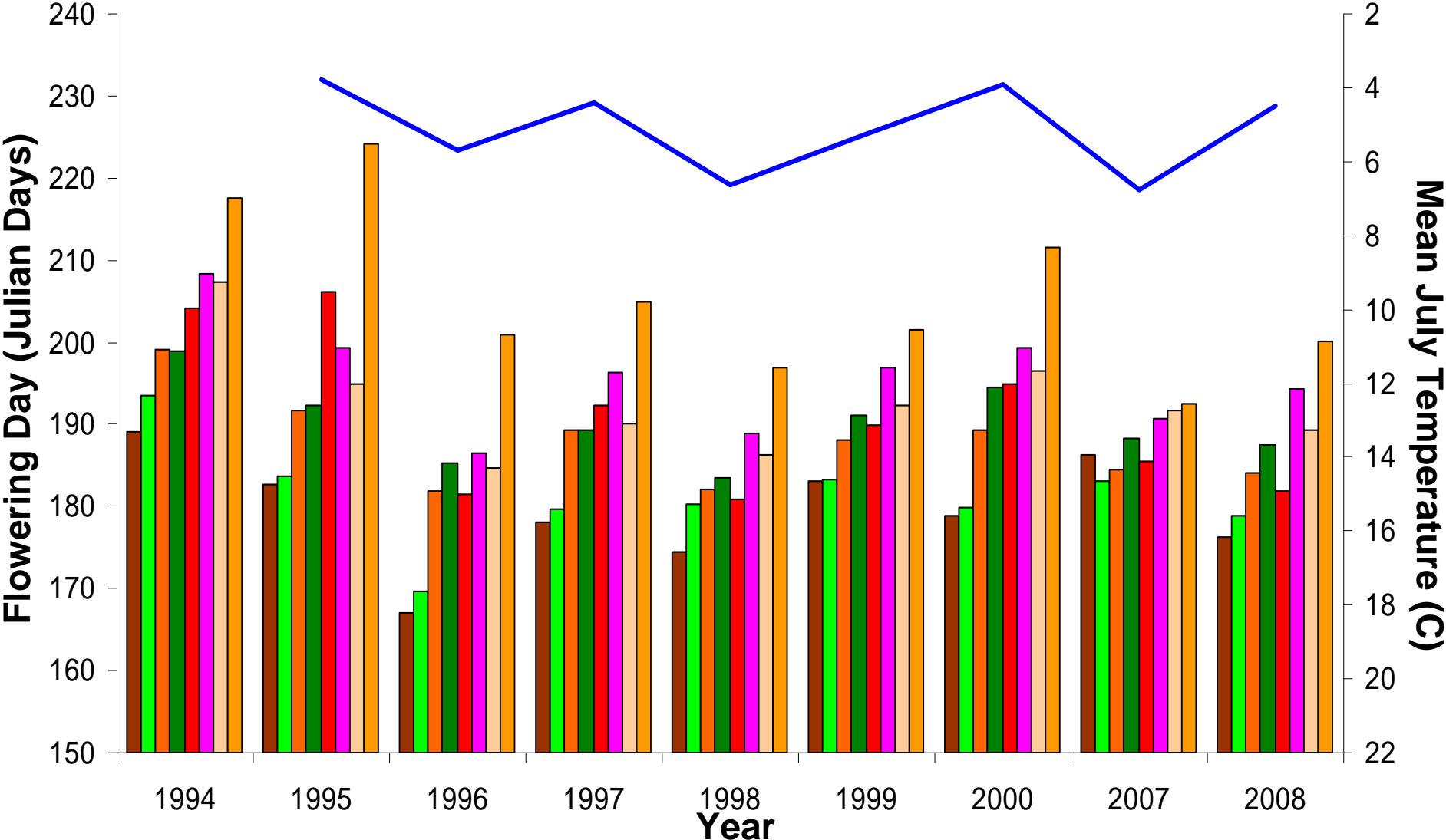
- Salix rotundifolia*
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- Cassiope tetragona*
- Papaver hultenii*
- Saxifraga punctata*
- Stellaria laeta*
- OTC
- Control

Barrow Dry



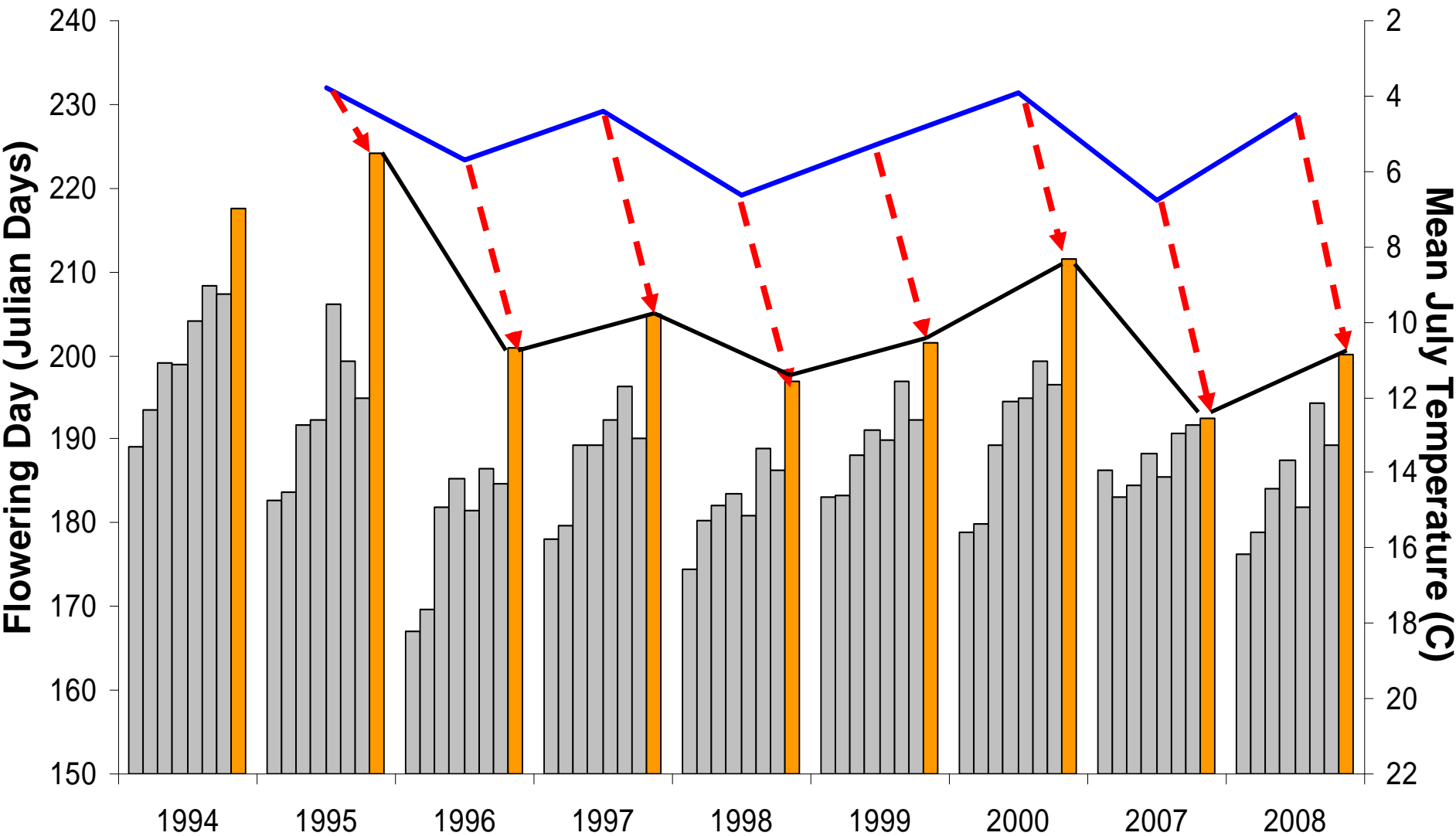
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- Cassiope tetragona*
- Papaver hultenii*
- Saxifraga punctata*
- Stellaria laeta*
- OTC
- Control

Barrow Dry



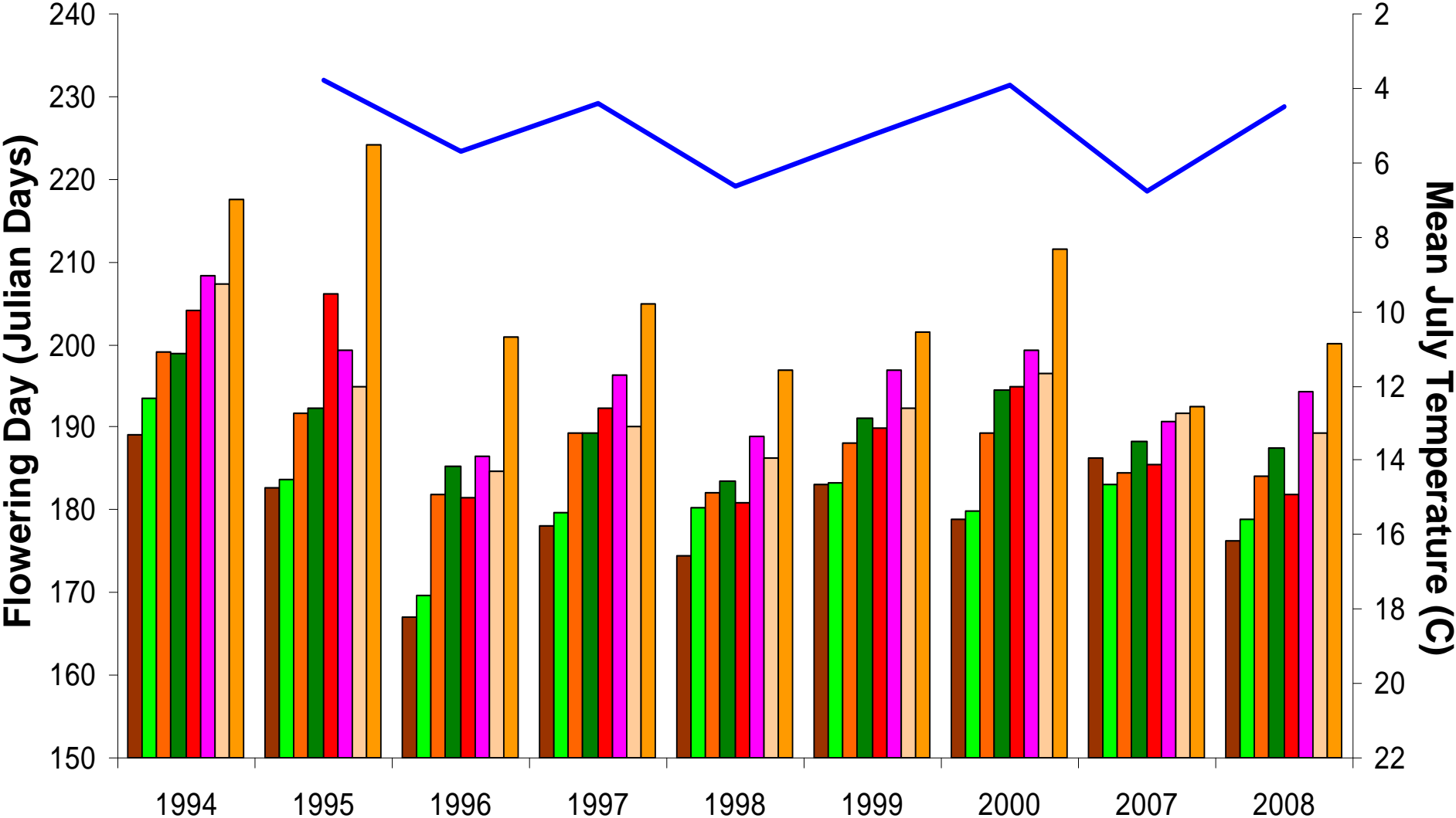
- Salix rotundifolia*
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- Luzula confusa*
- Cassiope tetragona*
- Papaver hultenii*
- Stellaria laeta*
- Saxifraga punctata*
- Temp

Barrow Dry



- Salix rotundifolia*
- Luzula arctica*
- Potentilla hyparctica*
- Luzula confusa*
- Cassiope tetragona*
- Papaver hultenii*
- Stellaria laeta*
- Temp

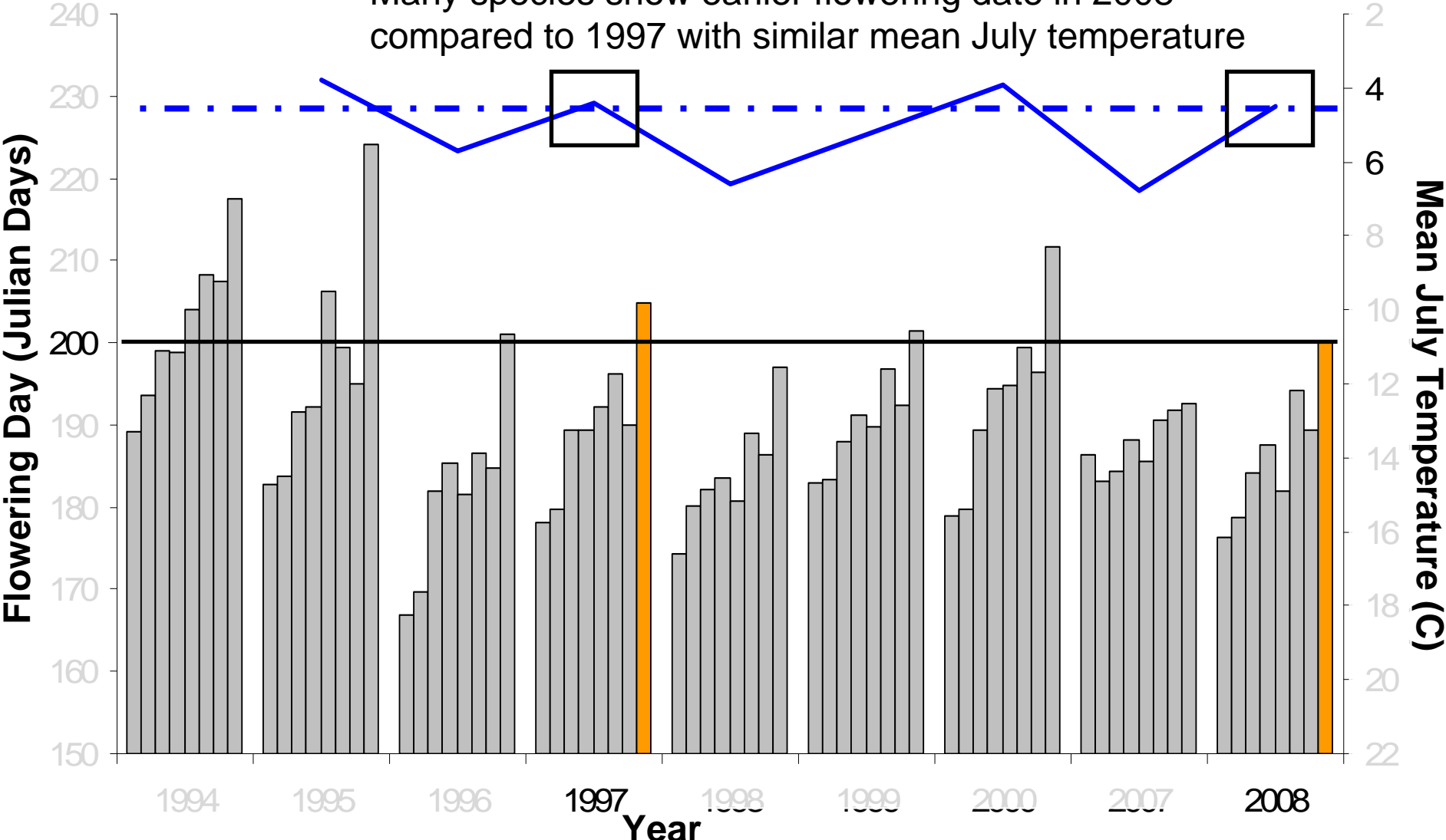
Barrow Dry



- Salix rotundifolia*
- Luzula arctica*
- Potentilla hyparctica*
- Luzula confusa*
- Cassiope tetragona*
- Papaver hultenii*
- Saxifraga punctata*
- Stellaria laeta*
- Temp

Barrow Dry

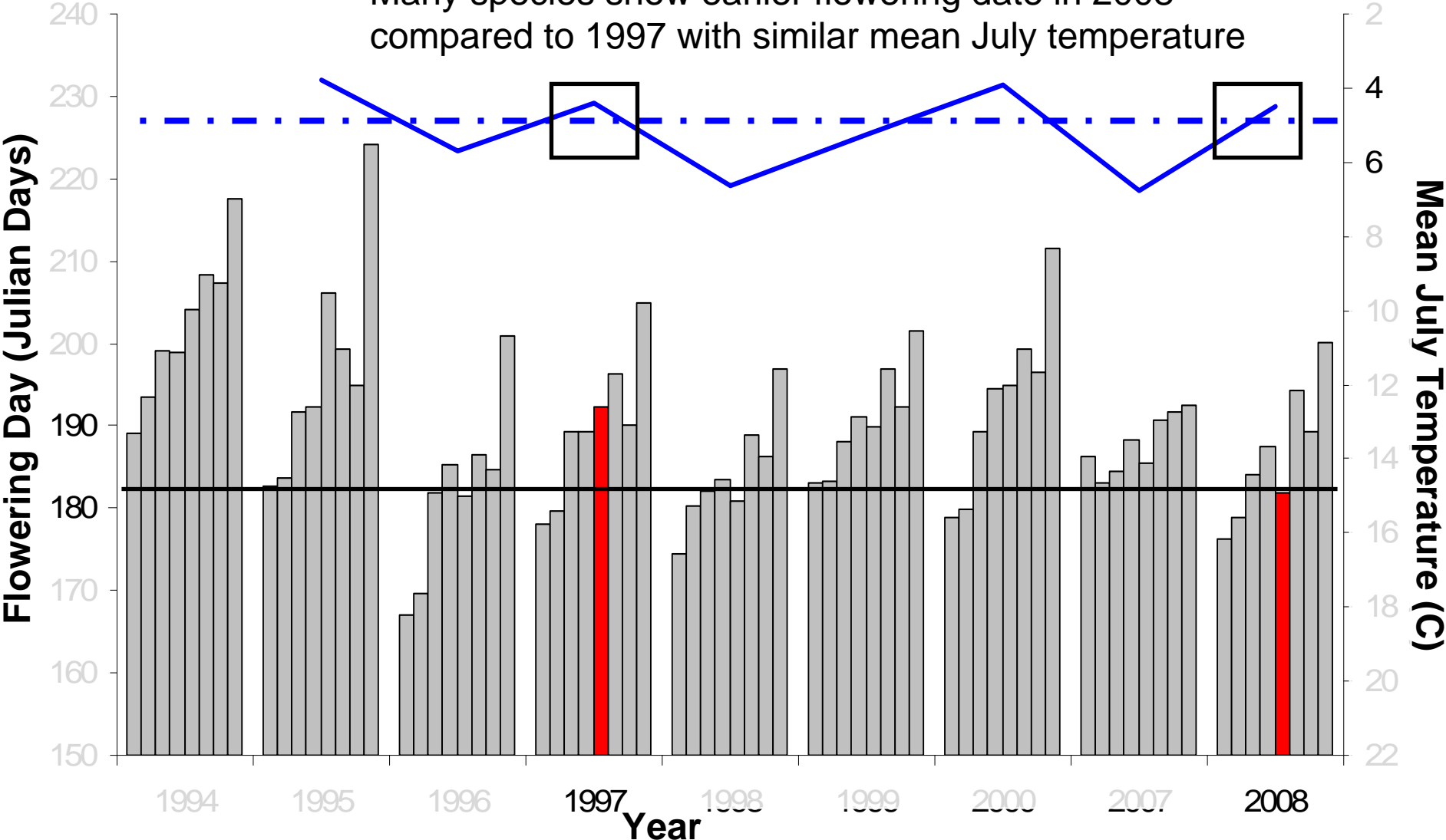
Many species show earlier flowering date in 2008 compared to 1997 with similar mean July temperature



- Salix rotundifolia*
- Luzula arctica*
- Potentilla hyparctica*
- Luzula confusa*
- Cassiope tetragona*
- Papaver hultenii*
- Saxifraga punctata*
- Stellaria laeta*
- Temp

Barrow Dry

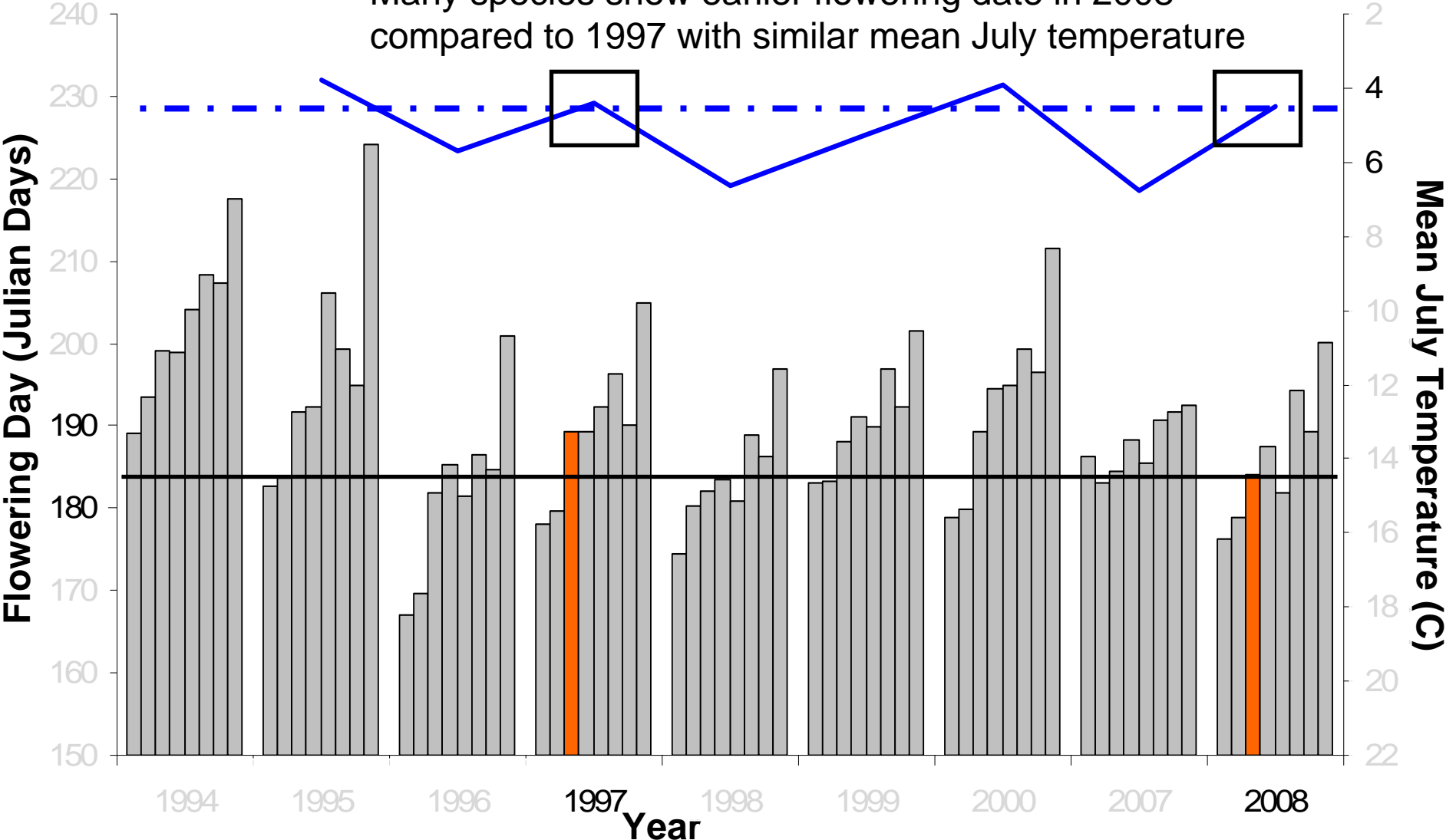
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- Stellaria laeta*
- Temp

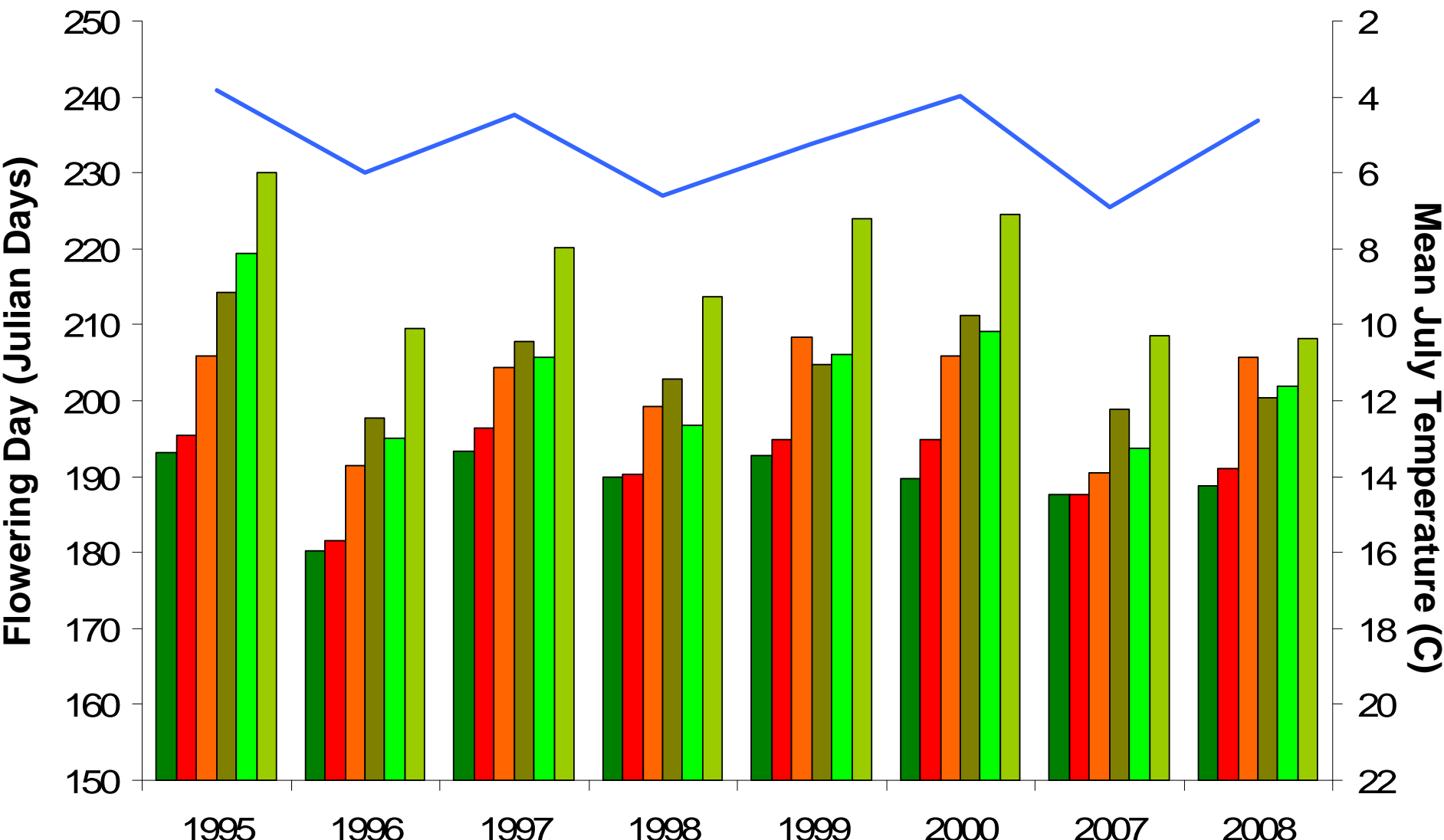
Barrow Dry

Many species show earlier flowering date in 2008 compared to 1997 with similar mean July temperature



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- Cassiope tetragona*
- Papaver hultenii*
- Saxifraga punctata*
- Stellaria laeta*
- Temp

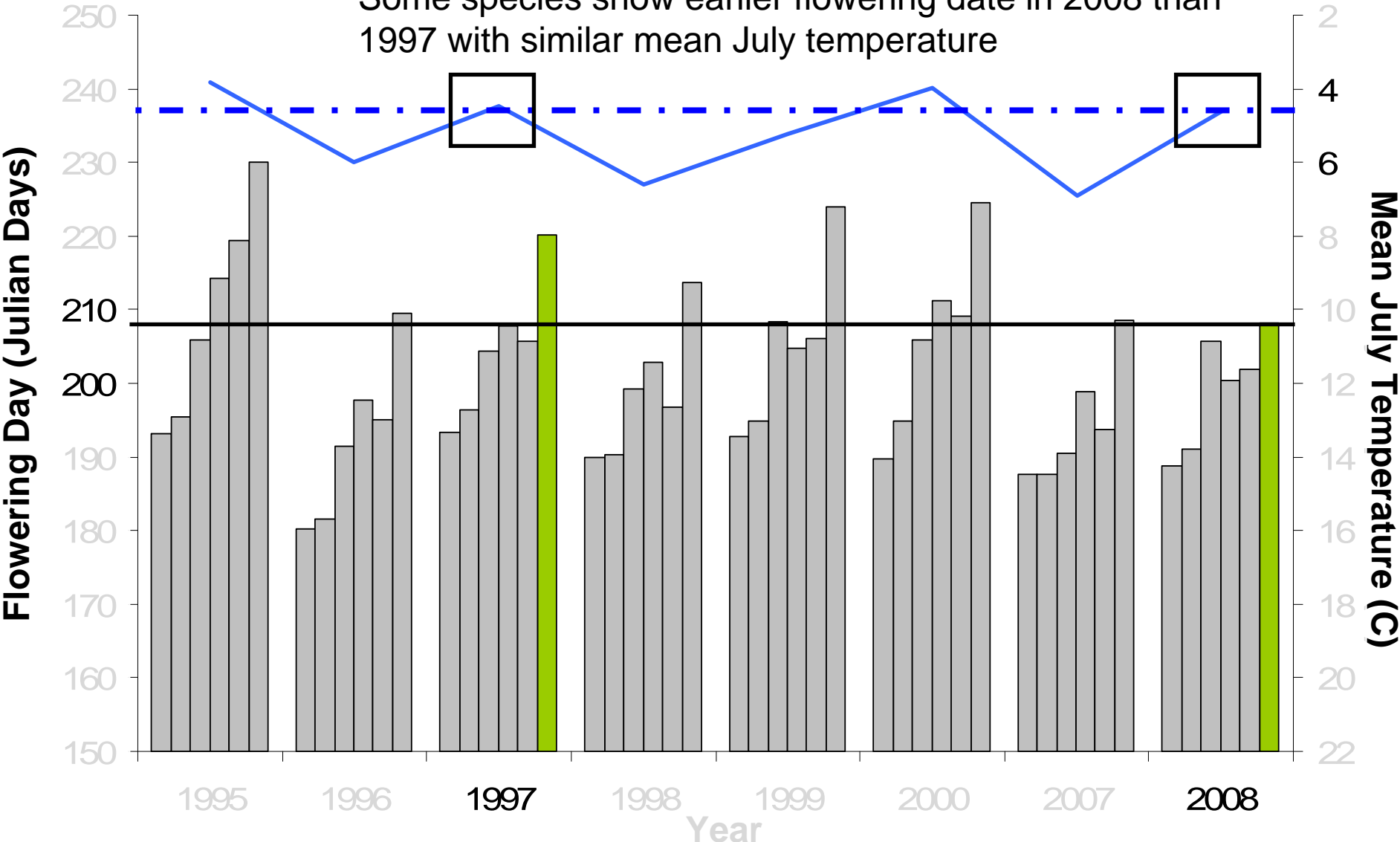
Barrow Wet



- Luzula arctica*
- Draba lactea*
- Saxifraga hieracifolia*
- Carex stans*
- Hierachloe pauciflora*
- Dupontia fisheri*
- Temp

Barrow Wet

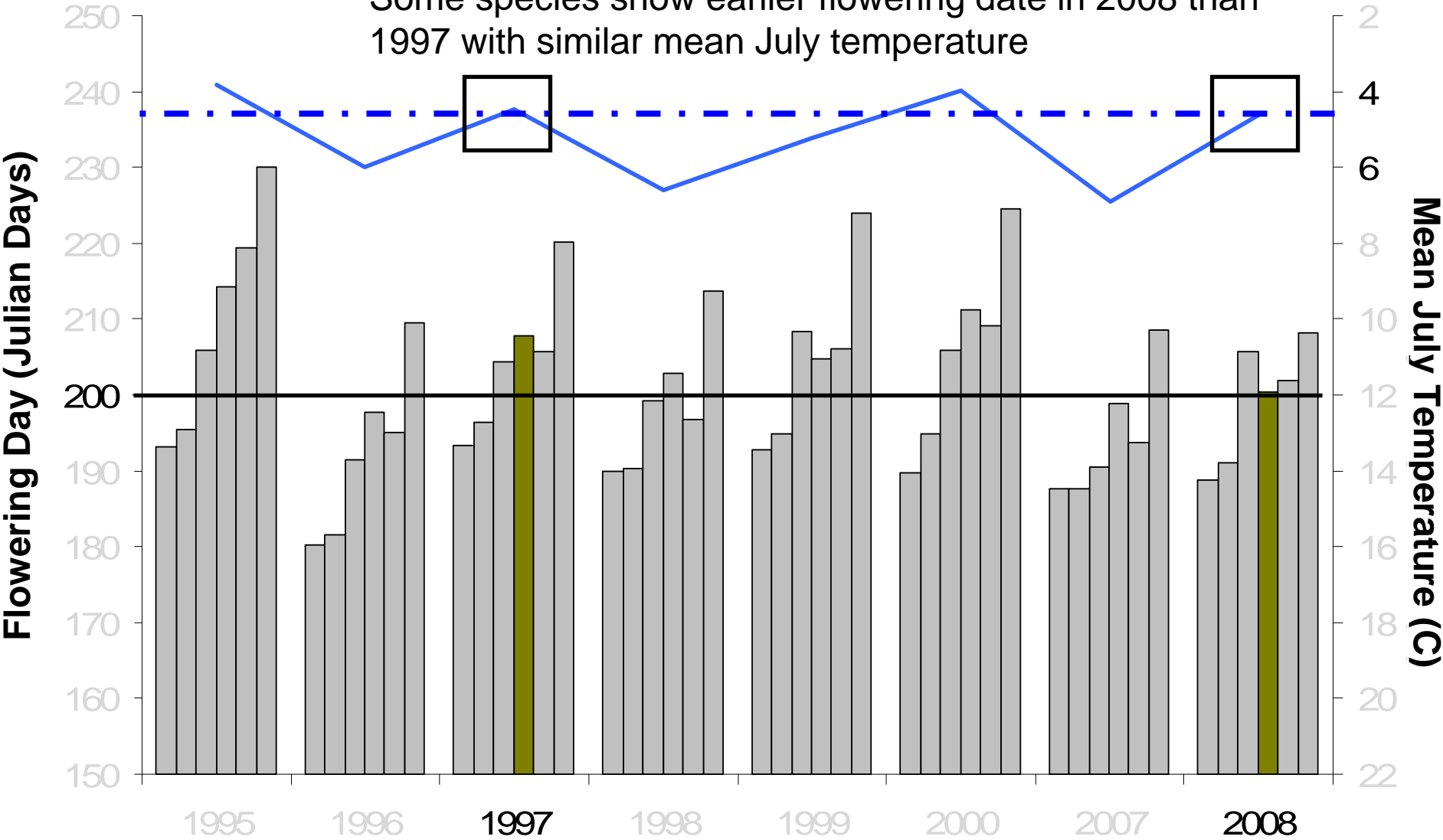
Some species show earlier flowering date in 2008 than 1997 with similar mean July temperature



- Luzula arctica*
- Carex stans*
- Draba lactea*
- Hierachloe pauciflora*
- Saxifraga hieracifolia*
- DuPontia fisheri*
- Temp

Barrow Wet

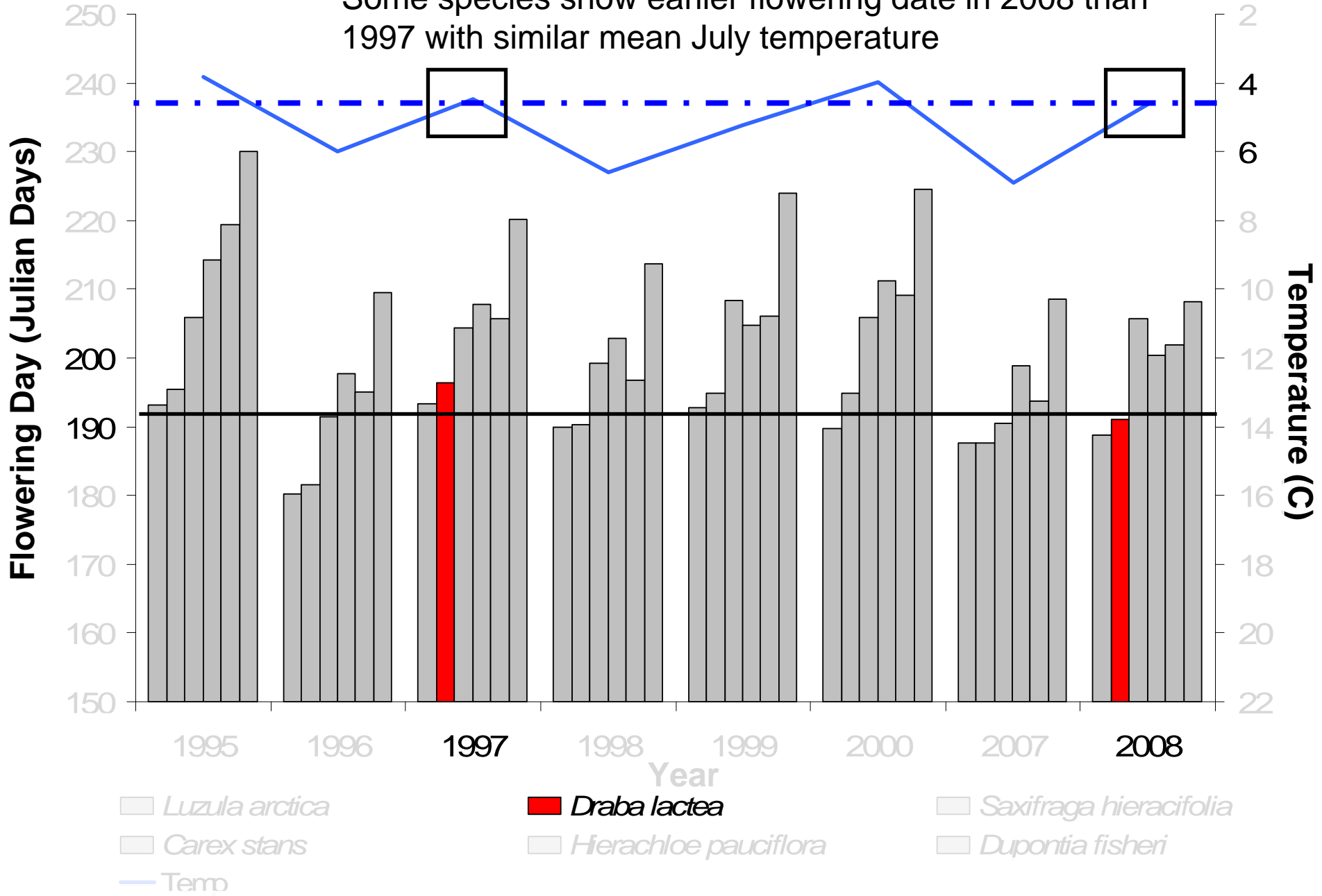
Some species show earlier flowering date in 2008 than 1997 with similar mean July temperature



- Luzula arctica*
- Draba lactea*
- Saxifraga hieracifolia*
- Carex stans*
- Hierachloe pauciflora*
- DuPontia fisheri*
- Temp

Barrow Wet

Some species show earlier flowering date in 2008 than 1997 with similar mean July temperature

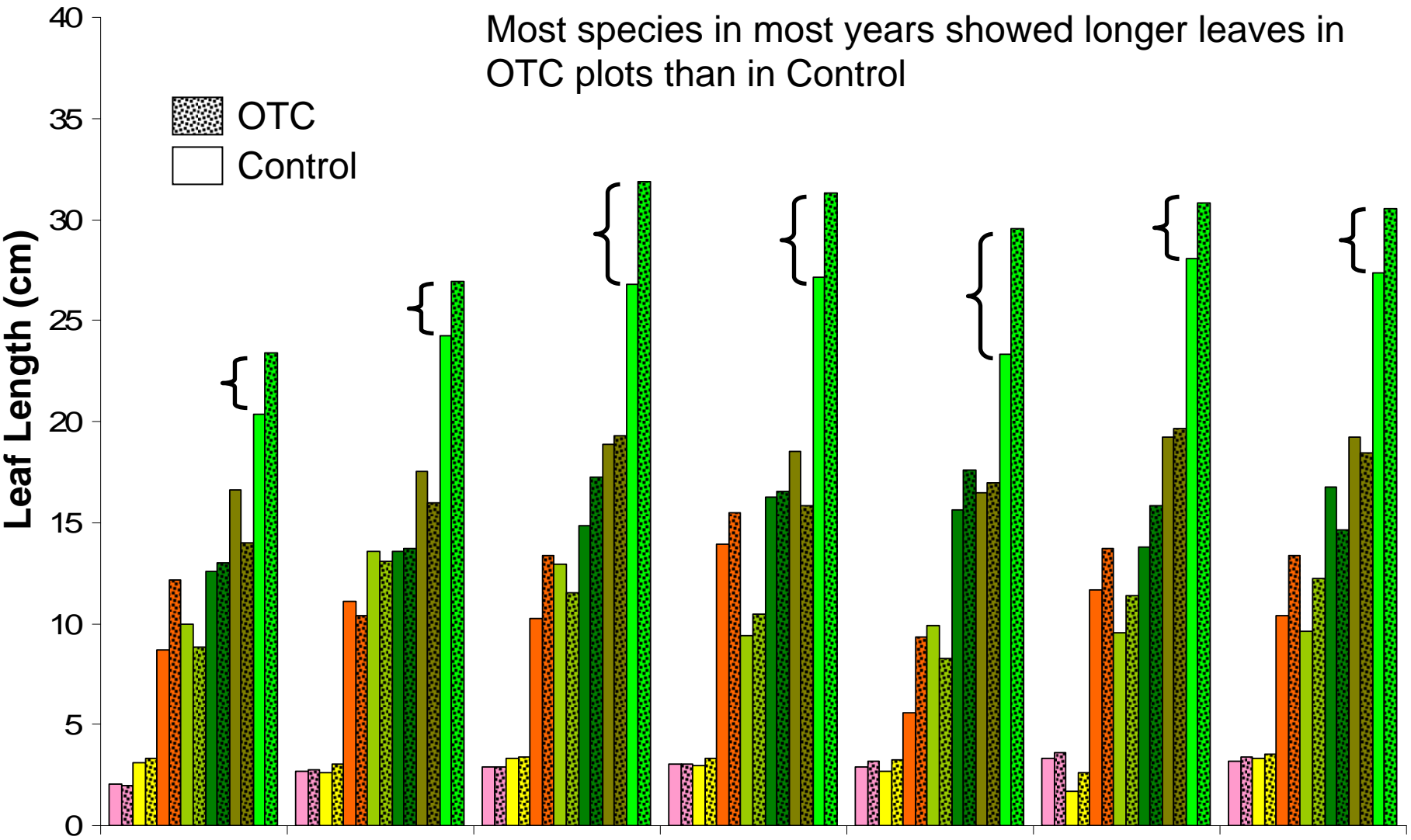


Longest Leaf



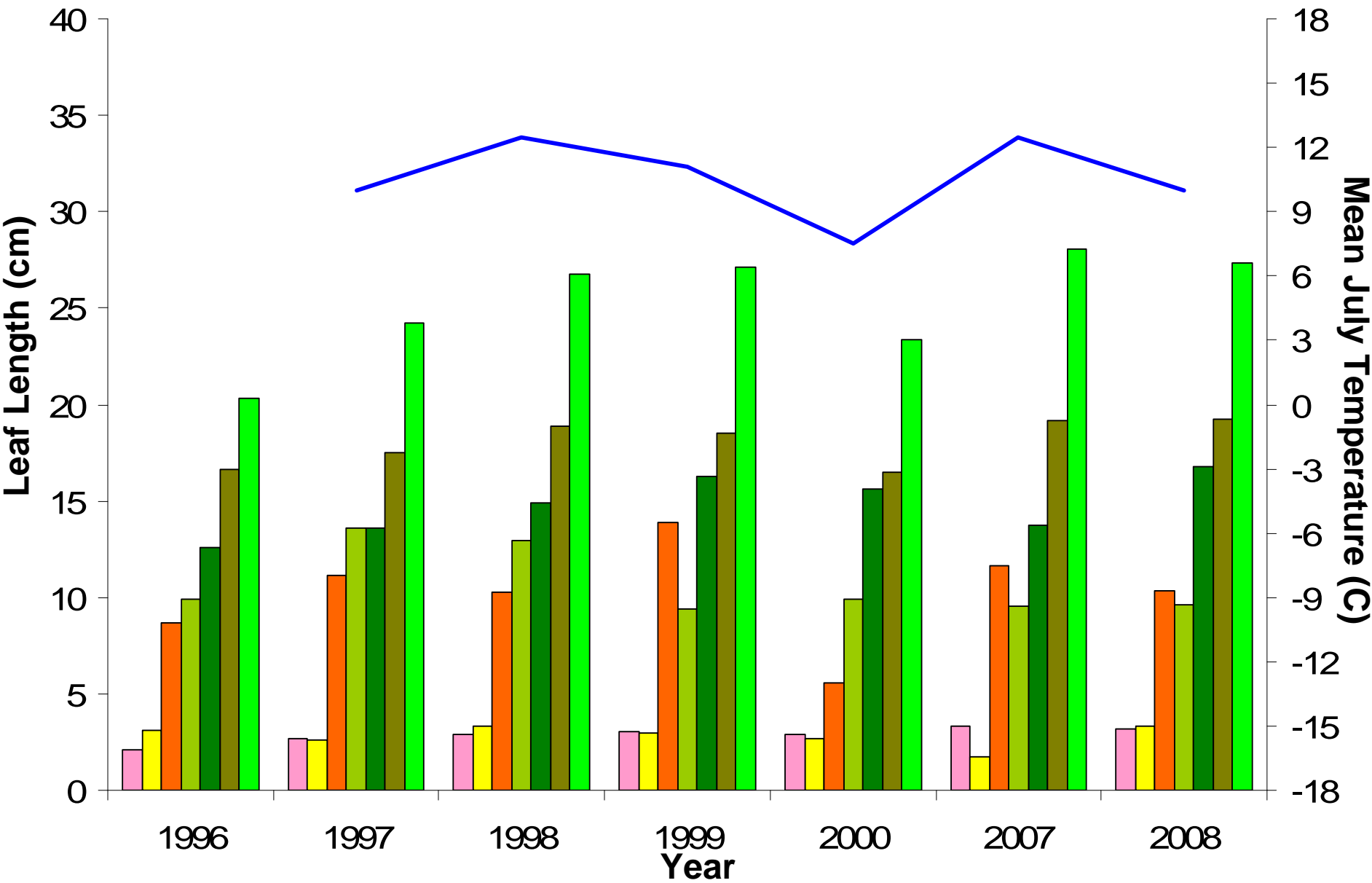
Atqasuk Dry

Most species in most years showed longer leaves in OTC plots than in Control



- Diapensia lapponica*
- Minuartia obtusiloba*
- Polygonum bistorta*
- Luzula arctica*
- Carex bigelowii*
- Luzula confusa*
- Hierachloe alpina*

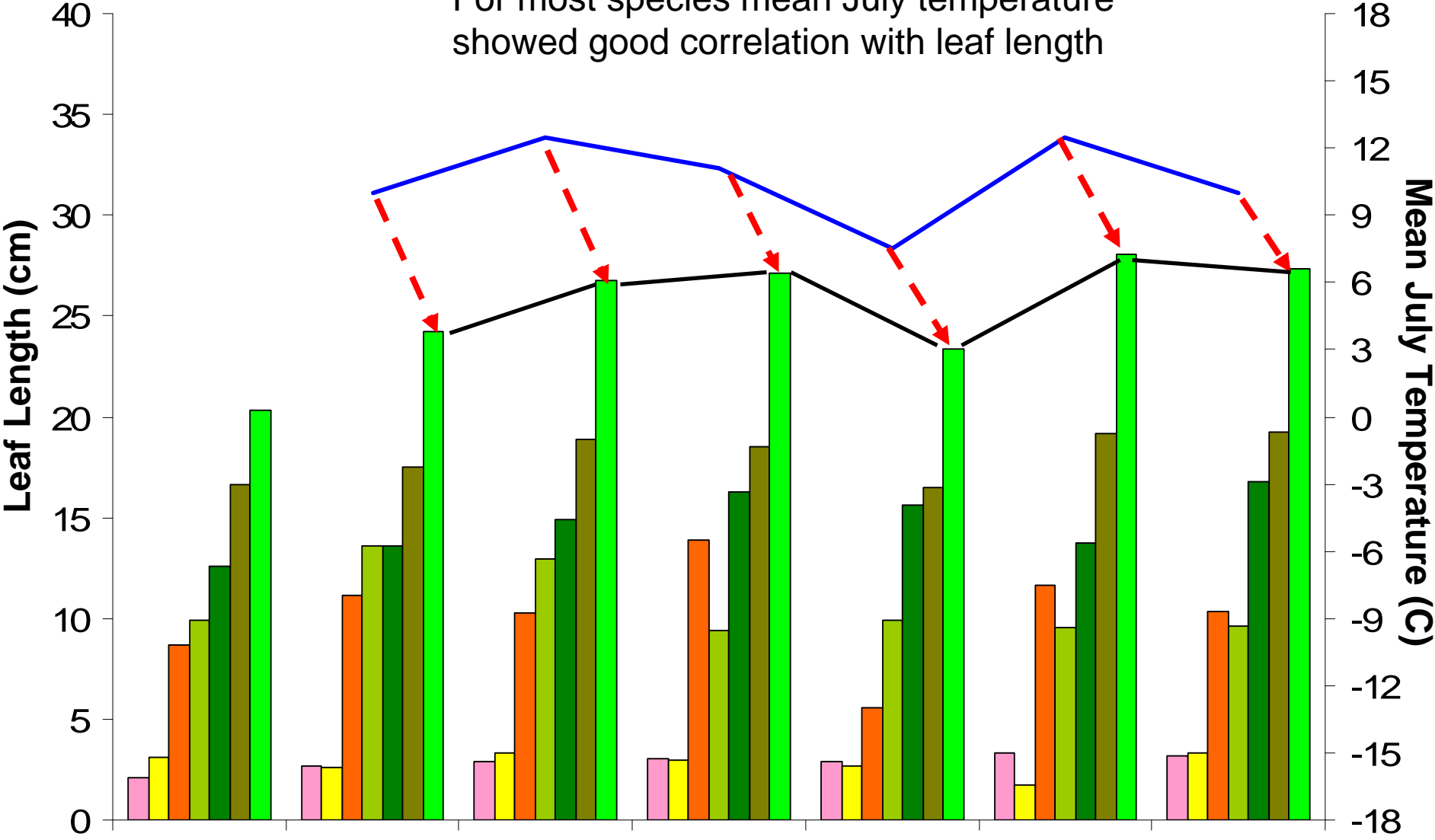
Atqasuk Dry



Diapensia lapponica
 Mnuartia obtusiloba
 Polygonum bistorta
 Luzula arctica
 Carex bigelowii
 Luzula confusa
 Hierachloe alpina
 Temp

Atqasuk Dry

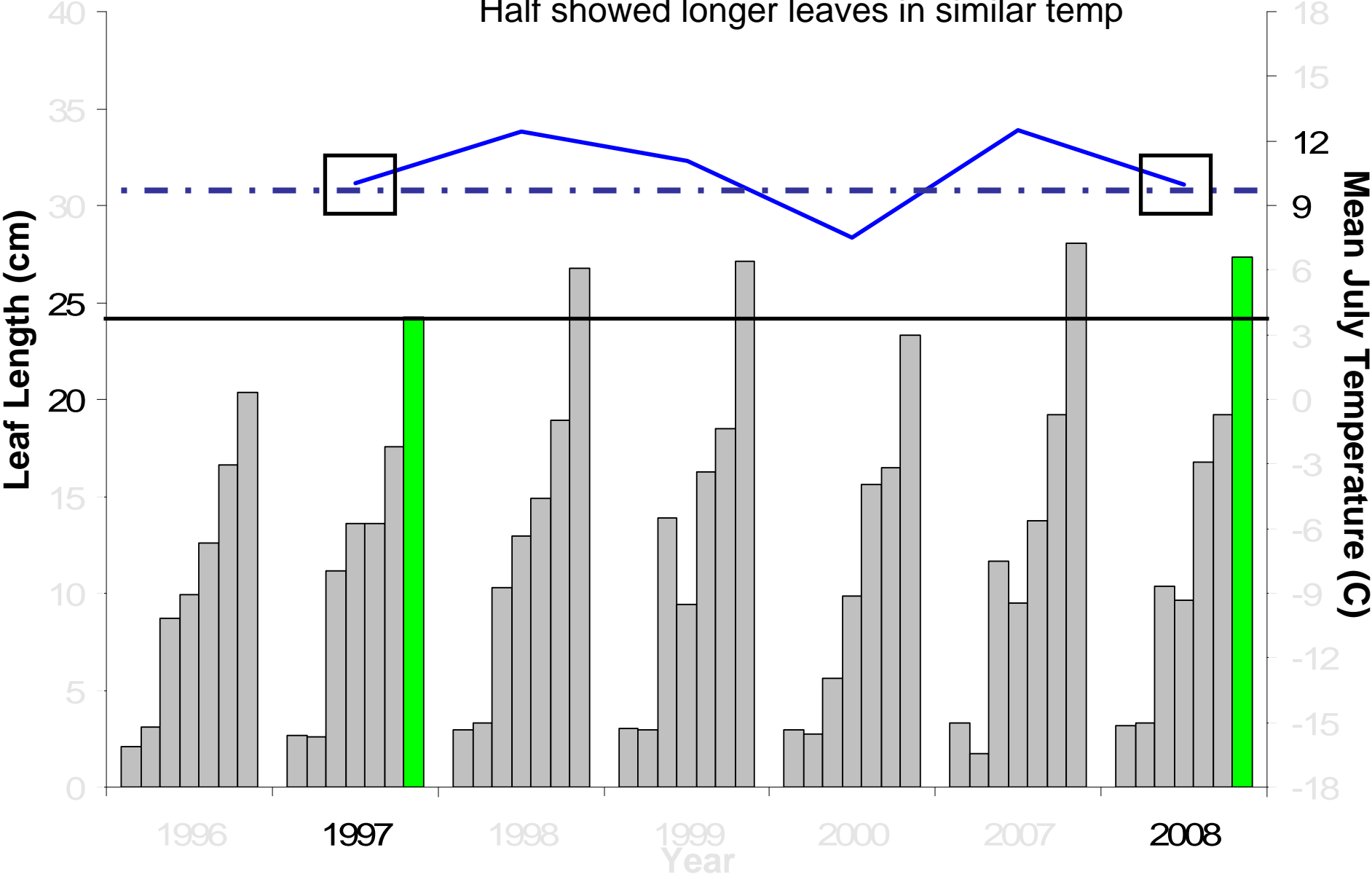
For most species mean July temperature showed good correlation with leaf length



- Diapensia lapponica*
- Mnuartia obtusiloba*
- Polygonum bistorta*
- Luzula arctica*
- Carex bigelowii*
- Luzula confusa*
- Hierachloe alpina*
- Temp

Atqasuk Dry

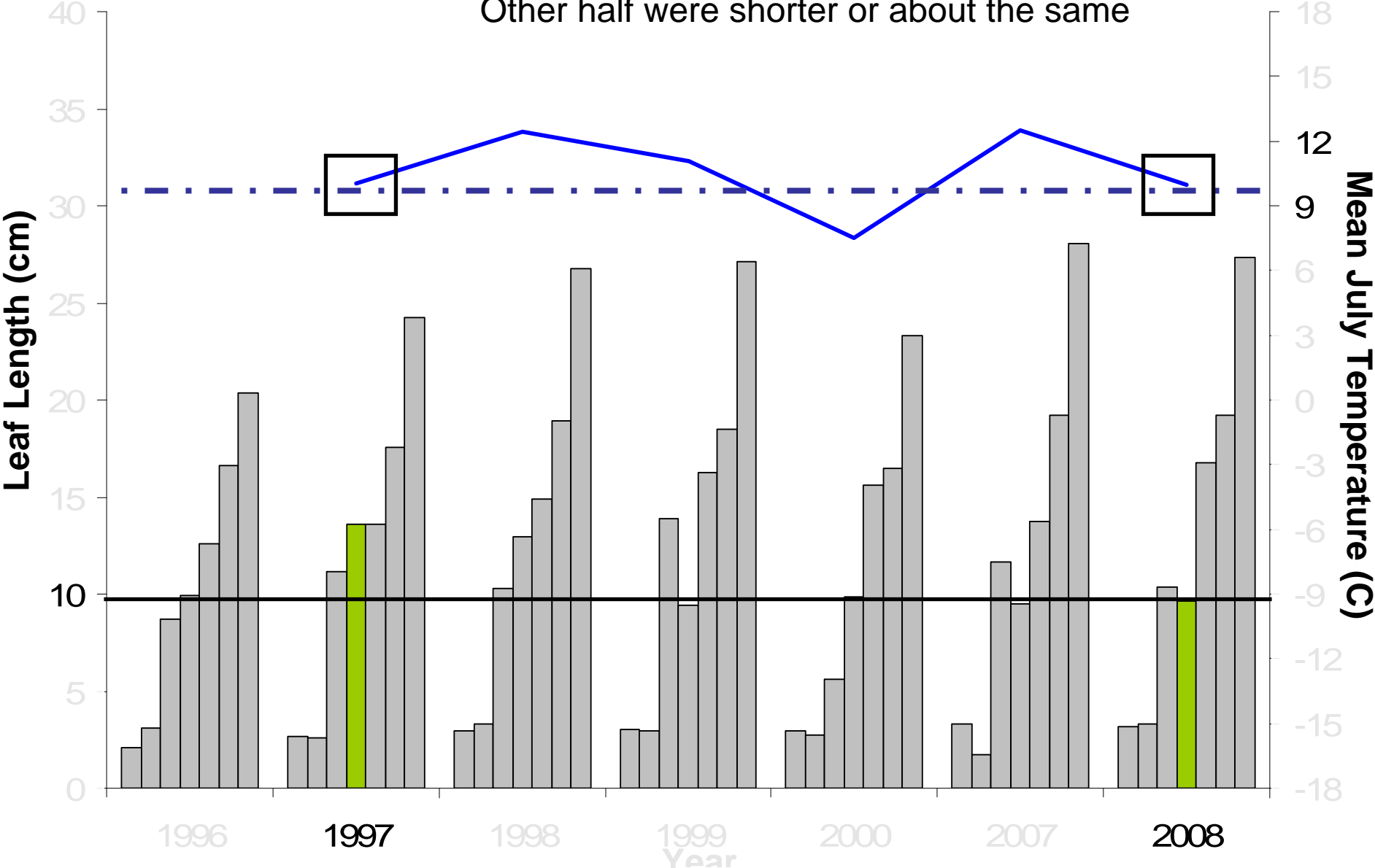
Half showed longer leaves in similar temp



- Diapensia lapponica*
- Mnuartia obtusiloba*
- Polygonum bistorta*
- Luzula arctica*
- Carex bigelowii*
- Luzula confusa*
- Hierachloe alpina*
- Temp

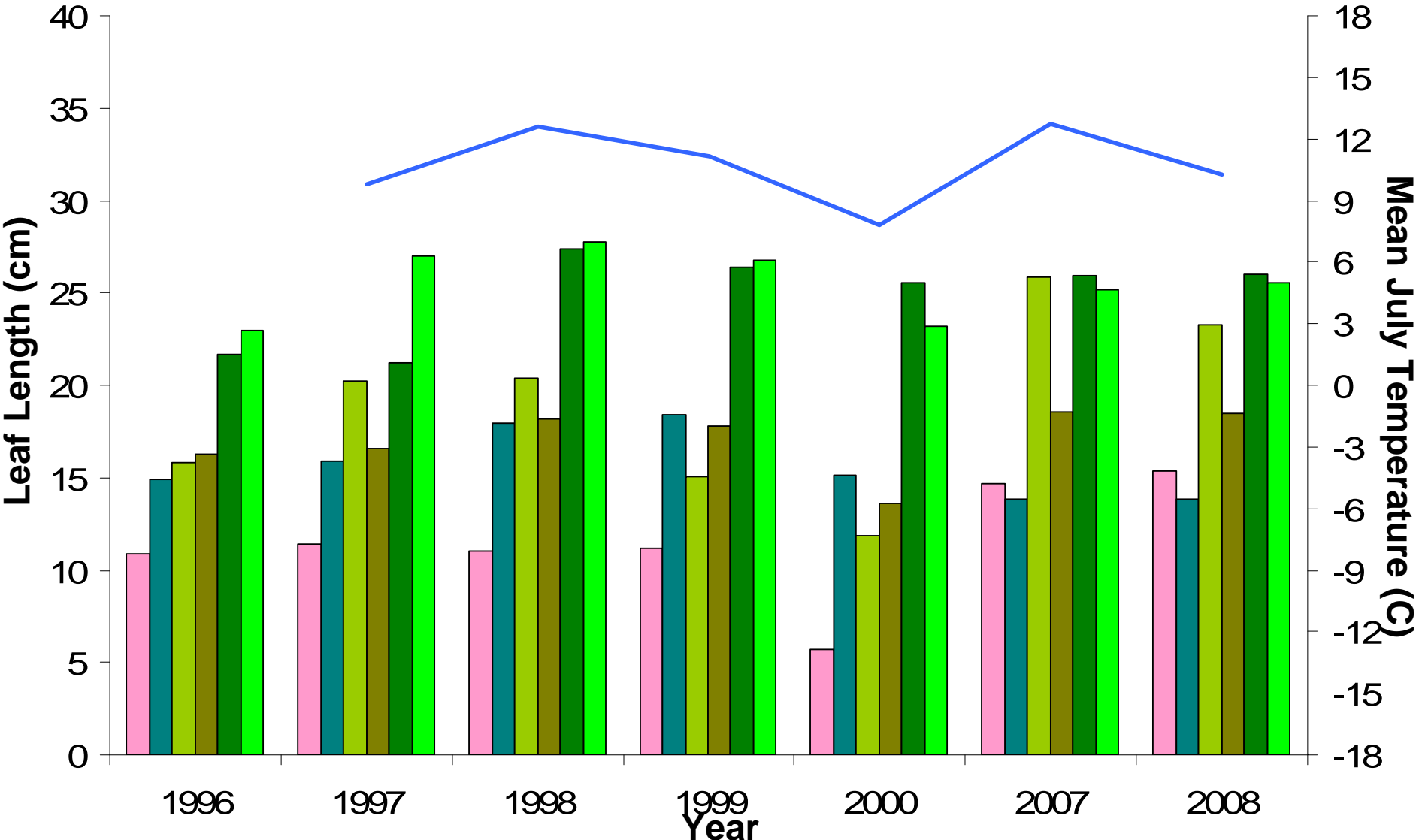
Atqasuk Dry

Other half were shorter or about the same



- Diapensia lapponica*
- Mnuartia obtusiloba*
- Polygonum bistorta*
- Luzula arctica*
- Carex bigelowii*
- Luzula confusa*
- Hierachloe alpina*
- Temp

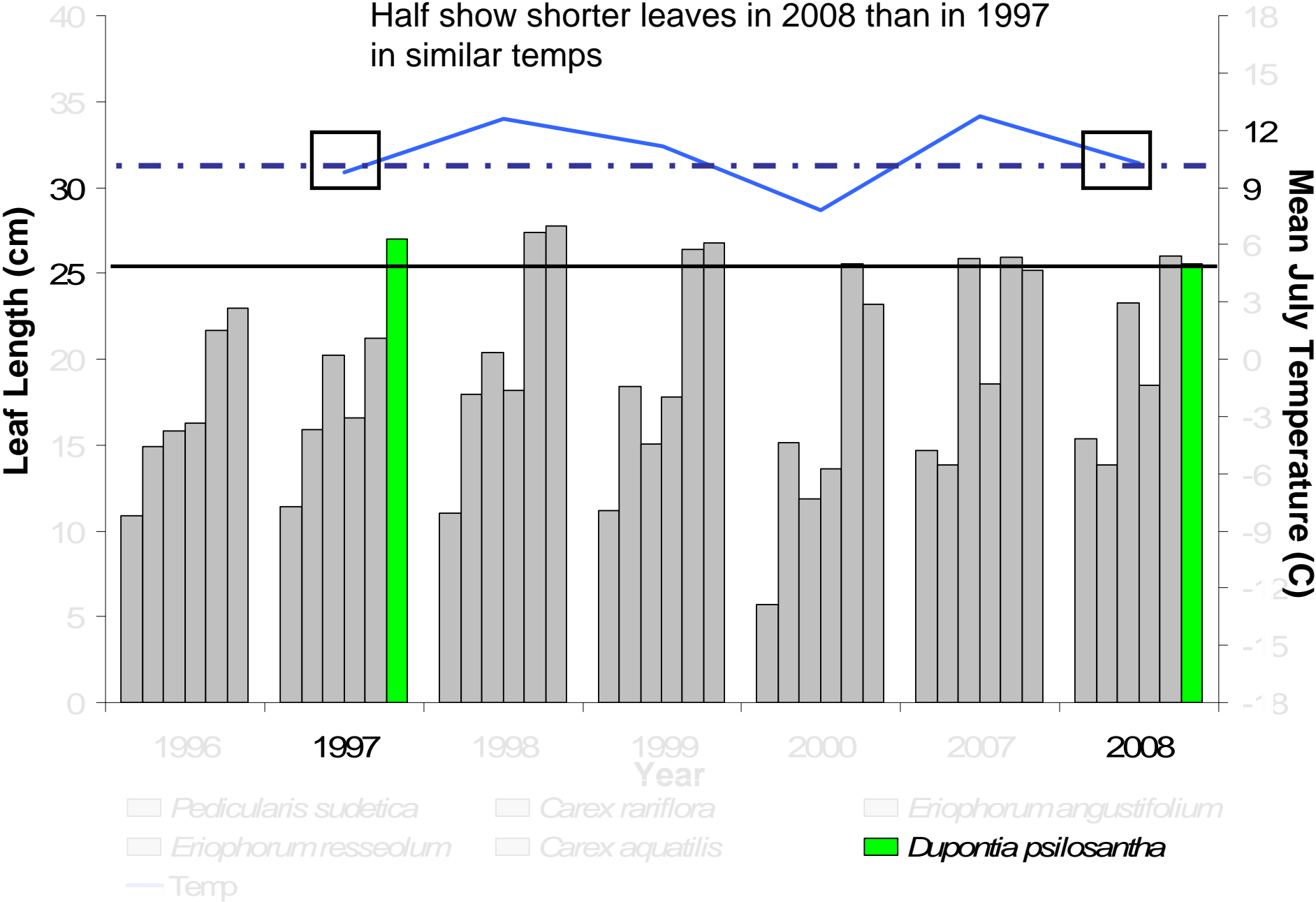
Atqasuk Wet



- Pedicularis sudetica*
- Carex rariflora*
- Eriophorum angustifolium*
- Eriophorum resseolum*
- Carex aquatilis*
- Dupontia psilosantha*
- Temp

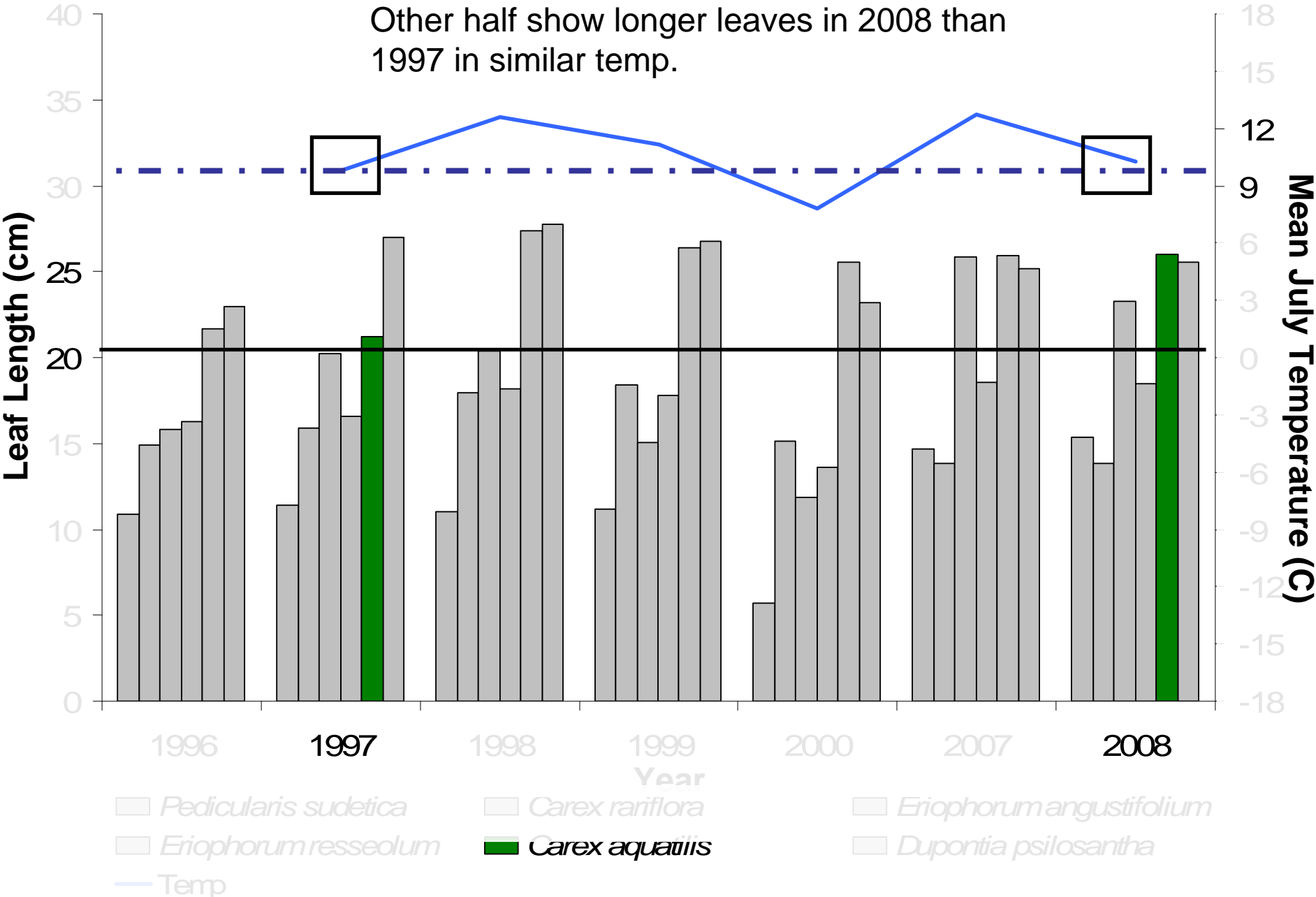
Atqasuk Wet

Half show shorter leaves in 2008 than in 1997
in similar temps

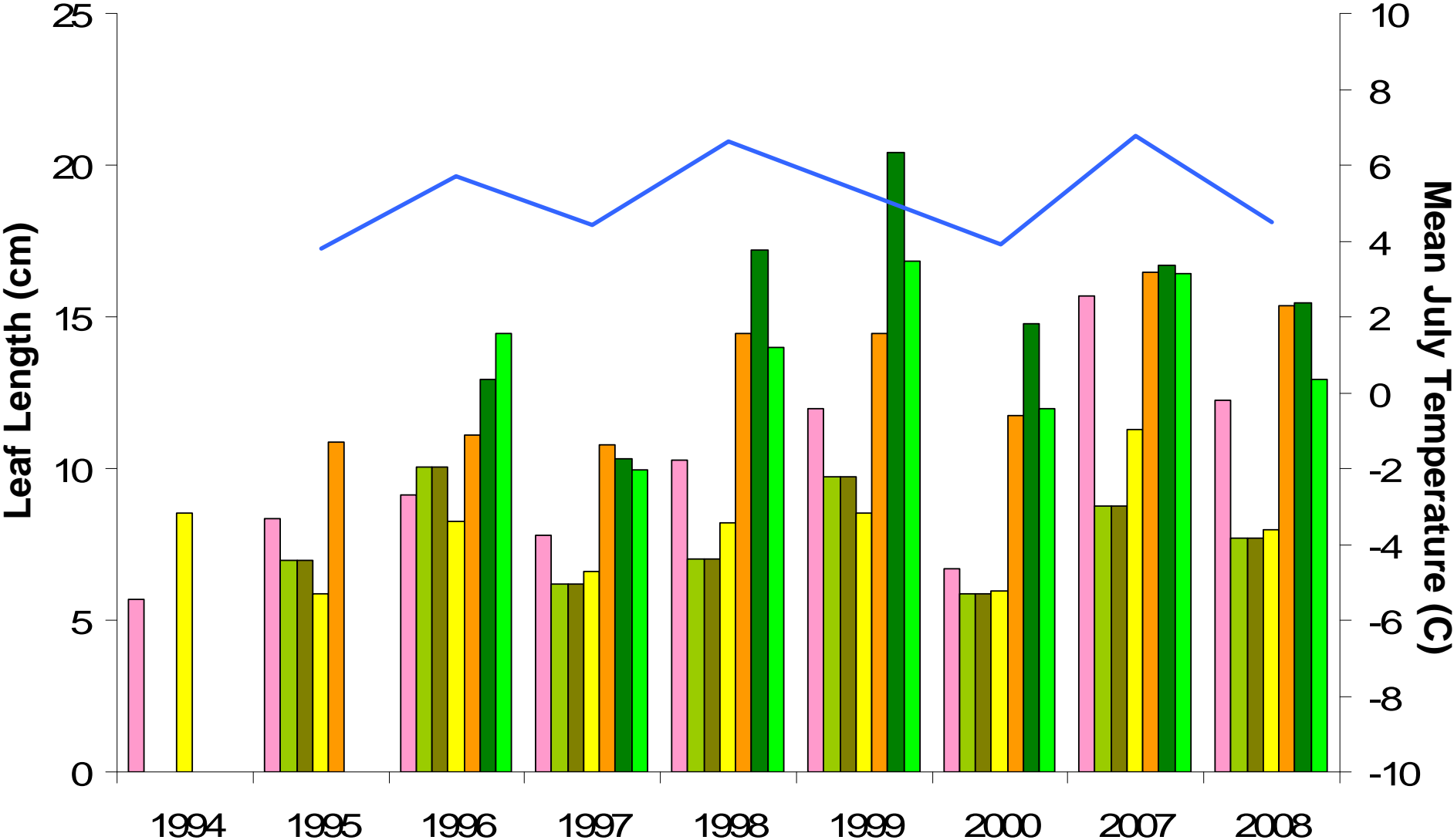


Atqasuk Wet

Other half show longer leaves in 2008 than 1997 in similar temp.



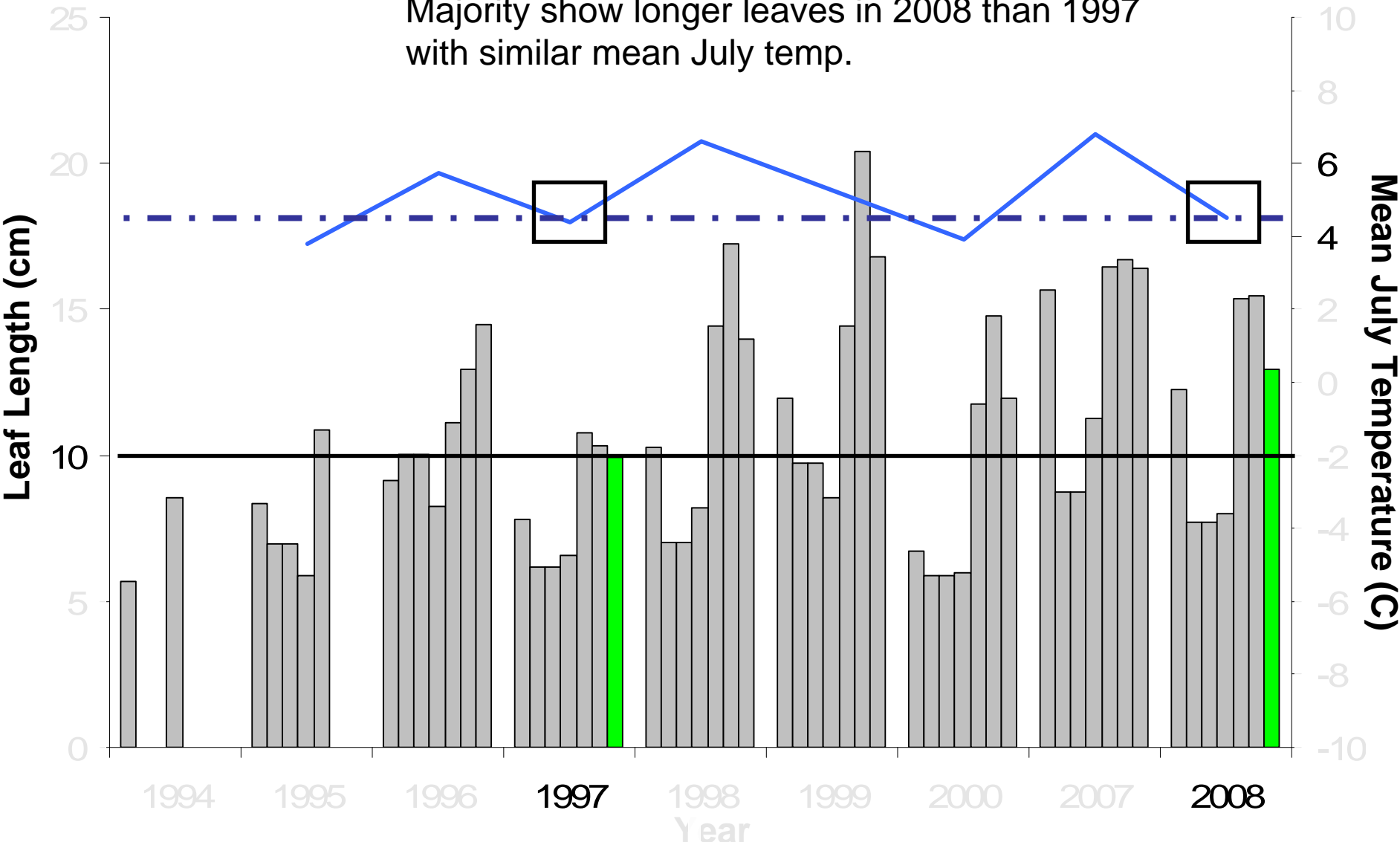
Barrow Dry



- Saxifraga punctata*
- Luzula arctica*
- Luzula confusa*
- Potentilla hyparctica*
- Papaver hultenii*
- Arctagrostis latifolia*
- Poa arctica*
- Temp

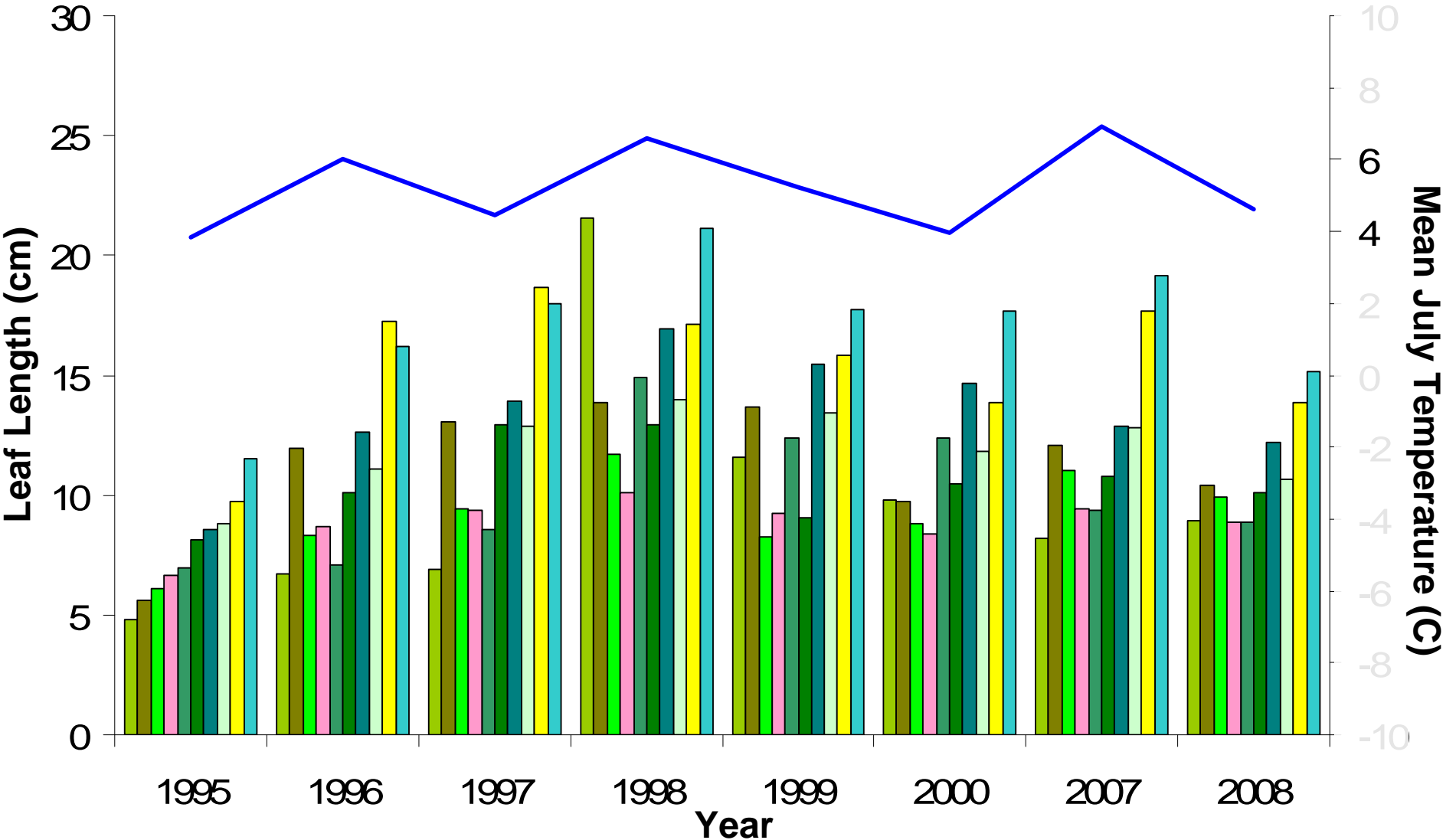
Barrow Dry

Majority show longer leaves in 2008 than 1997 with similar mean July temp.



- Saxifraga punctata*
- Luzula arctica*
- Luzula confusa*
- Potentilla hyperarctica*
- Papaver hultenii*
- Arctagrostis latifolia*
- Poa arctica*
- Temp

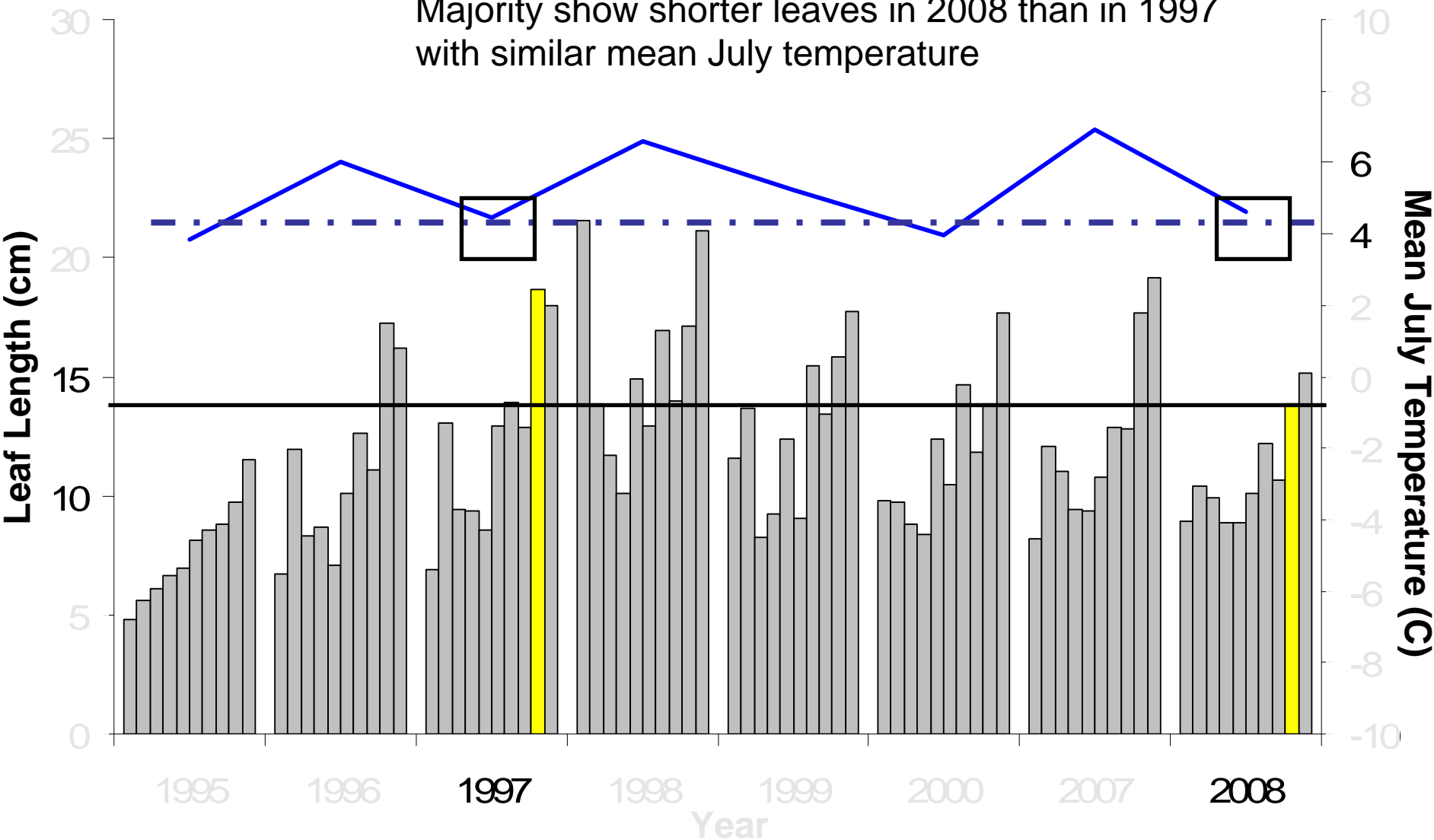
Barrow Wet



- Eriophorum russeolum*
- Poa arctica*
- Luzula arctica*
- Saxifraga cernua*
- Eriophorum triste*
- Luzula confusa*
- Carex stans*
- Hierachloe pauciflora*
- Saxifraga hieracifolia*
- Dupontia fisheri*
- Temp

Barrow Wet

Majority show shorter leaves in 2008 than in 1997 with similar mean July temperature



- Eriophorum russeolum*
- Poa arctica*
- Luzula arctica*
- Saxifraga cernua*
- Eriophorum triste*
- Luzula confusa*
- Carex stans*
- Hierachloe pauciflora*
- Saxifraga hieracifolia*
- Temp
- Dupontia fisheri*

Conclusions

- Findings in previous ITEX studies have held for duration of the study
- Flowering events and leaf lengths show good correspondence with temperature
- Factors outside of temperature play role in both
- Need further investigation into significance of correlations

Acknowledgements

Organizations

- National Science Foundation (NSF)
- Grand Valley State University (GVSU)
- Barrow Arctic Science Consortium (BASC)
- International Tundra Experiment (ITEX)



GVSU Arctic Ecology Program

Michael Lothschutz

Jeremy May

Amanda Snyder

Jean Galang

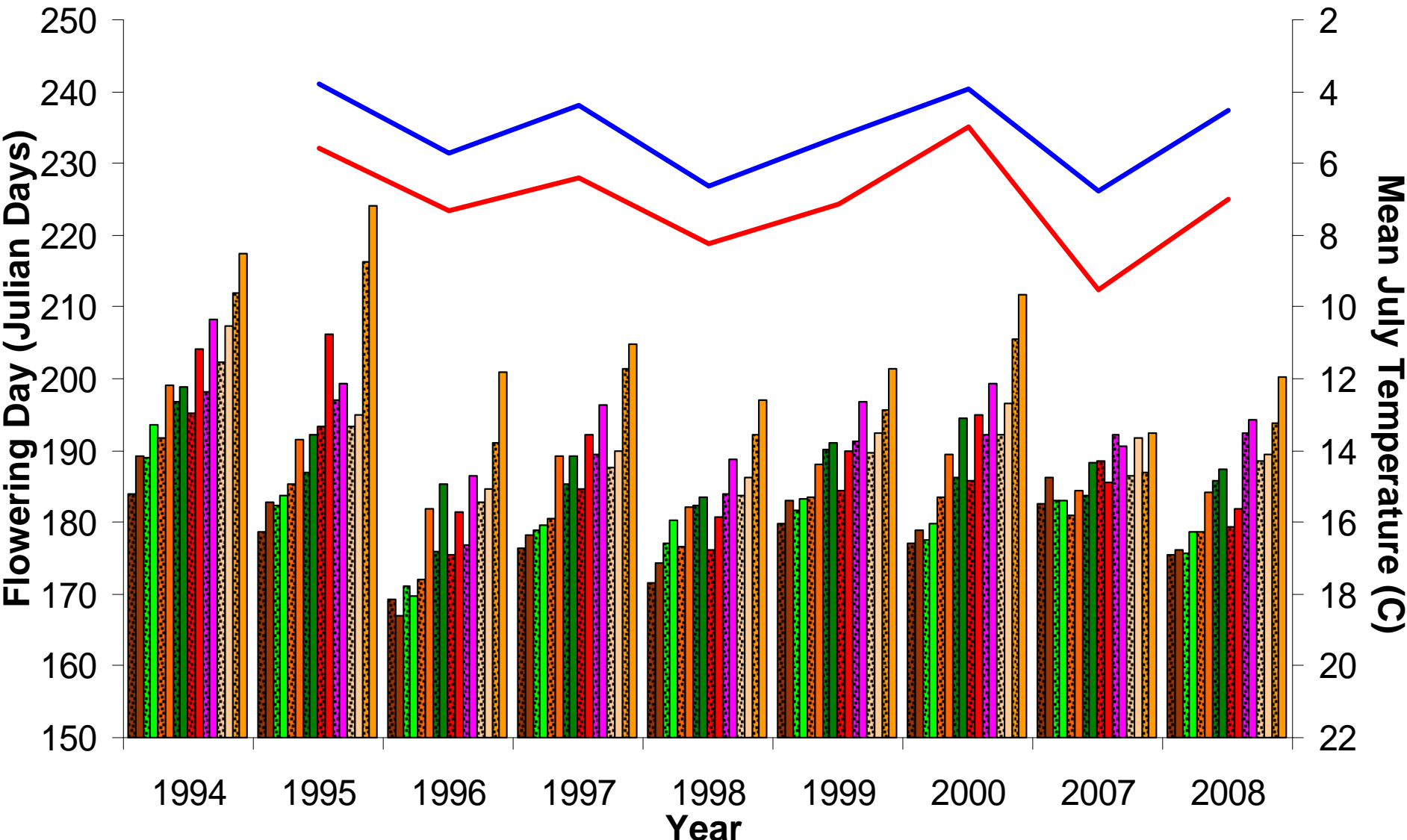
Jenny Liebig



Questions?

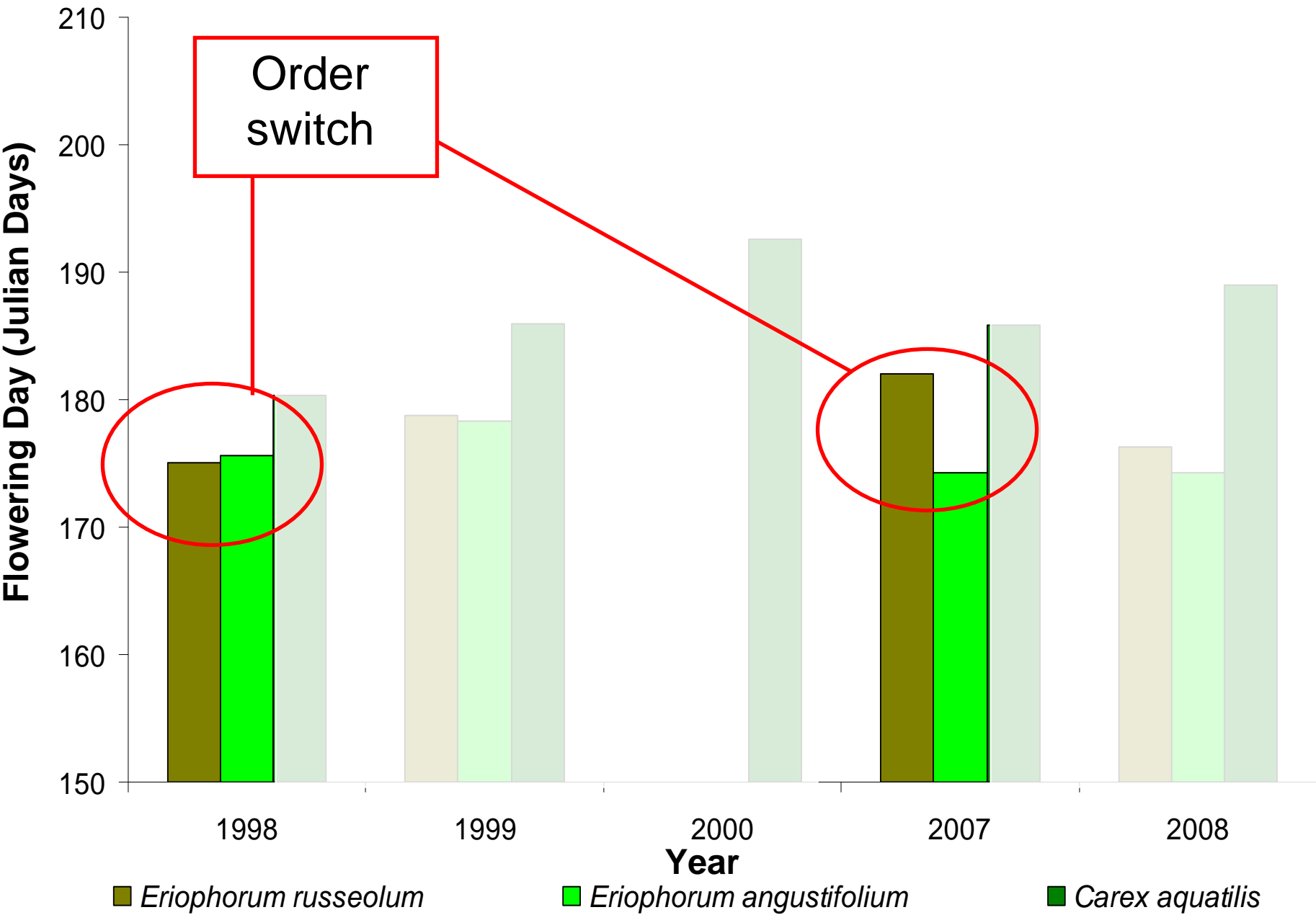


Barrow Dry

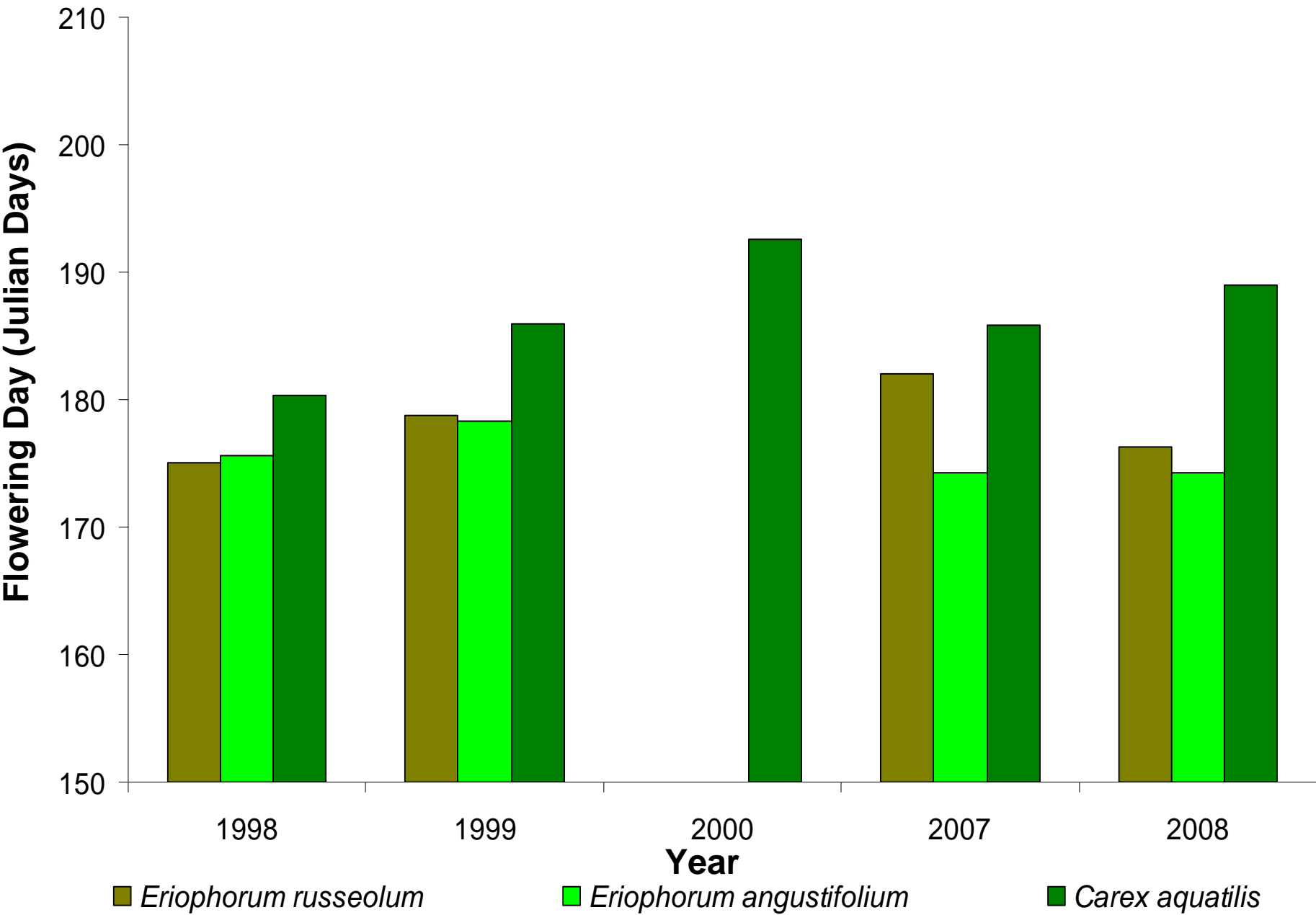


- Salix rotundifolia*
- Luzula arctica*
- Potentilla hyparctica*
- Luzula confusa*
- Cassiope tetragona*
- Papaver hultenii*
- Saxifraga punctata*
- Stellaria laeta*
- Control Temp
- OTC Temp
- OTC
- Control

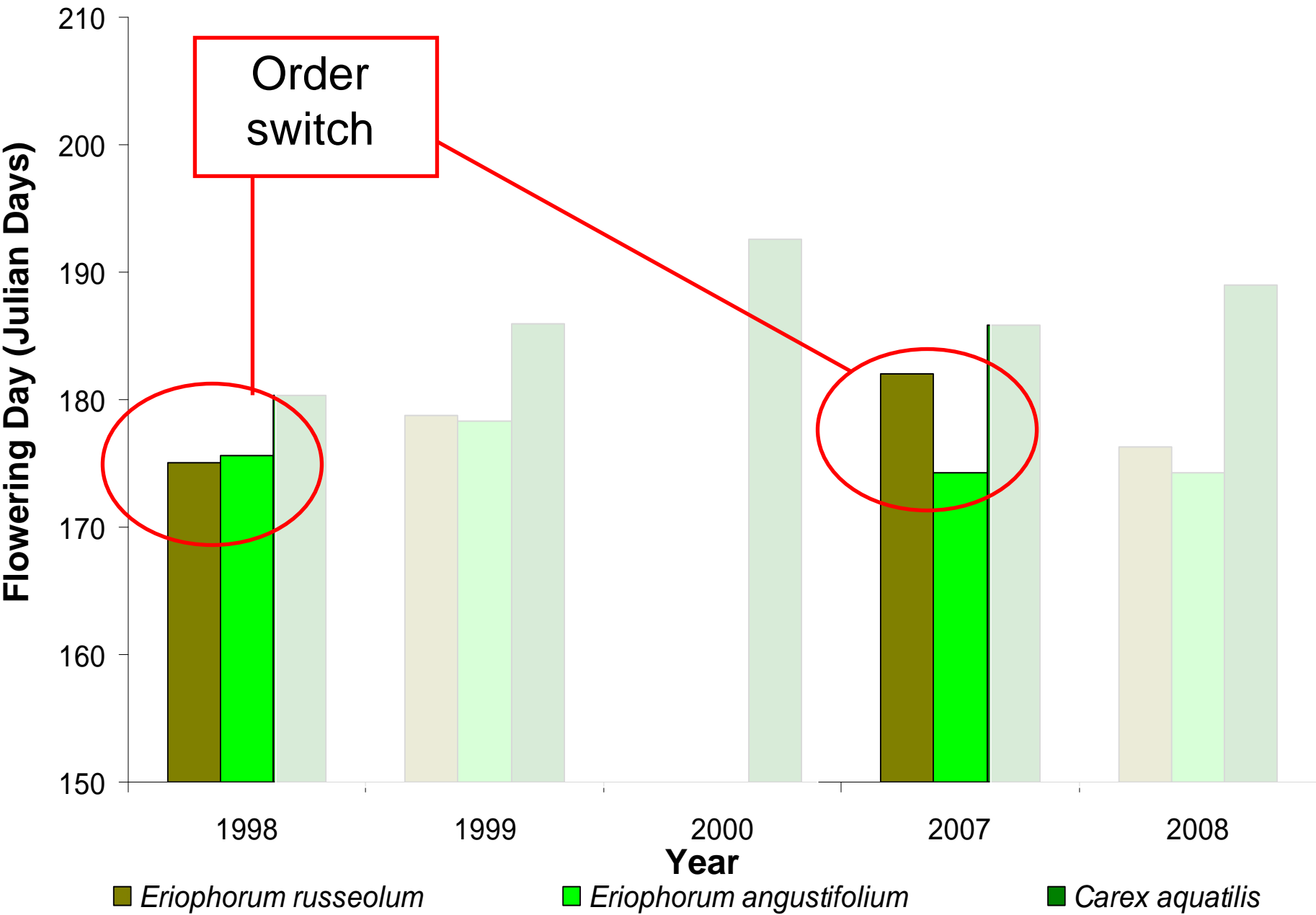
Atqasuk Dry



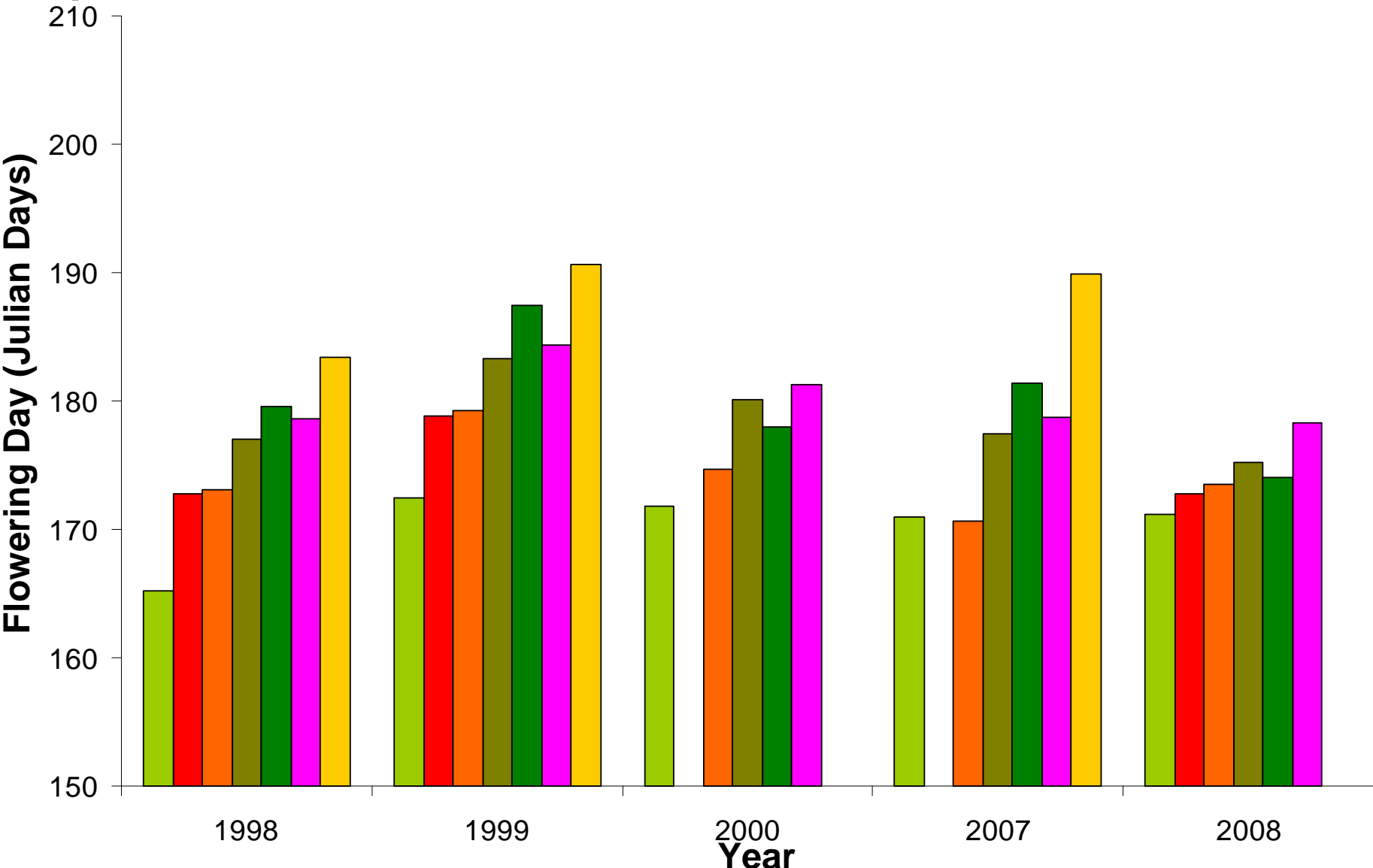
Atqasuk Dry



Atqasuk Dry



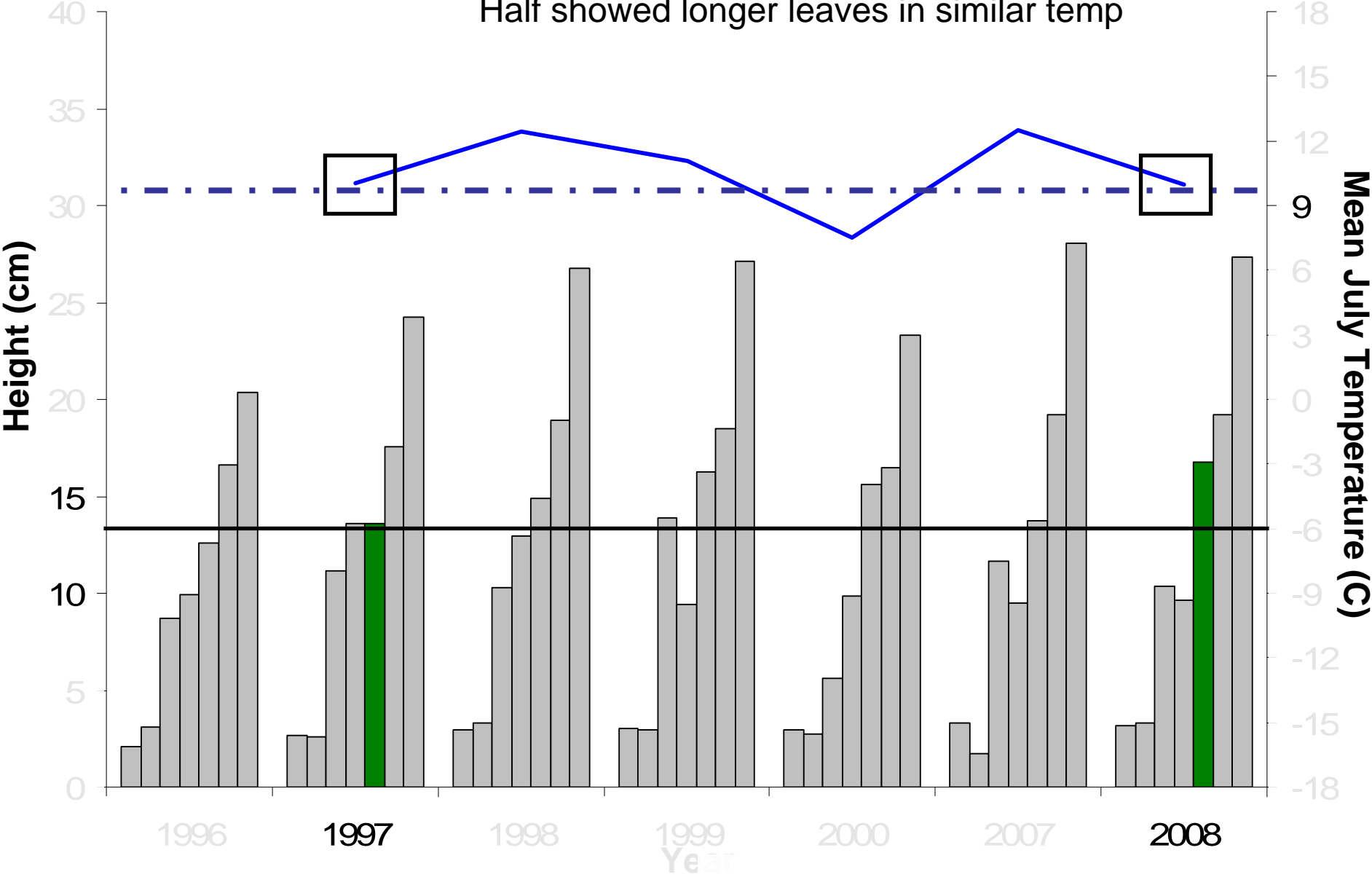
Atqasuk Wet



- Luzula arctica*
- Cassiope tetragona*
- Diapensia lapponica*
- Luzula confusa*
- Hierachloe alpina*
- Ledum palustre*
- Polygonum bistorta*

Atqasuk Dry

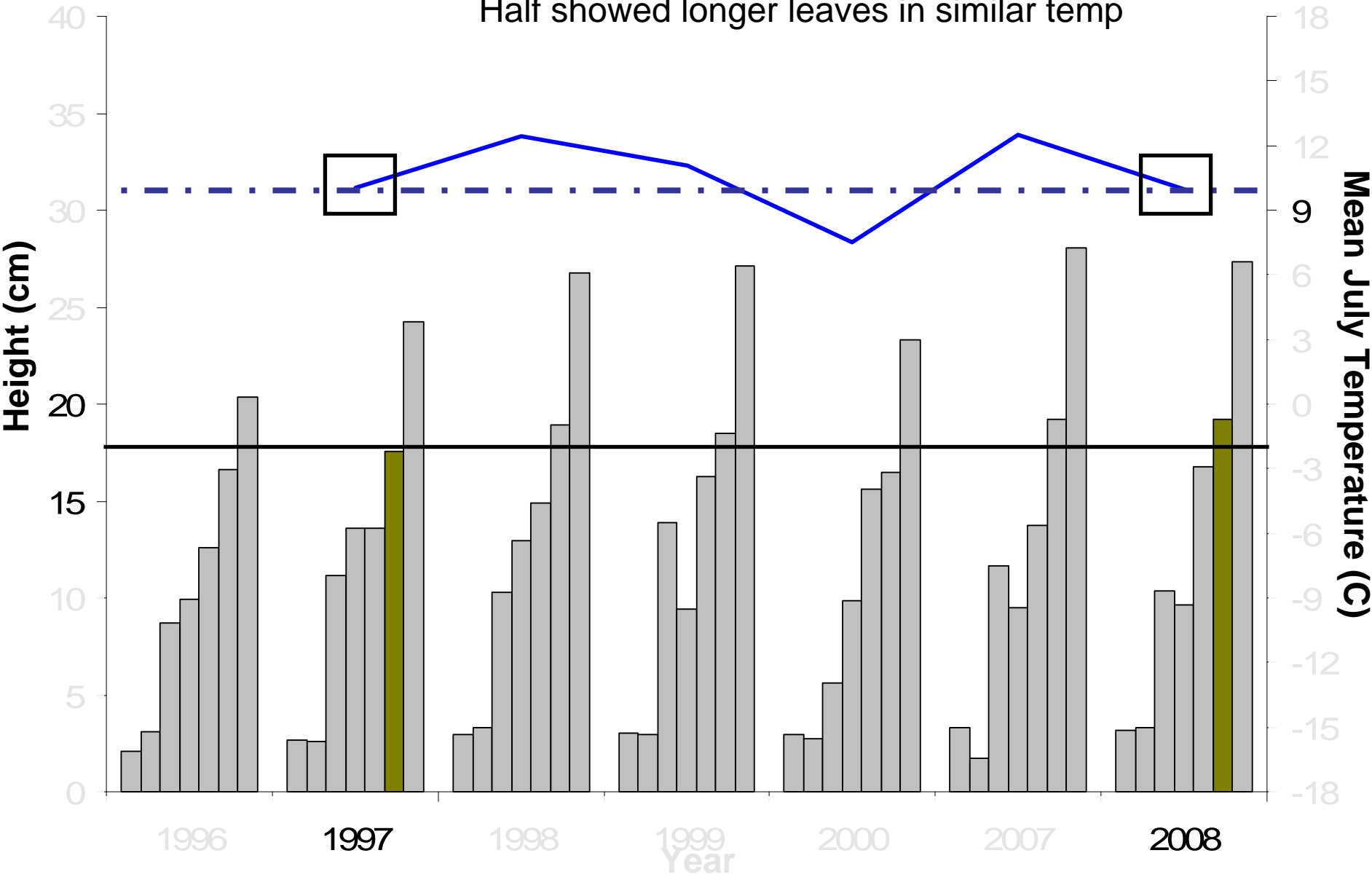
Half showed longer leaves in similar temp



- Diapensia lapponica*
- Mnuartia obtusiloba*
- Polygonum bistorta*
- Luzula arctica*
- Carex bigelowii*
- Luzula confusa*
- Hierachloe alpina*
- Temp

Atqasuk Dry

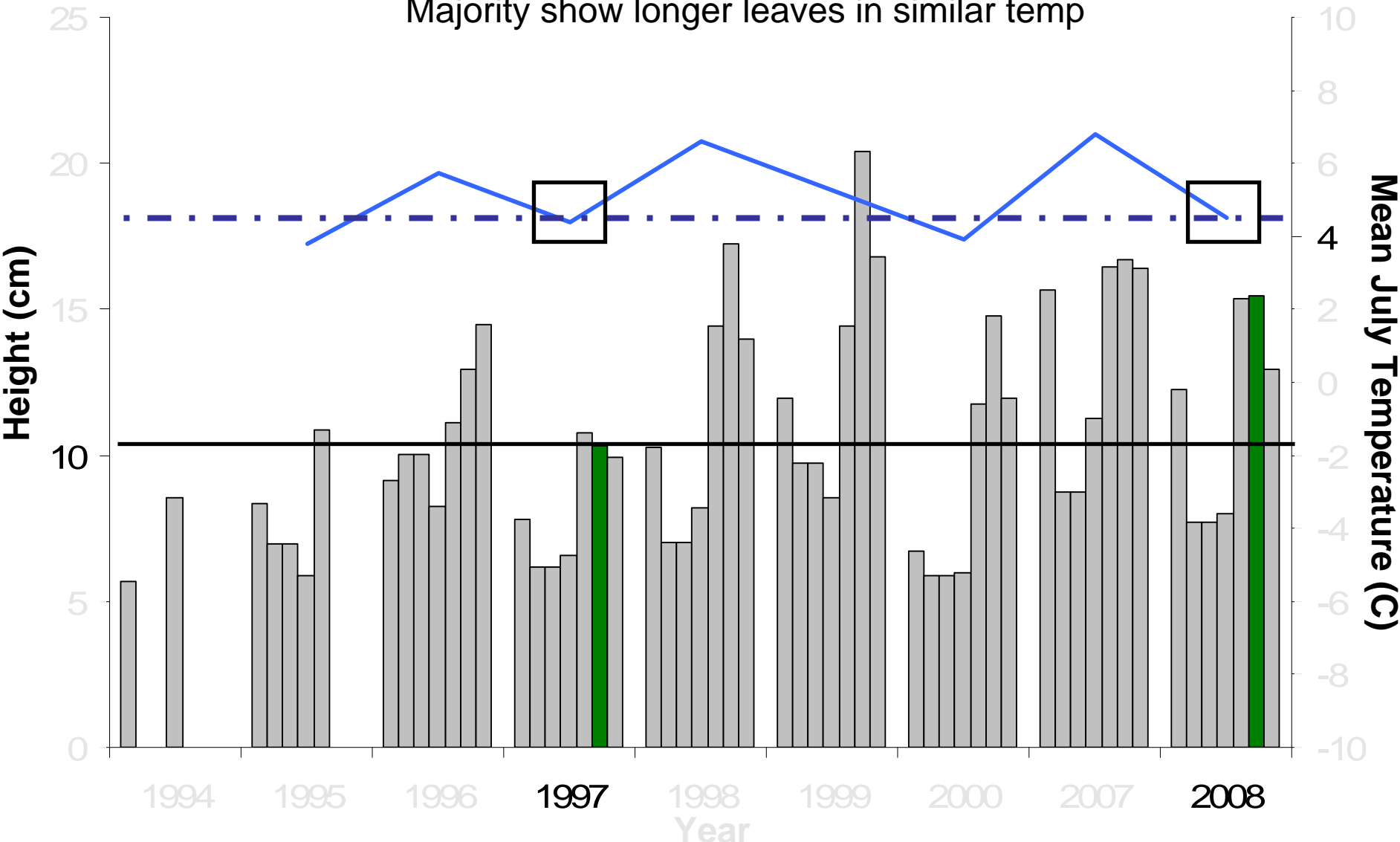
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- Dianensia lannonica*
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- Polygonum bistorta*
- Luzula arctica*
- Luzula confusa*
- Hierachloe alpina*
- Temp

Barrow Dry

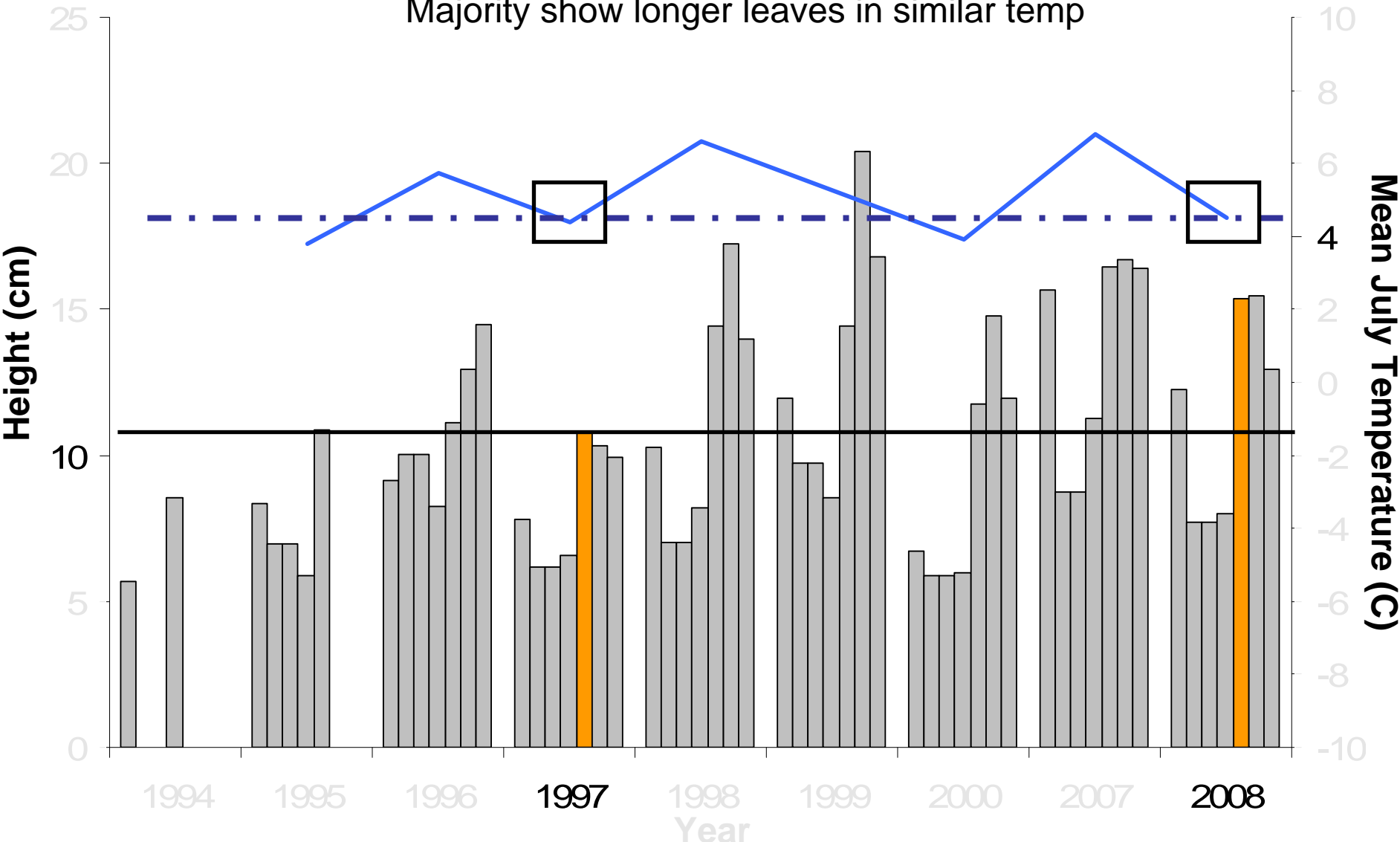
Majority show longer leaves in similar temp



- Saxifraga punctata*
- Luzula arctica*
- Luzula confusa*
- Potentilla hyperarctica*
- Papaver hultenii*
- Arctagrostis latifolia*
- Poa arctica*
- Temp

Barrow Dry

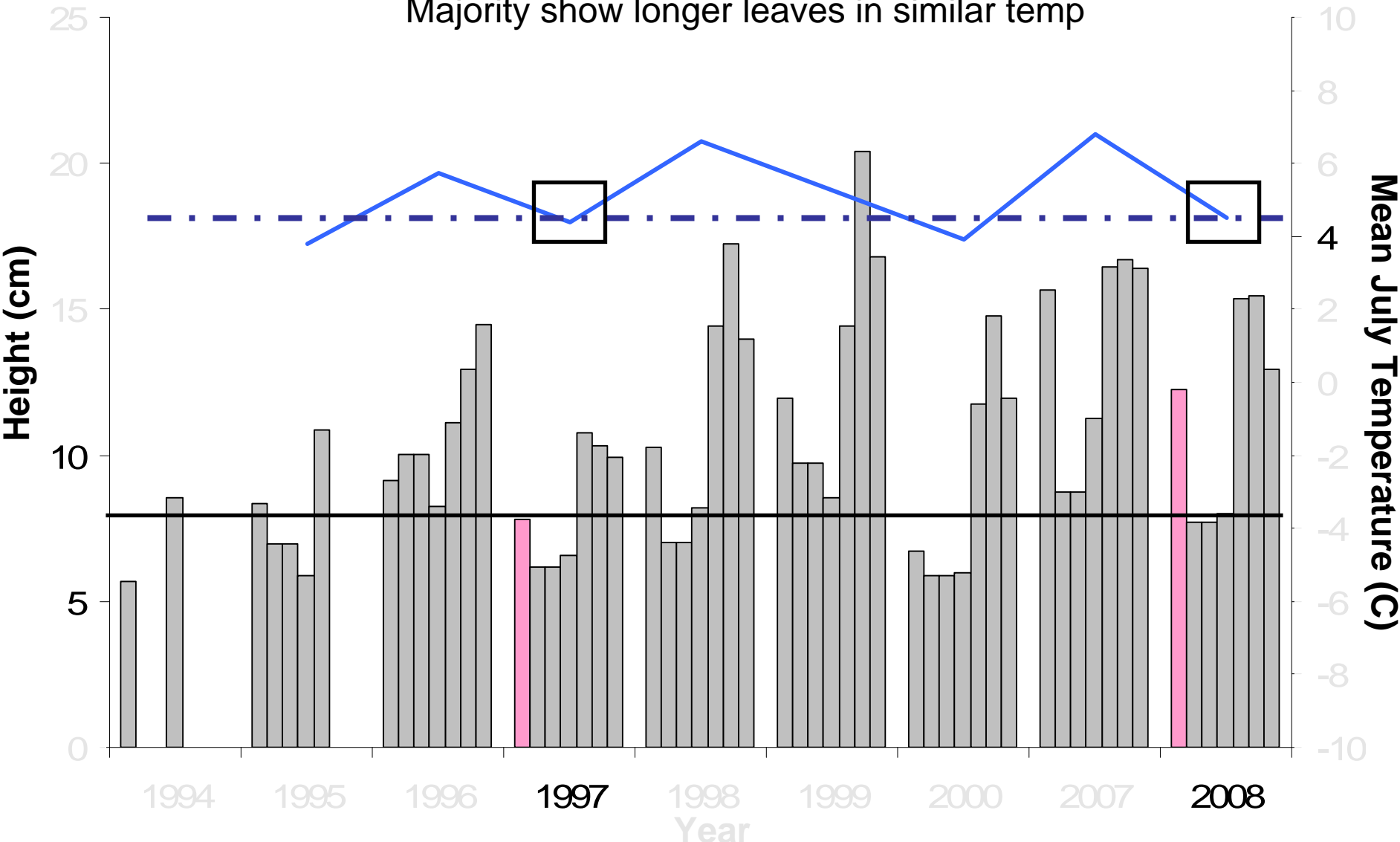
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- Temp

Barrow Dry

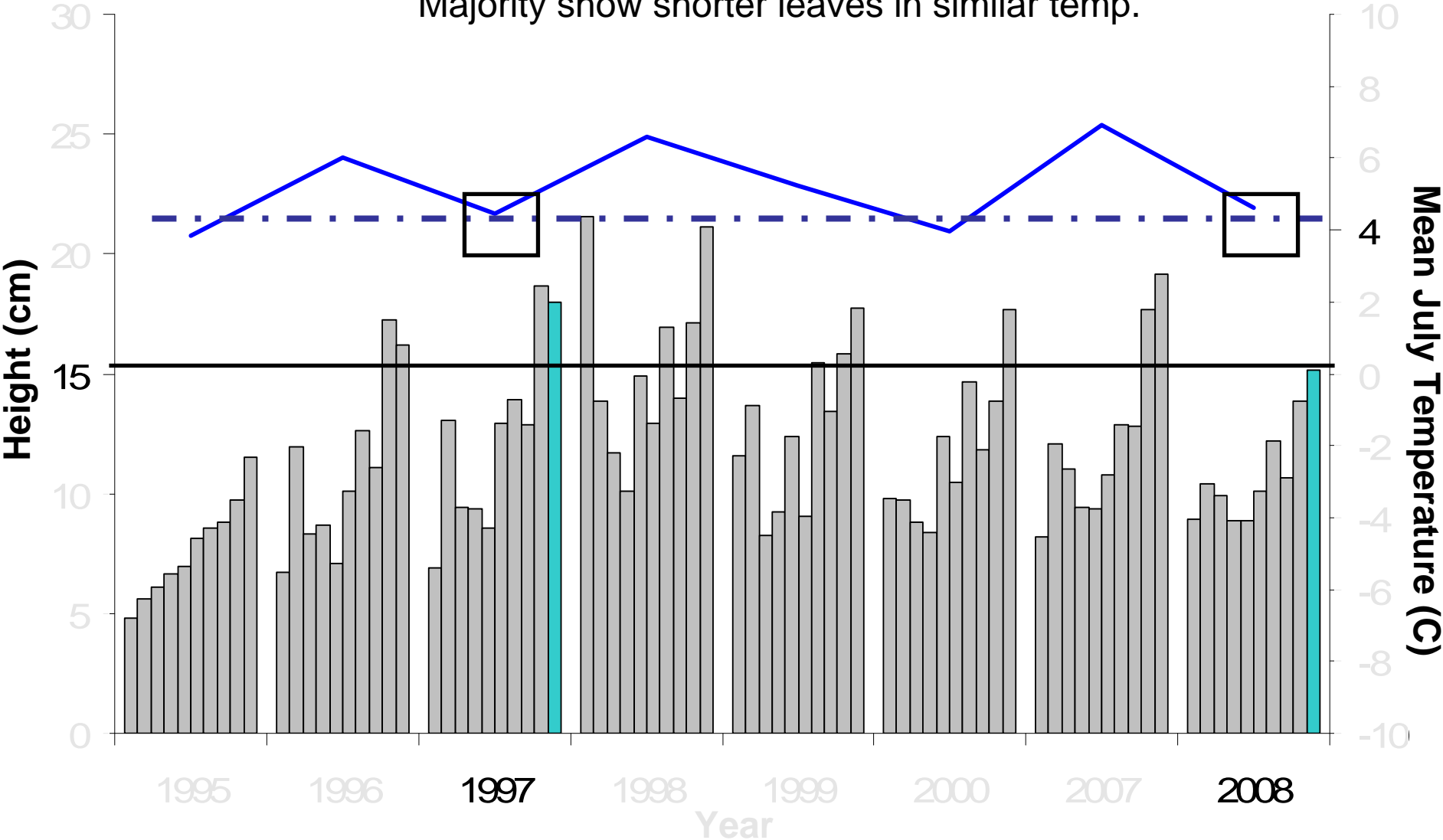
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Barrow Wet

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- Temp