

Tracking Changes in Vegetative Cover due to Experimental Warming

Katlyn Betway and Dr. Robert Hollister; Grand Valley State University



This project is part of the
International **T**undra **E**xperiment (**ITEX**)



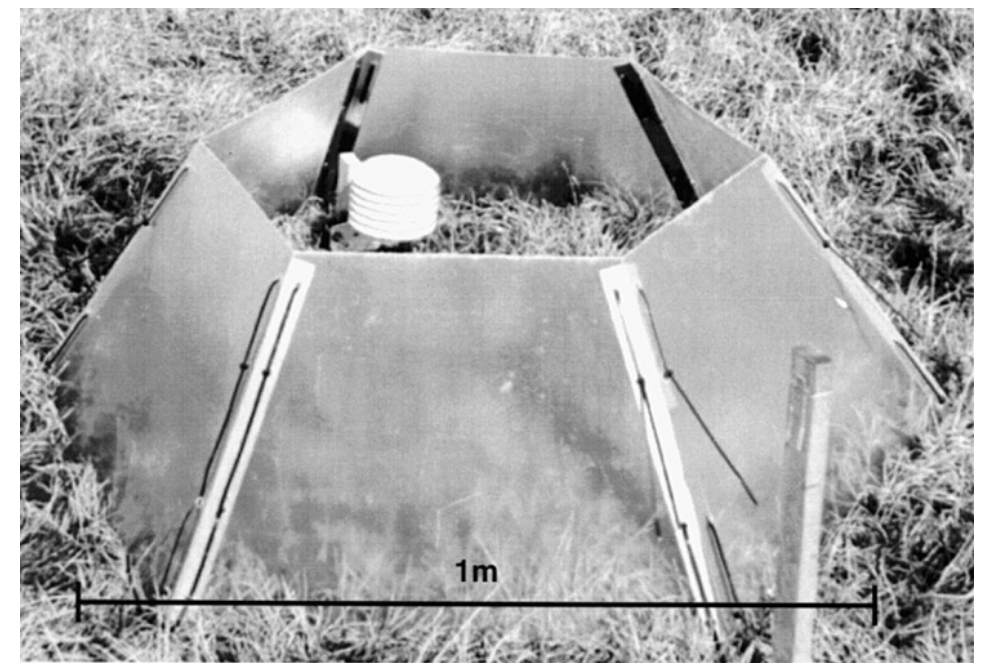
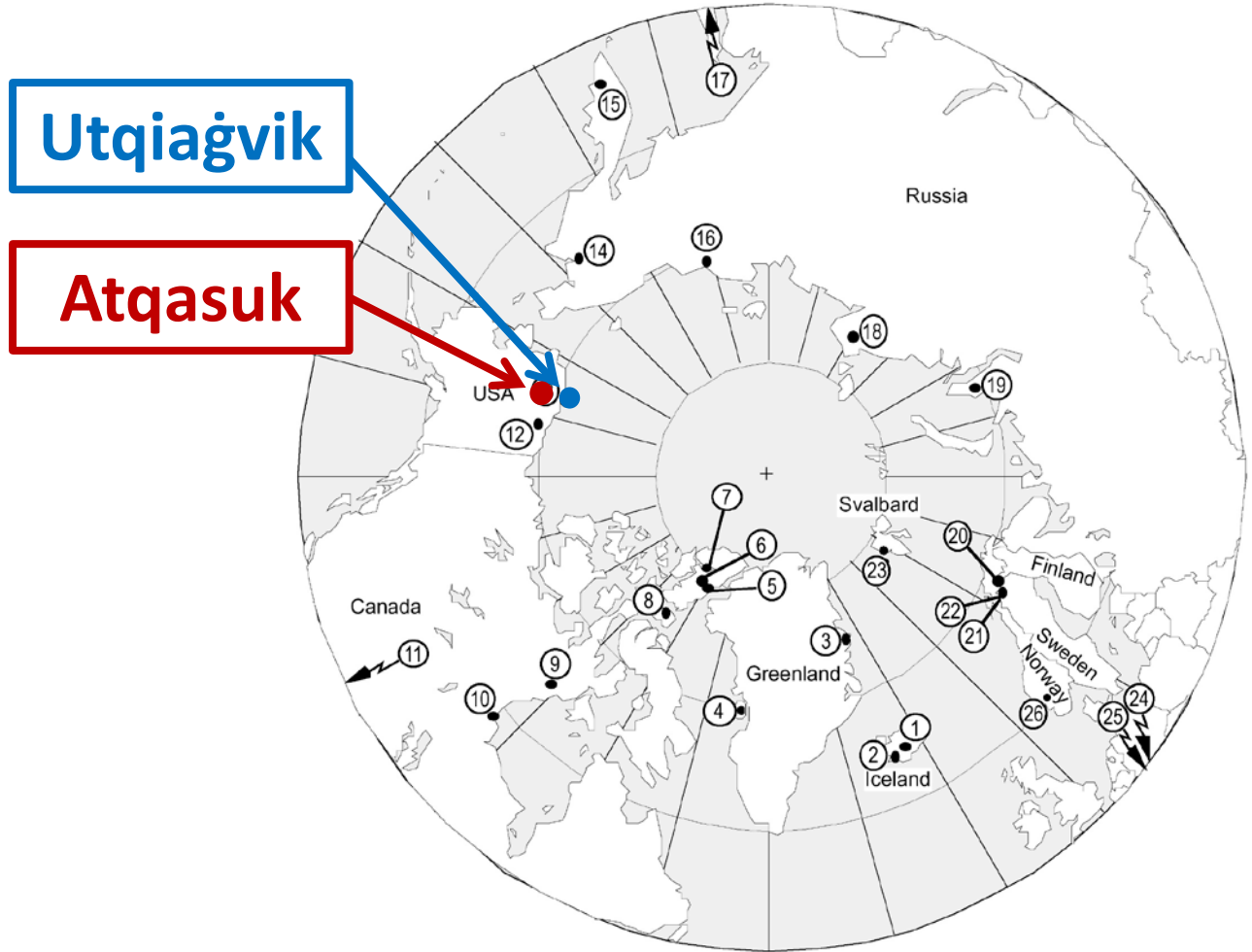
A network of arctic
researchers from over
11 countries



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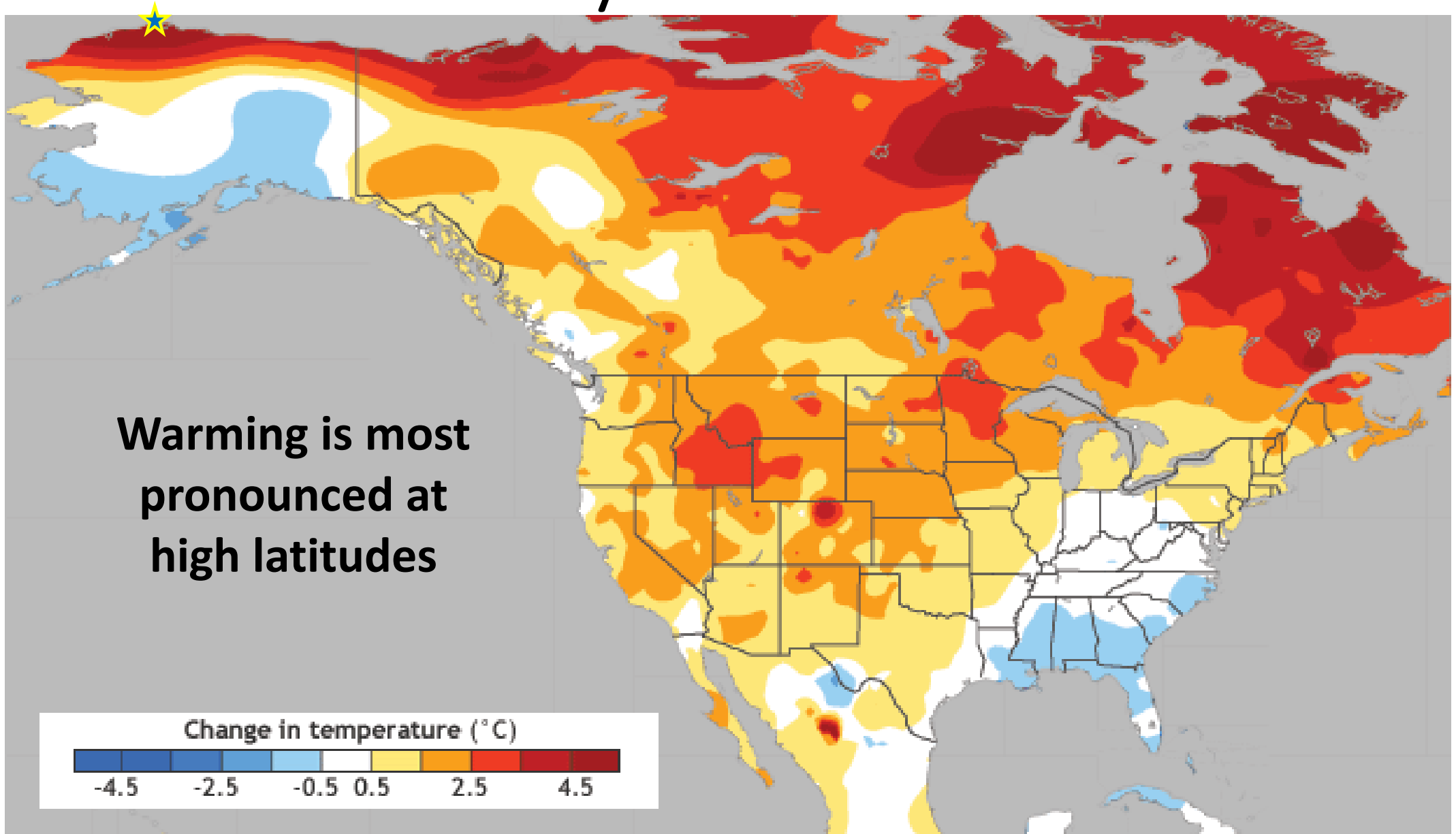


A network of arctic
researchers from over
11 countries



An ITEX open-top chamber (OTC).

Why the Arctic?



Capital Weather Gang

This city in Alaska is warming so fast, algorithms removed the data because it seemed unreal






By Angela Fritz December 12, 2017 [Email the author](#)



Change in temperature (°C)



Most Read Local

- 1 Airlines try to get planes back in the air, Amtrak runs on modified schedule in nor'easter's wake 
- 2 Wind gusts topped 93 mph in nor'easter, Boston storm surge falls short of record 
- 3 Trump, Pence and many evangelical leaders mourn Billy Graham at his funeral 
- 4 Parents killed by son in Central Michigan University dorm, campus police say 
- 5 In a prestigious high school math and science program, alumni say #MeToo 



Capital Weather Gang

This city in Alaska is warming so fast, algorithms

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Temperatures in Alaska Warmed So Fast This Year, NOAA Had to Rewrite its Algorithms

By Ryan Whitwam on December 13, 2017 at 1:00 pm | 77 Comments

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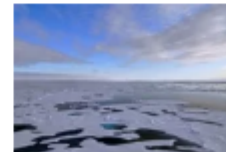
Alaska's Northernmost Town Warms So Fast, It Fools NOAA Computers

As sea ice grows shockingly low and late, Utqiagvik's record warmth stymies algorithms

By Andrea Thompson on December 20, 2017



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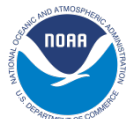


The Arctic Is Getting Crazy



Alaska's Coast Is Vanishing, 1 Storm at a Time

In this aerial image, lakes created by melting permafrost are seen on June 15, 2017 in Utqiagvik





Home » Alaskan North Slope climate change just outran one of our tools to measure it

Alaskan North Slope climate change just outran one of our tools to measure it

Author: Deke Arndt

December 6, 2017



It was bound to happen. In fact, my colleagues have planned for this. More on that later.

On December 4th, the folks in the Climate Monitoring group at the National Centers for Environmental Information (NCEI) did what we do pretty much every 4th of the month: we processed the previous month's data to prepare our initial US climate report. The data from Utqiagvik, Alaska, was missing, which was odd. It was also missing for all of 2017 and the last few months of 2016. This was even weirder, because we knew we'd kinda marveled at how insanely warm the station had been for several weeks and months during 2017.

What happened?

The short version: in an ironic exclamation point to swift regional climate change in and near the Arctic, the average temperature observed at the weather station at Utqiagvik has now changed so rapidly that it triggered an algorithm designed to detect artificial changes in a station's

Beyond the Data
A blog by the nation's official climate record keepers.

Disclaimer:
Beyond the Data is written and edited by Derek Arndt, Jake Crouch, Jessica Blunden (NOAA NCEI), and Rebecca Lindsey (contractor to NOAA CPO). Posts reflect the views of the bloggers or guest contributors themselves, not necessarily NOAA.

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Experiment Setup

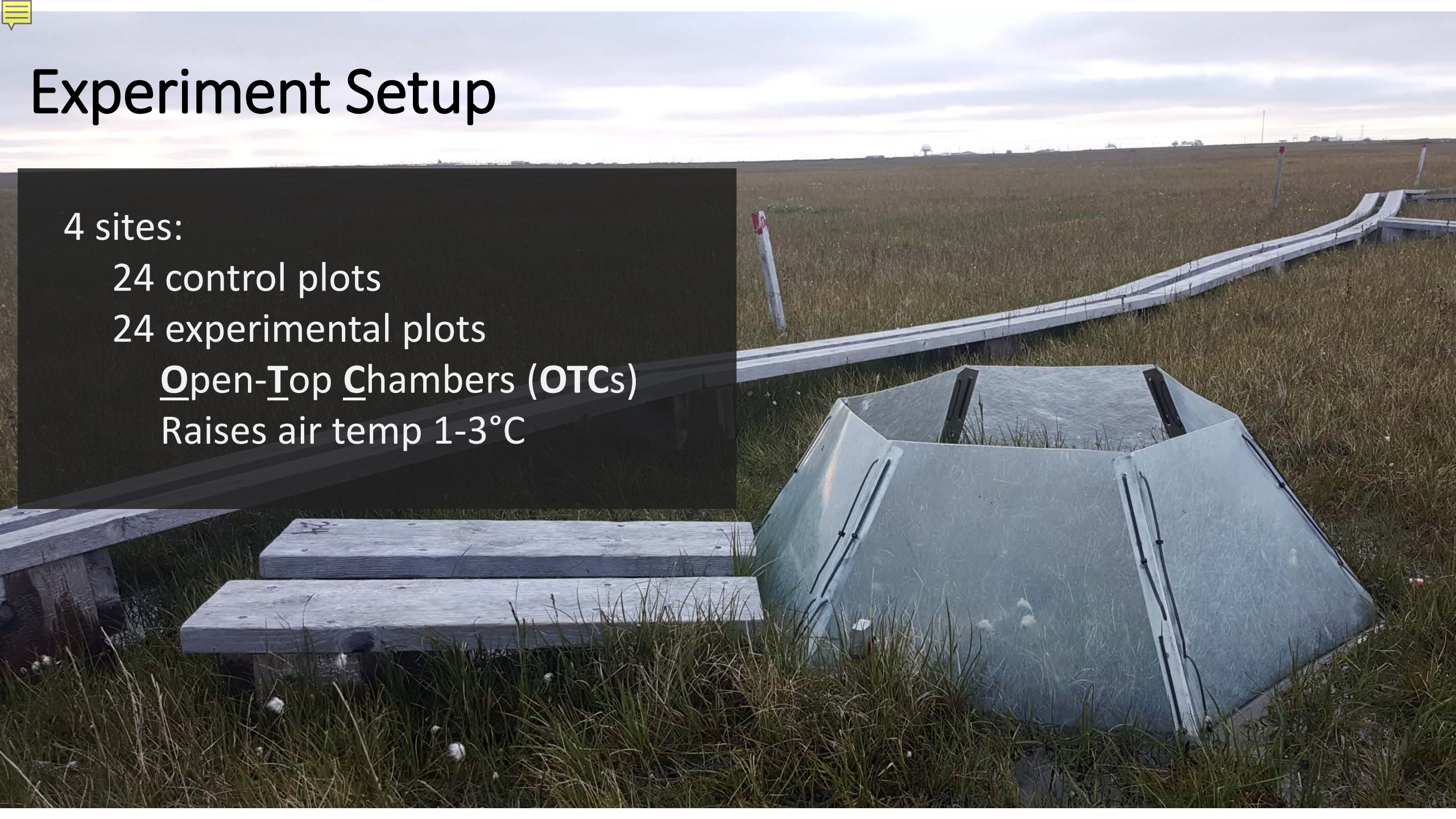
4 sites:

24 control plots

24 experimental plots

Open-Top Chambers (OTCs)

Raises air temp 1-3°C





GOALS

- look at changes in vegetative cover after over 20 years of experimental warming
- look for consistency (in change) with the control plots (given the region has warmed)
- identify trends likely to persist in future decades



Utqiagvik

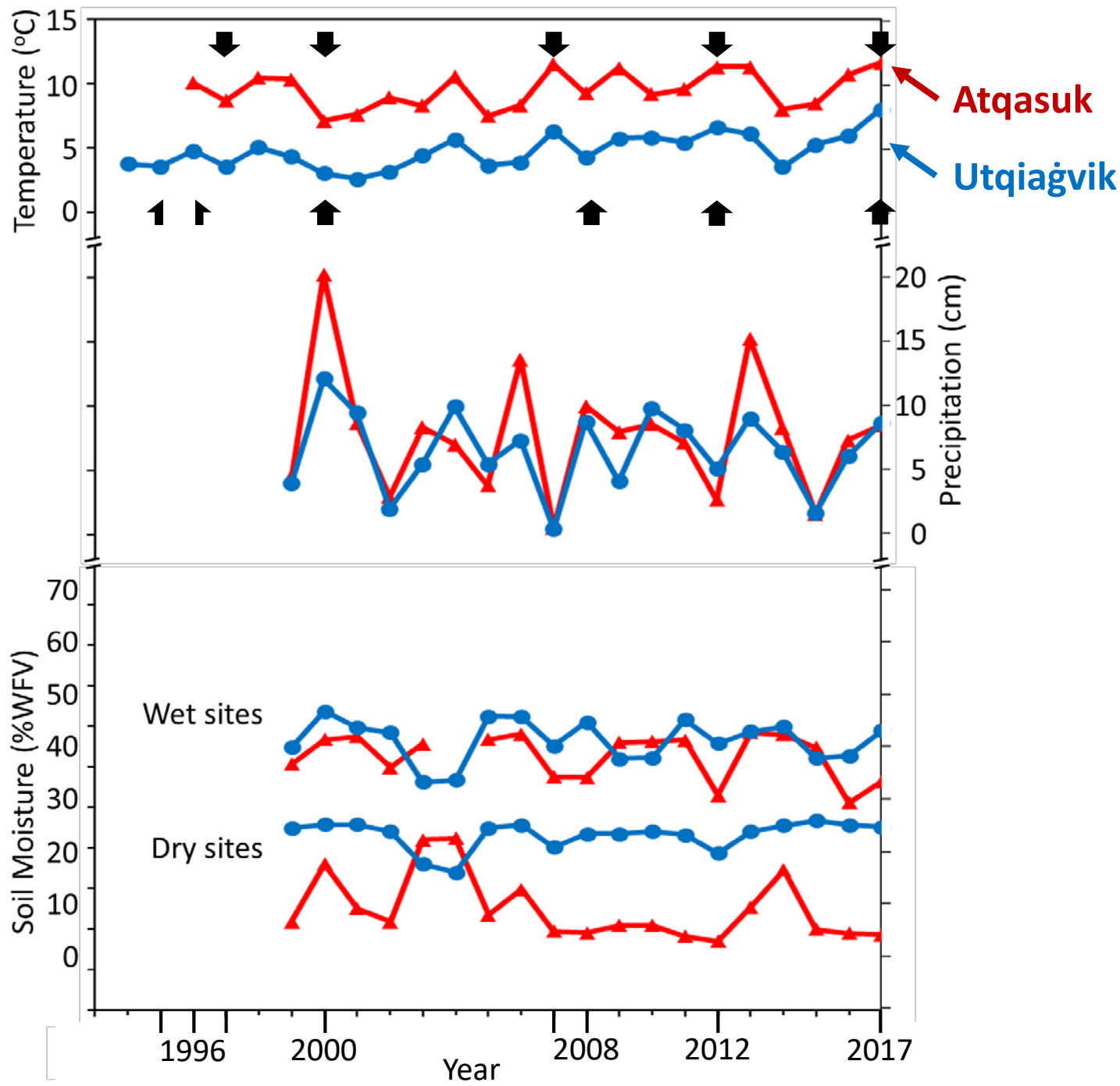


Dry

Wet

Atqasuk





Graminoids

Alopecurus alpius
Arctagrostis latifolia
Calamagrostis homii
Carex spp.
Dupontia fisheri
Eriophorum spp.
Hierochloa spp.
Juncus biglumis
Luzula spp.
Poa spp.
Trisetum spicatum

Deciduous Shrubs

Salix spp.
Betula nana

Evergreen Shrubs

Cassiope tetragona
Ledum palustre
Diapensia lapponica
Vaccinium vitis-idaea

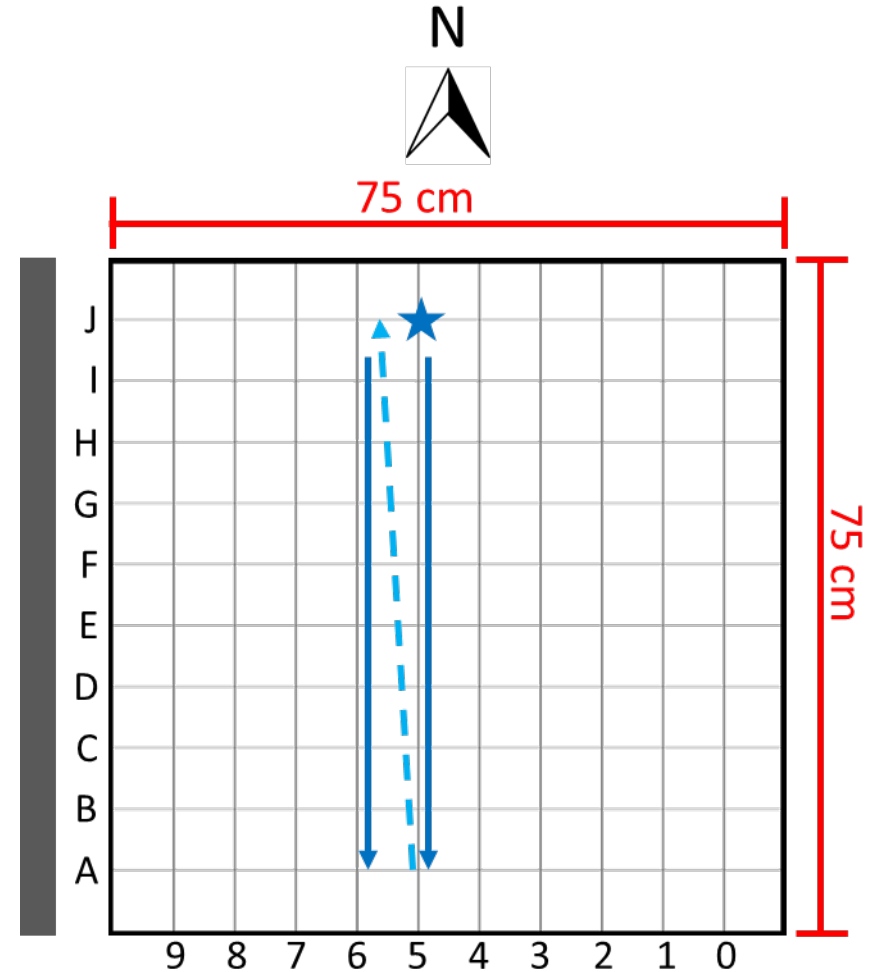
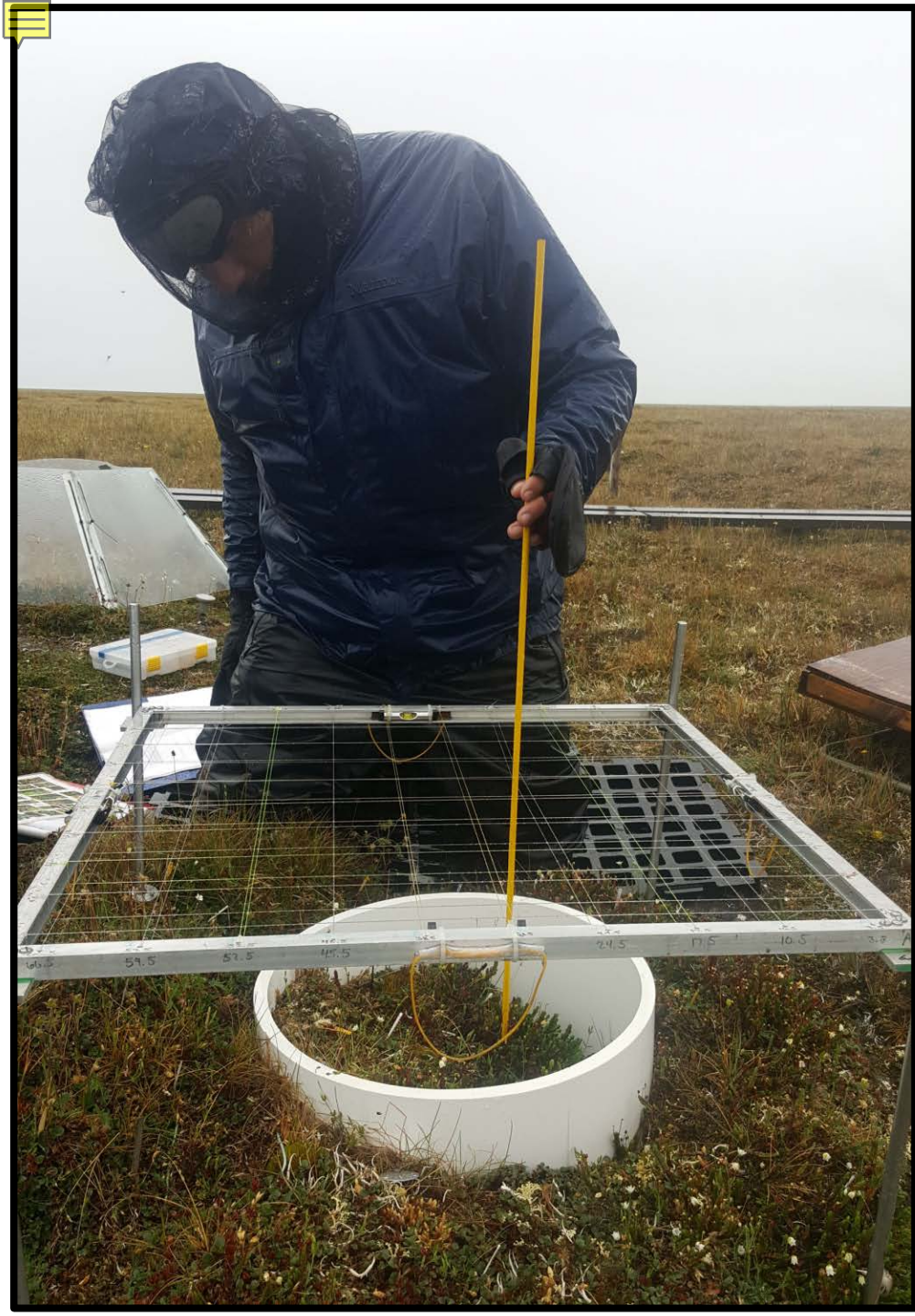
Forbs

Antennaria friesiana
Artemisia borealis
Cardamine pratensis
Cerastium beeringianum
Chrysosplenium tetrandum
Cochlearia officinalis
Draba lactea
Melandrium apetalum
Minuartia obtusiloba
Oxyria digyna
Papaver hultenii
Pedicularis spp.
Petasites frigidus
Polygonum spp.
Potentilla hyparctica
Ranunculus spp.
Saxifraga spp.
Senecio atropurpureus
Stellaria spp.



Pointframing

- Same two weeks each year
- Point frame grid
 - 75cm x 75cm
 - 100 points
- At each point:
 - Every contact from canopy to ground
 - Species
 - Live/Dead Status
 - Height





Taxa	C1
Utqiagvik dry (BD) site	
Deciduous Shrub	15.0
Evergreen Shrub	11.4
Graminoid	3.0
Forb	4.5
Bryophyte	11.0
Lichen	27.0

Average cover of each growth form





Taxa	C1
Utqiagvik dry (BD) site	
Deciduous Shrub	15.0
Evergreen Shrub	11.4
Graminoid	3.0
Forb	4.5
Bryophyte	11.0
Lichen	27.0

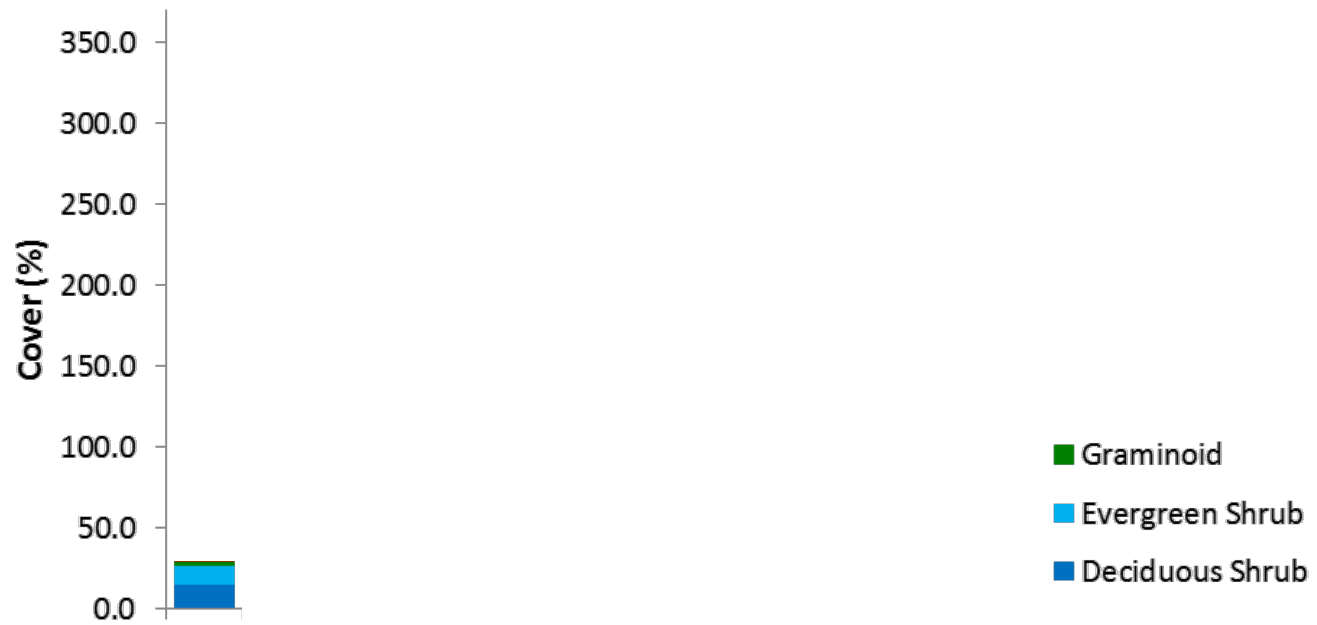
Average cover of each growth form





Taxa	C1
Utqiagvik dry (BD) site	
Deciduous Shrub	15.0
Evergreen Shrub	11.4
Graminoid	3.0
Forb	4.5
Bryophyte	11.0
Lichen	27.0

Average cover of each growth form





Taxa	C1
Utqiagvik dry (BD) site	
Deciduous Shrub	15.0
Evergreen Shrub	11.4
Graminoid	3.0
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Bryophyte	11.0
Lichen	27.0

Average cover of each growth form





Taxa	C1
Utqiagvik dry (BD) site	
Deciduous Shrub	15.0
Evergreen Shrub	11.4
Graminoid	3.0
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Bryophyte	11.0
Lichen	27.0

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Forb	4.5
Bryophyte	11.0
Lichen	27.0

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Evergreen Shrub	11.4
Graminoid	3.0
Forb	4.5
Bryophyte	11.0
Lichen	27.0

Average cover of each growth form





Taxa	C1
Utqiagvik dry (BD) site	
Deciduous Shrub	15.0
Evergreen Shrub	11.4
Graminoid	3.0
Forb	4.5
Bryophyte	11.0
Lichen	27.0

Average cover of each growth form





Taxa	C1
Utqiagvik dry (BD) site	
Deciduous Shrub	15.0
Evergreen Shrub	11.4
Graminoid	3.0
Forb	4.5
Bryophyte	11.0
Lichen	27.0

each year sampled





Taxa	C1	C2
Utqiagvik dry (BD) site		
Deciduous Shrub	15.0	28.5
Evergreen Shrub	11.4	20.4
Graminoid	3.0	7.3
Forb	4.5	7.7
Bryophyte	11.0	19.8
Lichen	27.0	37.9

each year sampled





Taxa	C1	C2	C3
Utqiagvik dry (BD) site			
Deciduous Shrub	15.0	28.5	24.5
Evergreen Shrub	11.4	20.4	19.5
Graminoid	3.0	7.3	8.2
Forb	4.5	7.7	7.7
Bryophyte	11.0	19.8	11.8
Lichen	27.0	37.9	32.5

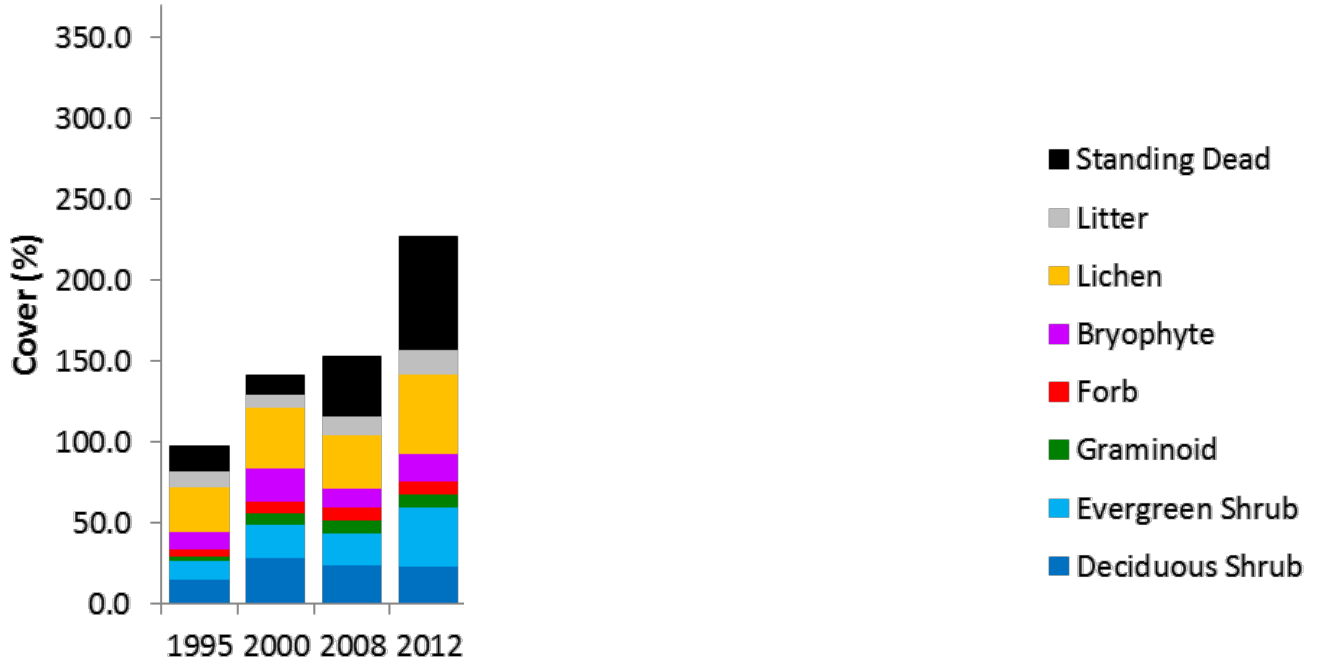
each year sampled





Taxa	C1	C2	C3	C4
Utqiagvik dry (BD) site				
Deciduous Shrub	15.0	28.5	24.5	23.0
Evergreen Shrub	11.4	20.4	19.5	37.1
Graminoid	3.0	7.3	8.2	8.0
Forb	4.5	7.7	7.7	7.6
Bryophyte	11.0	19.8	11.8	17.5
Lichen	27.0	37.9	32.5	48.4

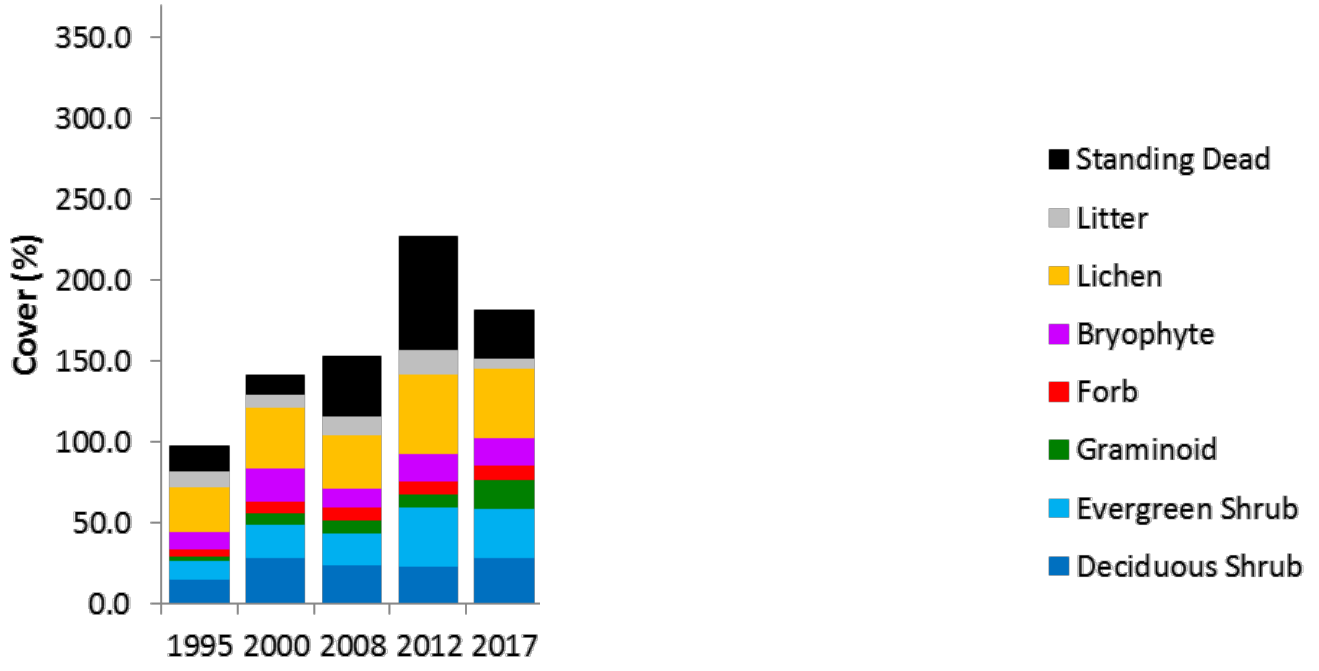
each year sampled





Taxa	C1	C2	C3	C4	C5
Utqiagvik dry (BD) site					
Deciduous Shrub	15.0	28.5	24.5	23.0	28.3
Evergreen Shrub	11.4	20.4	19.5	37.1	30.3
Graminoid	3.0	7.3	8.2	8.0	18.0
Forb	4.5	7.7	7.7	7.6	9.2
Bryophyte	11.0	19.8	11.8	17.5	16.8
Lichen	27.0	37.9	32.5	48.4	42.7

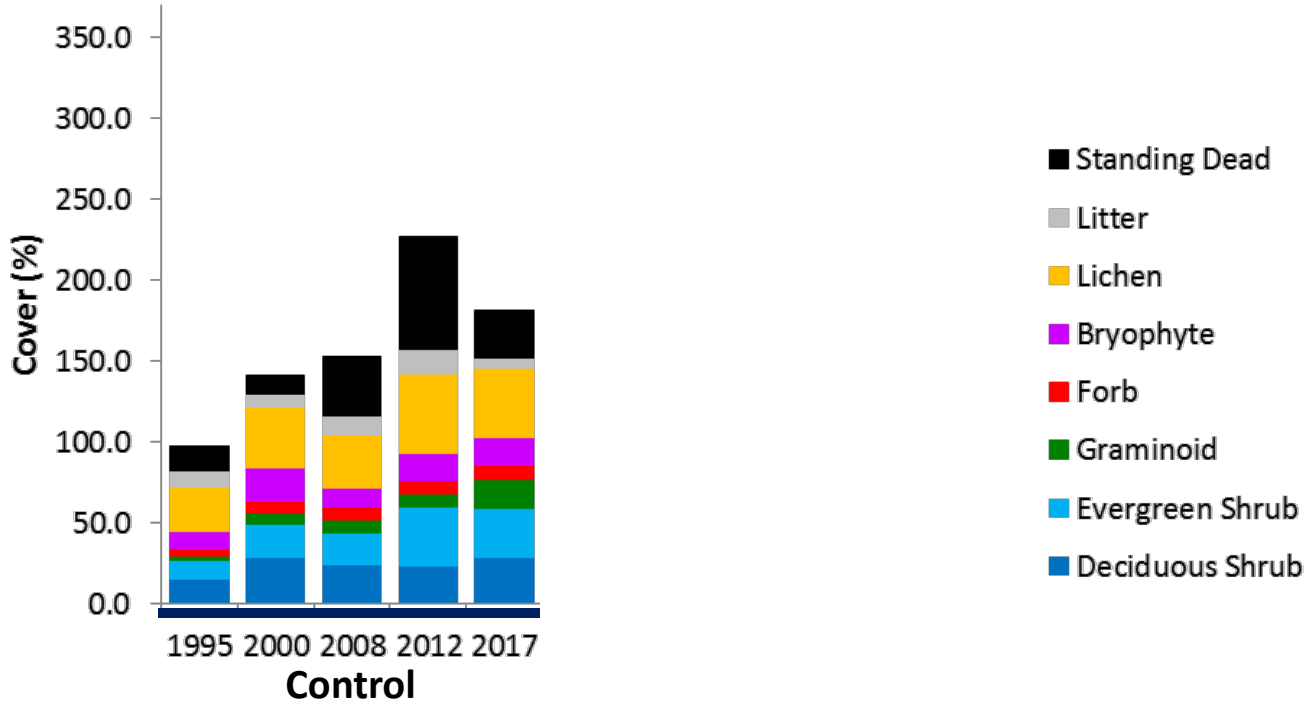
each year sampled





Taxa	C1	C2	C3	C4	C5	E1	E2	E3	E4	E5	W1	W2	W3	W4	W5		
Utqiagvik dry (BD) site																	
Deciduous Shrub	15.0	28.5	24.5	23.0	28.3	I	14.9	24.3	20.0	24.1	27.2	.	-0.1	-4.2	-4.4	1.1	-1.2
Evergreen Shrub	11.4	20.4	19.5	37.1	30.3	D ⁺	15.2	24.8	27.7	50.2	40.2	C ⁺	3.8	4.4	8.2	13.0	9.9
Graminoid	3.0	7.3	8.2	8.0	18.0	D ⁺	4.5	12.3	19.6	17.7	29.4	D ⁺	1.4	5.0	11.4	9.7	11.4
Forb	4.5	7.7	7.7	7.6	9.2	D ⁺	4.3	6.6	12.3	11.3	10.6	.	-0.3	-1.0	4.6	3.7	1.5
Bryophyte	11.0	19.8	11.8	17.5	16.8	I	8.4	13.8	6.3	9.6	11.5	C ⁻	-2.6	-6.0	-5.5	-7.9	-5.3
Lichen	27.0	37.9	32.5	48.4	42.7	I	25.8	24.7	15.9	19.6	18.0	I	-1.3	-13.2	-16.6	-28.8	-24.7

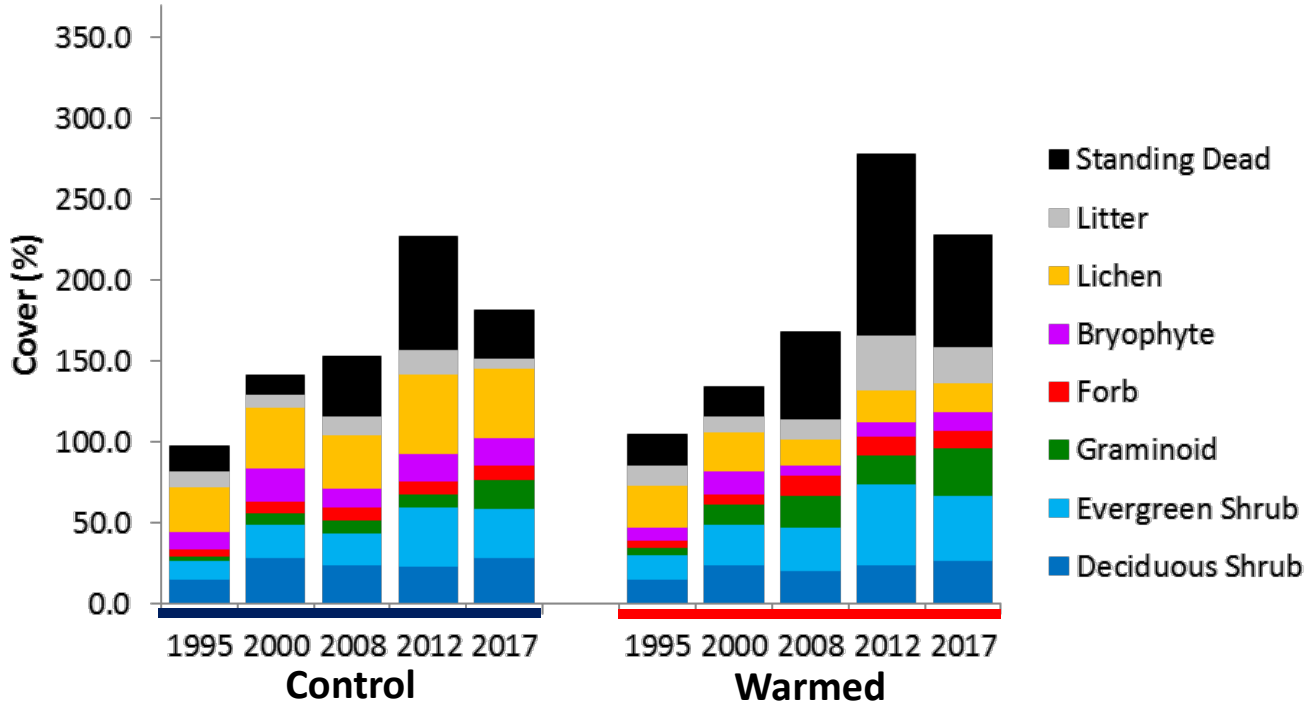
each treatment





Taxa	C1	C2	C3	C4	C5		E1	E2	E3	E4	E5		W1	W2	W3	W4	W5	
Utqiagvik dry (BD) site																		
Deciduous Shrub	15.0	28.5	24.5	23.0	28.3	I	14.9	24.3	20.0	24.1	27.2	.	-0.1	-4.2	-4.4	1.1	-1.2	
Evergreen Shrub	11.4	20.4	19.5	37.1	30.3	D ⁺	15.2	24.8	27.7	50.2	40.2	C ⁺	3.8	4.4	8.2	13.0	9.9	
Graminoid	3.0	7.3	8.2	8.0	18.0	D ⁺	4.5	12.3	19.6	17.7	29.4	D ⁺	1.4	5.0	11.4	9.7	11.4	
Forb	4.5	7.7	7.7	7.6	9.2	D ⁺	4.3	6.6	12.3	11.3	10.6	.	-0.3	-1.0	4.6	3.7	1.5	
Bryophyte	11.0	19.8	11.8	17.5	16.8	I	8.4	13.8	6.3	9.6	11.5	C ⁻	-2.6	-6.0	-5.5	-7.9	-5.3	
Lichen	27.0	37.9	32.5	48.4	42.7	I	25.8	24.7	15.9	19.6	18.0	I	-1.3	-13.2	-16.6	-28.8	-24.7	

each treatment





Taxa	C1	C2	C3	C4	C5	
Utqiagvik dry (BD) site						
Deciduous Shrub	15.0	28.5	24.5	23.0	28.3	I
Evergreen Shrub	11.4	20.4	19.5	37.1	30.3	D ⁺
Graminoid	3.0	7.3	8.2	8.0	18.0	D ⁺
Forb	4.5	7.7	7.7	7.6	9.2	D ⁺
Bryophyte	11.0	19.8	11.8	17.5	16.8	I
Lichen	27.0	37.9	32.5	48.4	42.7	I
Utqiagvik wet (BW) site						
Deciduous Shrub	0.2	0.0	0.0	0.3	1.0	I
Graminoid	43.3	63.0	50.6	75.6	93.6	D ⁺
Forb	17.8	14.6	14.0	19.1	22.3	.
Bryophyte	42.0	56.4	25.1	34.0	27.6	I
Lichen	2.5	3.3	5.5	6.0	6.1	.

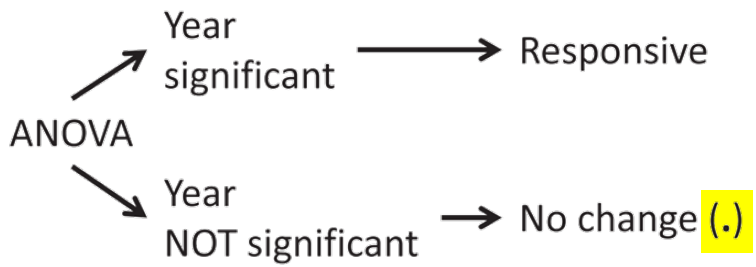
Statistical Tests



Taxa	C1	C2	C3	C4	C5	
Utqiagvik dry (BD) site						
Deciduous Shrub	15.0	28.5	24.5	23.0	28.3	I
Evergreen Shrub	11.4	20.4	19.5	37.1	30.3	D ⁺
Graminoid	3.0	7.3	8.2	8.0	18.0	D ⁺
Forb	4.5	7.7	7.7	7.6	9.2	D ⁺
Bryophyte	11.0	19.8	11.8	17.5	16.8	I
Lichen	27.0	37.9	32.5	48.4	42.7	I
Utqiagvik wet (BW) site						
Deciduous Shrub	0.2	0.0	0.0	0.3	1.0	I
Graminoid	43.3	63.0	50.6	75.6	93.6	D ⁺
Forb	17.8	14.6	14.0	19.1	22.3	.
Bryophyte	42.0	56.4	25.1	34.0	27.6	I
Lichen	2.5	3.3	5.5	6.0	6.1	.

Statistical Tests

Ambient change (control plots only)

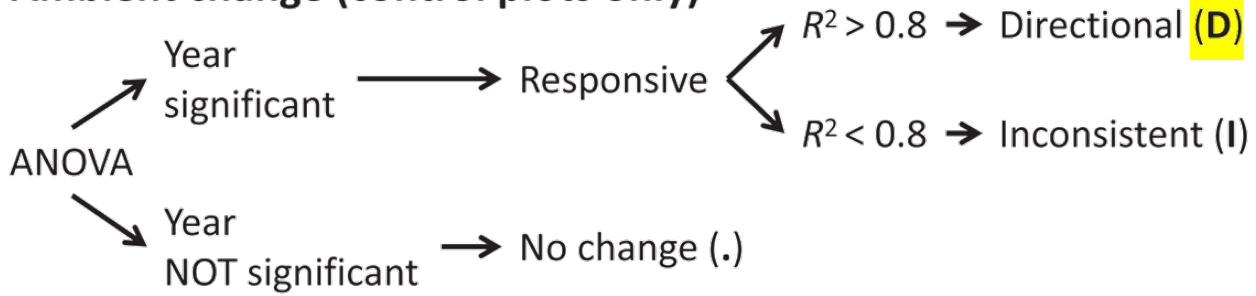




Taxa	C1	C2	C3	C4	C5	
Utqiagvik dry (BD) site						
Deciduous Shrub	15.0	28.5	24.5	23.0	28.3	I
Evergreen Shrub	11.4	20.4	19.5	37.1	30.3	D ⁺
Graminoid	3.0	7.3	8.2	8.0	18.0	D⁺
Forb	4.5	7.7	7.7	7.6	9.2	D ⁺
Bryophyte	11.0	19.8	11.8	17.5	16.8	I
Lichen	27.0	37.9	32.5	48.4	42.7	I
Utqiagvik wet (BW) site						
Deciduous Shrub	0.2	0.0	0.0	0.3	1.0	I
Graminoid	43.3	63.0	50.6	75.6	93.6	D ⁺
Forb	17.8	14.6	14.0	19.1	22.3	.
Bryophyte	42.0	56.4	25.1	34.0	27.6	I
Lichen	2.5	3.3	5.5	6.0	6.1	.

Statistical Tests

Ambient change (control plots only)

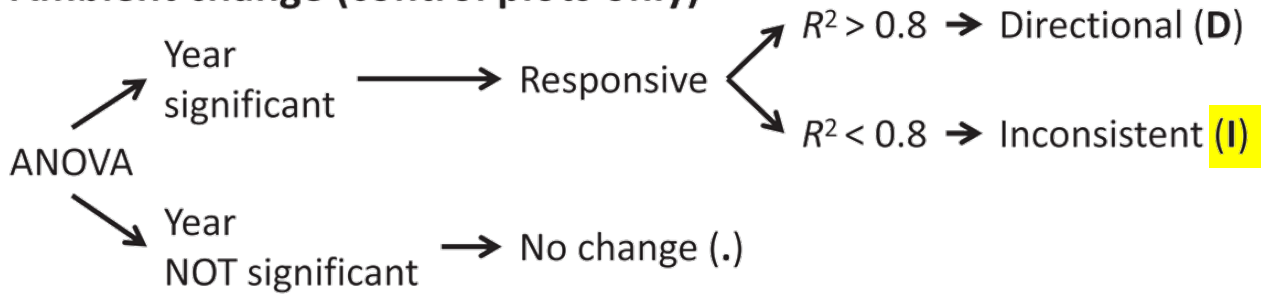




Taxa	C1	C2	C3	C4	C5	
Utqiagvik dry (BD) site						
Deciduous Shrub	15.0	28.5	24.5	23.0	28.3	I
Evergreen Shrub	11.4	20.4	19.5	37.1	30.3	D ⁺
Graminoid	3.0	7.3	8.2	8.0	18.0	D ⁺
Forb	4.5	7.7	7.7	7.6	9.2	D ⁺
Bryophyte	11.0	19.8	11.8	17.5	16.8	I
Lichen	27.0	37.9	32.5	48.4	42.7	I
Utqiagvik wet (BW) site						
Deciduous Shrub	0.2	0.0	0.0	0.3	1.0	I
Graminoid	43.3	63.0	50.6	75.6	93.6	D ⁺
Forb	17.8	14.6	14.0	19.1	22.3	.
Bryophyte	42.0	56.4	25.1	34.0	27.6	I
Lichen	2.5	3.3	5.5	6.0	6.1	.

Statistical Tests

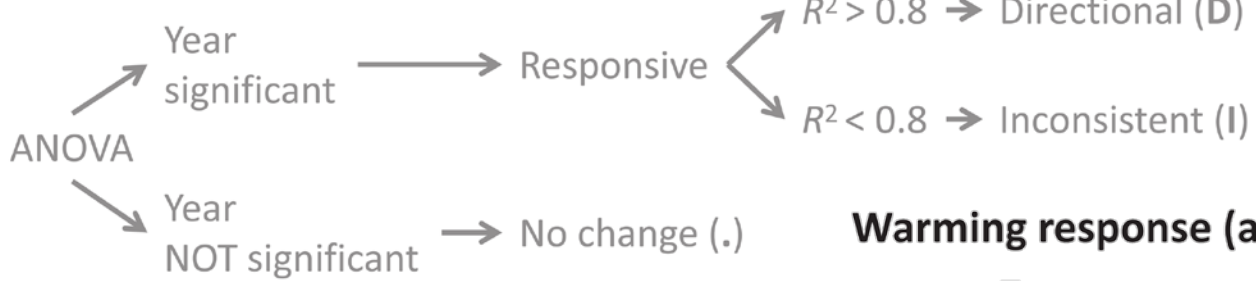
Ambient change (control plots only)



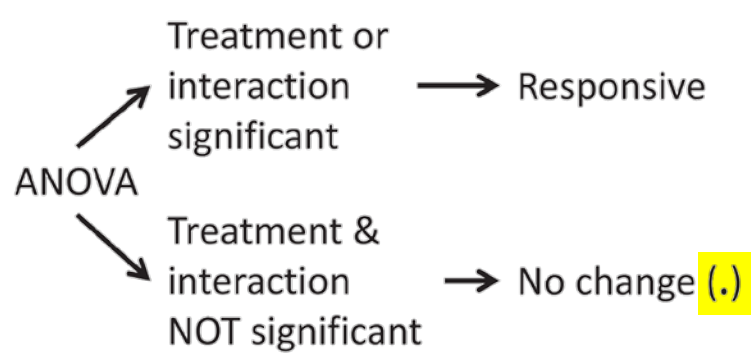


Taxa	C1	C2	C3	C4	C5		E1	E2	E3	E4	E5		W1	W2	W3	W4	W5
Utqiagvik dry (BD) site																	
Deciduous Shrub	15.0	28.5	24.5	23.0	28.3	I	14.9	24.3	20.0	24.1	27.2	.	-0.1	-4.2	-4.4	1.1	-1.2
Evergreen Shrub	11.4	20.4	19.5	37.1	30.3	D ⁺	15.2	24.8	27.7	50.2	40.2	C ⁺	3.8	4.4	8.2	13.0	9.9
Graminoid	3.0	7.3	8.2	8.0	18.0	D ⁺	4.5	12.3	19.6	17.7	29.4	D ⁺	1.4	5.0	11.4	9.7	11.4
Forb	4.5	7.7	7.7	7.6	9.2	D ⁺	4.3	6.6	12.3	11.3	10.6	.	-0.3	-1.0	4.6	3.7	1.5
Bryophyte	11.0	19.8	11.8	17.5	16.8	I	8.4	13.8	6.3	9.6	11.5	C ⁻	-2.6	-6.0	-5.5	-7.9	-5.3
Lichen	27.0	37.9	32.5	48.4	42.7	I	25.8	24.7	15.9	19.6	18.0	I	-1.3	-13.2	-16.6	-28.8	-24.7
Utqiagvik wet (BW) site																	
Deciduous Shrub	0.2	0.0	0.0	0.3	1.0	I	0.3	0.7	1.8	3.8	6.1	D ⁺	0.2	0.6	1.8	3.5	5.1
Graminoid	43.3	63.0	50.6	75.6	93.6	D ⁺	44.4	60.4	51.3	80.0	96.6	.	1.1	-2.5	0.7	4.5	3.0
Forb	17.8	14.6	14.0	19.1	22.3	.	15.6	13.1	16.5	19.5	18.2	.	-2.2	-1.5	2.5	0.4	-4.1
Bryophyte	42.0	56.4	25.1	34.0	27.6	I	42.0	45.6	16.1	20.7	17.5	C ⁻	0.0	-10.8	-9.0	-13.3	-10.1
Lichen	2.5	3.3	5.5	6.0	6.1	.	1.8	1.8	1.8	1.9	1.1	D ⁻	-0.8	-1.5	-3.8	-4.2	-5.0

Ambient change (control plots only)



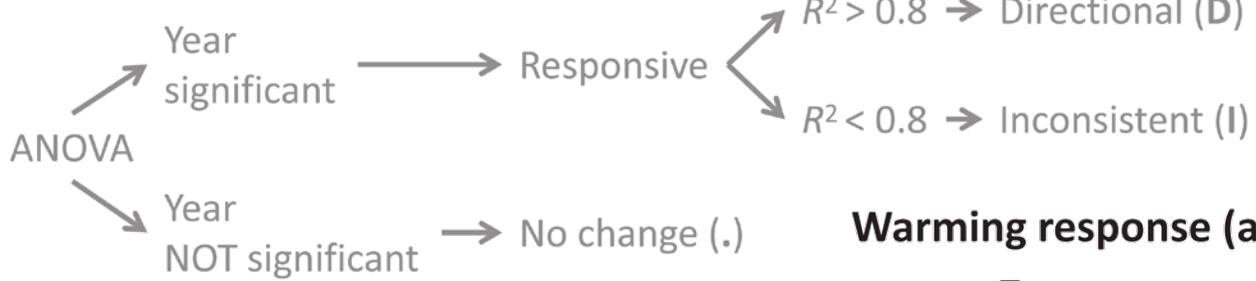
Warming response (all plots)



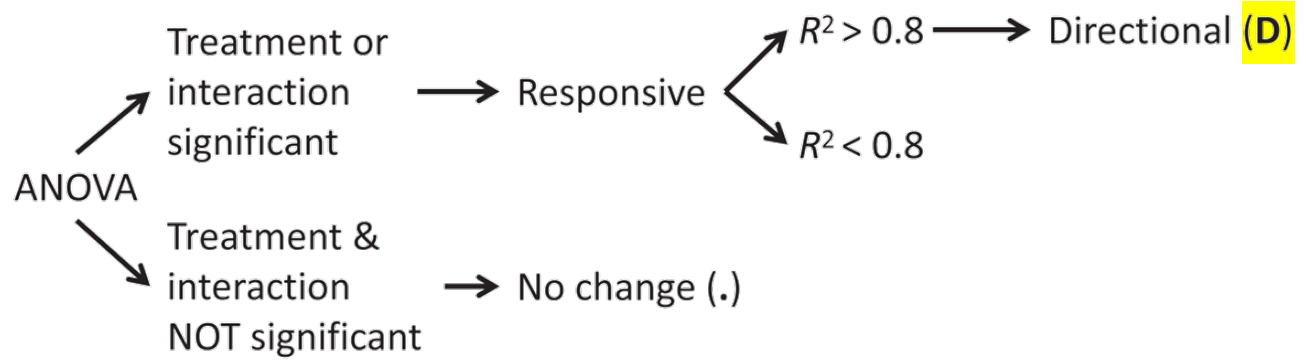


Taxa	C1	C2	C3	C4	C5		E1	E2	E3	E4	E5		W1	W2	W3	W4	W5
Utqiagvik dry (BD) site																	
Deciduous Shrub	15.0	28.5	24.5	23.0	28.3	I	14.9	24.3	20.0	24.1	27.2	.	-0.1	-4.2	-4.4	1.1	-1.2
Evergreen Shrub	11.4	20.4	19.5	37.1	30.3	D ⁺	15.2	24.8	27.7	50.2	40.2	C ⁺	3.8	4.4	8.2	13.0	9.9
Graminoid	3.0	7.3	8.2	8.0	18.0	D⁺	4.5	12.3	19.6	17.7	29.4	D⁺	1.4	5.0	11.4	9.7	11.4
Forb	4.5	7.7	7.7	7.6	9.2	D ⁺	4.3	6.6	12.3	11.3	10.6	.	-0.3	-1.0	4.6	3.7	1.5
Bryophyte	11.0	19.8	11.8	17.5	16.8	I	8.4	13.8	6.3	9.6	11.5	C ⁻	-2.6	-6.0	-5.5	-7.9	-5.3
Lichen	27.0	37.9	32.5	48.4	42.7	I	25.8	24.7	15.9	19.6	18.0	I	-1.3	-13.2	-16.6	-28.8	-24.7
Utqiagvik wet (BW) site																	
Deciduous Shrub	0.2	0.0	0.0	0.3	1.0	I	0.3	0.7	1.8	3.8	6.1	D ⁺	0.2	0.6	1.8	3.5	5.1
Graminoid	43.3	63.0	50.6	75.6	93.6	D ⁺	44.4	60.4	51.3	80.0	96.6	.	1.1	-2.5	0.7	4.5	3.0
Forb	17.8	14.6	14.0	19.1	22.3	.	15.6	13.1	16.5	19.5	18.2	.	-2.2	-1.5	2.5	0.4	-4.1
Bryophyte	42.0	56.4	25.1	34.0	27.6	I	42.0	45.6	16.1	20.7	17.5	C ⁻	0.0	-10.8	-9.0	-13.3	-10.1
Lichen	2.5	3.3	5.5	6.0	6.1	.	1.8	1.8	1.8	1.9	1.1	D ⁻	-0.8	-1.5	-3.8	-4.2	-5.0

Ambient change (control plots only)



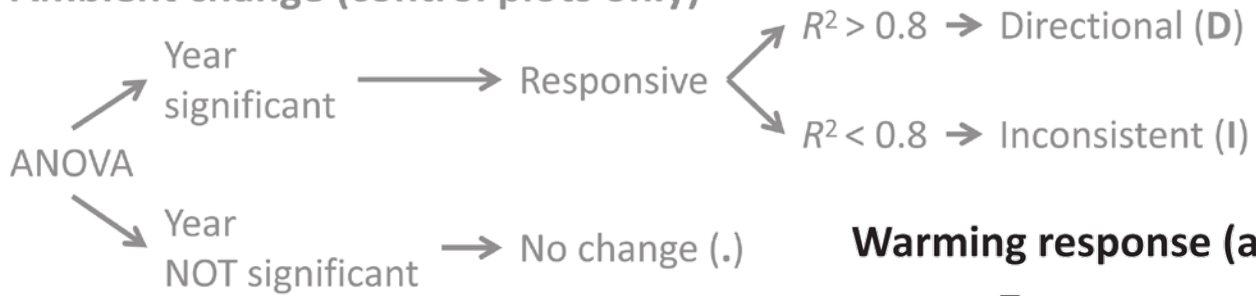
Warming response (all plots)



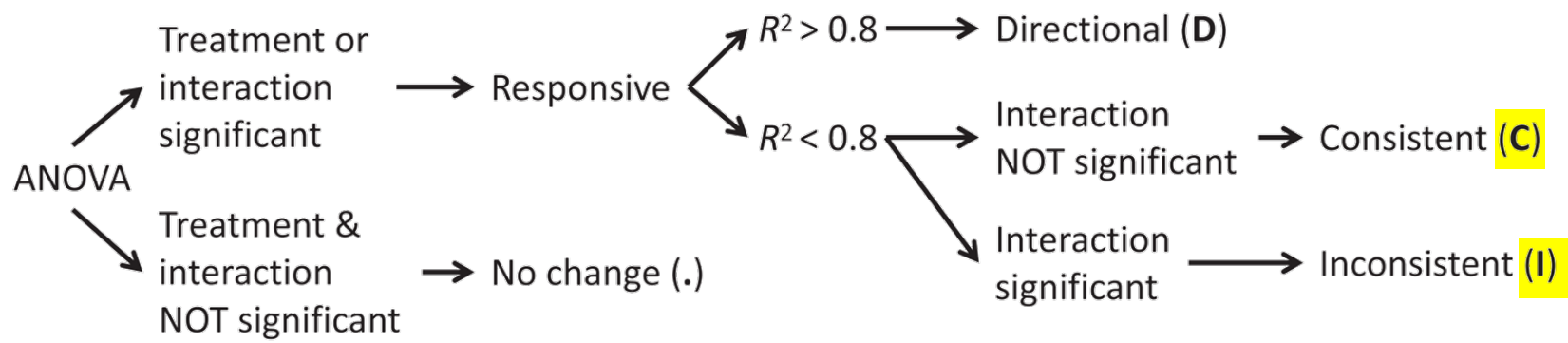


Taxa	C1	C2	C3	C4	C5		E1	E2	E3	E4	E5		W1	W2	W3	W4	W5
Utqiagvik dry (BD) site																	
Deciduous Shrub	15.0	28.5	24.5	23.0	28.3	I	14.9	24.3	20.0	24.1	27.2	.	-0.1	-4.2	-4.4	1.1	-1.2
Evergreen Shrub	11.4	20.4	19.5	37.1	30.3	D ⁺	15.2	24.8	27.7	50.2	40.2	C ⁺	3.8	4.4	8.2	13.0	9.9
Graminoid	3.0	7.3	8.2	8.0	18.0	D ⁺	4.5	12.3	19.6	17.7	29.4	D ⁺	1.4	5.0	11.4	9.7	11.4
Forb	4.5	7.7	7.7	7.6	9.2	D ⁺	4.3	6.6	12.3	11.3	10.6	.	-0.3	-1.0	4.6	3.7	1.5
Bryophyte	11.0	19.8	11.8	17.5	16.8	I	8.4	13.8	6.3	9.6	11.5	C ⁻	-2.6	-6.0	-5.5	-7.9	-5.3
Lichen	27.0	37.9	32.5	48.4	42.7	I	25.8	24.7	15.9	19.6	18.0	I	-1.3	-13.2	-16.6	-28.8	-24.7
Utqiagvik wet (BW) site																	
Deciduous Shrub	0.2	0.0	0.0	0.3	1.0	I	0.3	0.7	1.8	3.8	6.1	D ⁺	0.2	0.6	1.8	3.5	5.1
Graminoid	43.3	63.0	50.6	75.6	93.6	D ⁺	44.4	60.4	51.3	80.0	96.6	.	1.1	-2.5	0.7	4.5	3.0
Forb	17.8	14.6	14.0	19.1	22.3	.	15.6	13.1	16.5	19.5	18.2	.	-2.2	-1.5	2.5	0.4	-4.1
Bryophyte	42.0	56.4	25.1	34.0	27.6	I	42.0	45.6	16.1	20.7	17.5	C ⁻	0.0	-10.8	-9.0	-13.3	-10.1
Lichen	2.5	3.3	5.5	6.0	6.1	.	1.8	1.8	1.8	1.9	1.1	D ⁻	-0.8	-1.5	-3.8	-4.2	-5.0

Ambient change (control plots only)



Warming response (all plots)

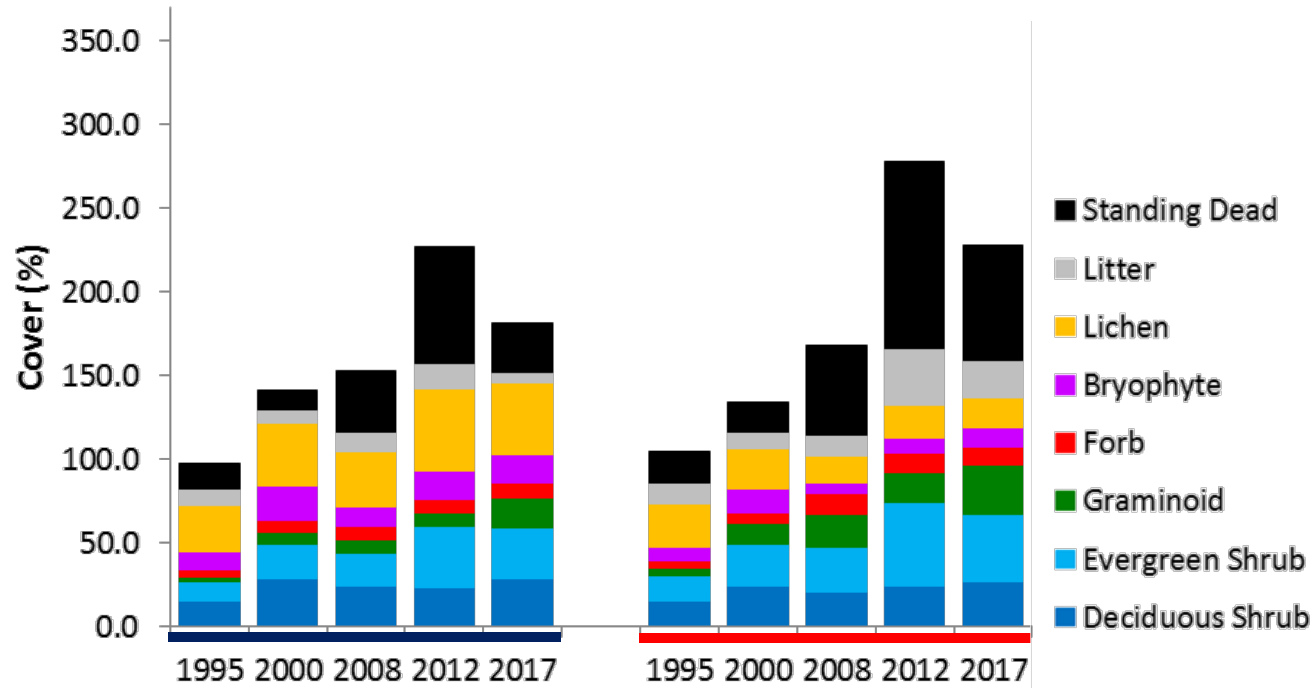


Utqiagvik Dry



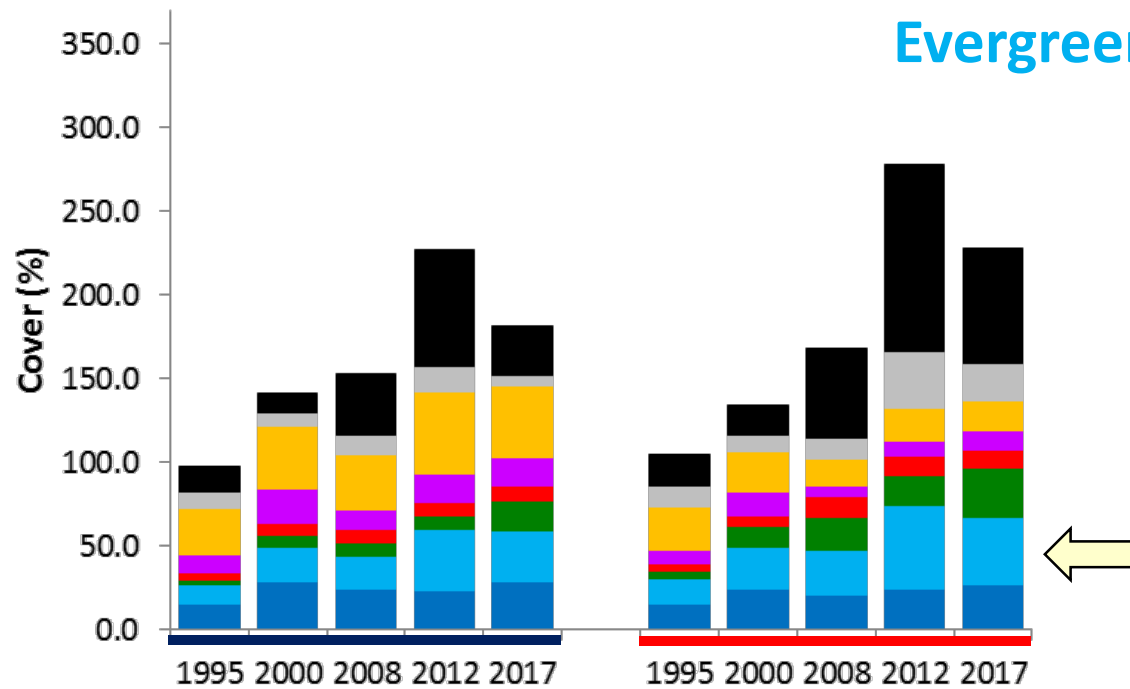
Utqiagvik Dry

Taxa	C1	C2	C3	C4	C5		E1	E2	E3	E4	E5		W1	W2	W3	W4	W5
Utqiagvik dry (BD) site																	
Deciduous Shrub	15.0	28.5	24.5	23.0	28.3	I	14.9	24.3	20.0	24.1	27.2	.	-0.1	-4.2	-4.4	1.1	-1.2
Evergreen Shrub	11.4	20.4	19.5	37.1	30.3	D ⁺	15.2	24.8	27.7	50.2	40.2	C ⁺	3.8	4.4	8.2	13.0	9.9
Graminoid	3.0	7.3	8.2	8.0	18.0	D ⁺	4.5	12.3	19.6	17.7	29.4	D ⁺	1.4	5.0	11.4	9.7	11.4
Forb	4.5	7.7	7.7	7.6	9.2	D ⁺	4.3	6.6	12.3	11.3	10.6	.	-0.3	-1.0	4.6	3.7	1.5
Bryophyte	11.0	19.8	11.8	17.5	16.8	I	8.4	13.8	6.3	9.6	11.5	C ⁻	-2.6	-6.0	-5.5	-7.9	-5.3
Lichen	27.0	37.9	32.5	48.4	42.7	I	25.8	24.7	15.9	19.6	18.0	I	-1.3	-13.2	-16.6	-28.8	-24.7



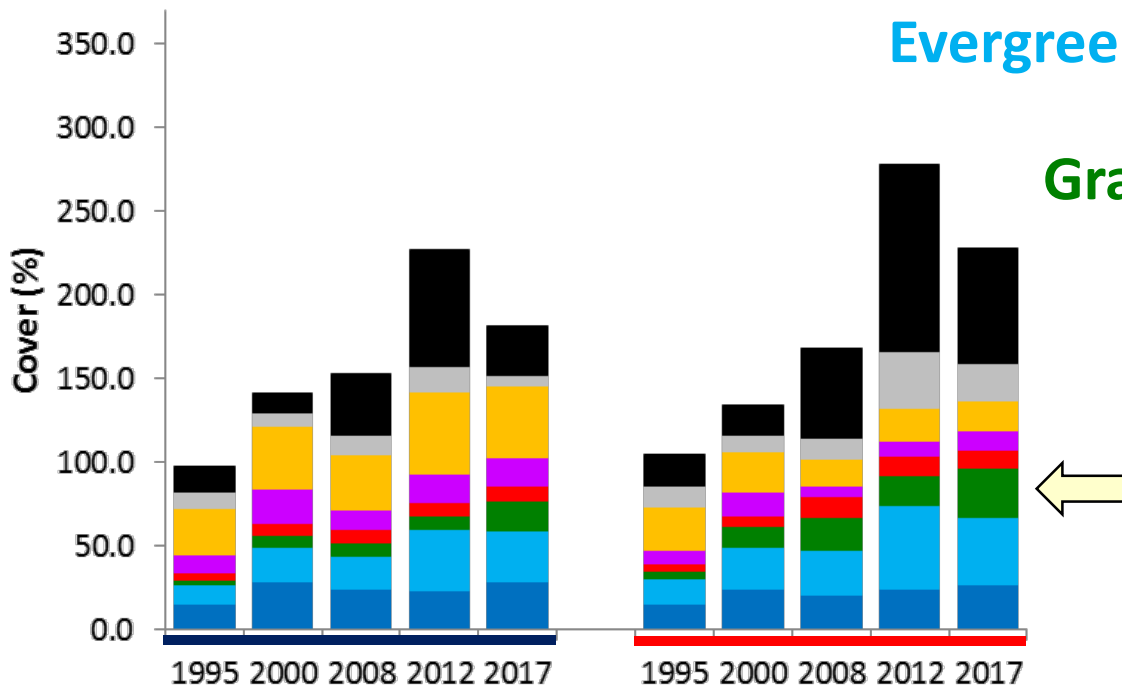
Utqiagvik Dry

Taxa	C1	C2	C3	C4	C5		E1	E2	E3	E4	E5		W1	W2	W3	W4	W5
Utqiagvik dry (BD) site																	
Deciduous Shrub	15.0	28.5	24.5	23.0	28.3	I	14.9	24.3	20.0	24.1	27.2	.	-0.1	-4.2	-4.4	1.1	-1.2
Evergreen Shrub	11.4	20.4	19.5	37.1	30.3	D ⁺	15.2	24.8	27.7	50.2	40.2	C ⁺	3.8	4.4	8.2	13.0	9.9
Graminoid	3.0	7.3	8.2	8.0	18.0	D ⁺	4.5	12.3	19.6	17.7	29.4	D ⁺	1.4	5.0	11.4	9.7	11.4
Forb	4.5	7.7	7.7	7.6	9.2	D ⁺	4.3	6.6	12.3	11.3	10.6	.	-0.3	-1.0	4.6	3.7	1.5
Bryophyte	11.0	19.8	11.8	17.5	16.8	I	8.4	13.8	6.3	9.6	11.5	C ⁻	-2.6	-6.0	-5.5	-7.9	-5.3
Lichen	27.0	37.9	32.5	48.4	42.7	I	25.8	24.7	15.9	19.6	18.0	I	-1.3	-13.2	-16.6	-28.8	-24.7



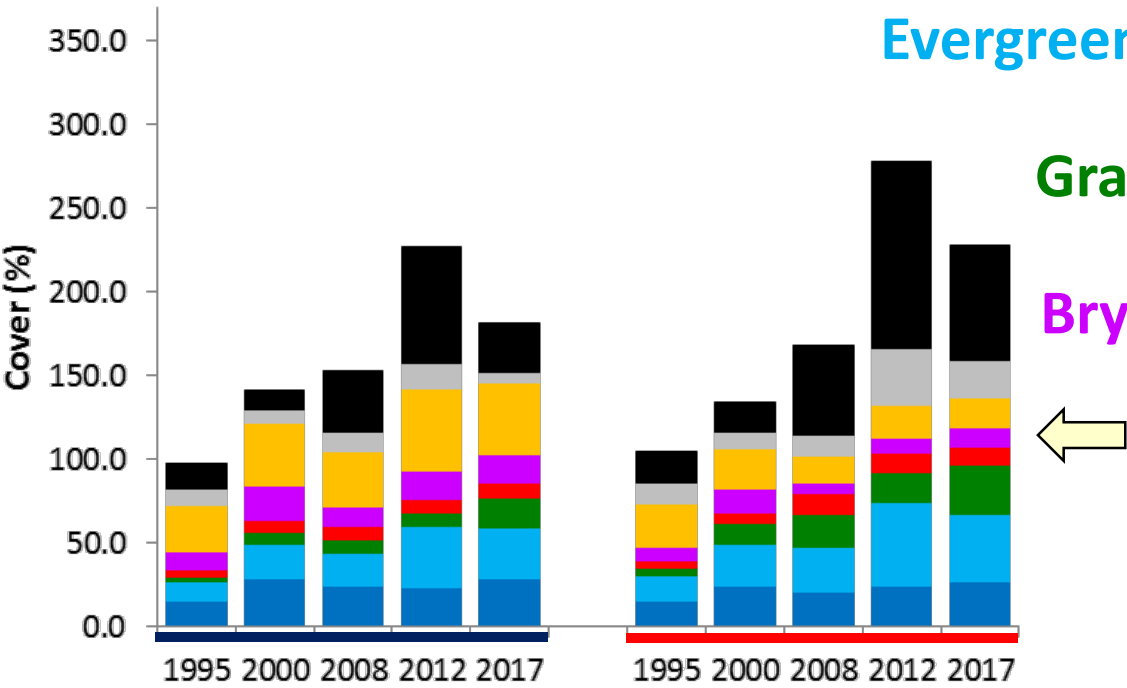
Utqiagvik Dry

Taxa	C1	C2	C3	C4	C5		E1	E2	E3	E4	E5		W1	W2	W3	W4	W5
Utqiagvik dry (BD) site																	
Deciduous Shrub	15.0	28.5	24.5	23.0	28.3	I	14.9	24.3	20.0	24.1	27.2	.	-0.1	-4.2	-4.4	1.1	-1.2
Evergreen Shrub	11.4	20.4	19.5	37.1	30.3	D ⁺	15.2	24.8	27.7	50.2	40.2	C ⁺	3.8	4.4	8.2	13.0	9.9
Graminoid	3.0	7.3	8.2	8.0	18.0	D ⁺	4.5	12.3	19.6	17.7	29.4	D ⁺	1.4	5.0	11.4	9.7	11.4
Forb	4.5	7.7	7.7	7.6	9.2	D ⁺	4.3	6.6	12.3	11.3	10.6	.	-0.3	-1.0	4.6	3.7	1.5
Bryophyte	11.0	19.8	11.8	17.5	16.8	I	8.4	13.8	6.3	9.6	11.5	C ⁻	-2.6	-6.0	-5.5	-7.9	-5.3
Lichen	27.0	37.9	32.5	48.4	42.7	I	25.8	24.7	15.9	19.6	18.0	I	-1.3	-13.2	-16.6	-28.8	-24.7



Utqiagvik Dry

Taxa	C1	C2	C3	C4	C5		E1	E2	E3	E4	E5		W1	W2	W3	W4	W5
Utqiagvik dry (BD) site																	
Deciduous Shrub	15.0	28.5	24.5	23.0	28.3	I	14.9	24.3	20.0	24.1	27.2	.	-0.1	-4.2	-4.4	1.1	-1.2
Evergreen Shrub	11.4	20.4	19.5	37.1	30.3	D ⁺	15.2	24.8	27.7	50.2	40.2	C ⁺	3.8	4.4	8.2	13.0	9.9
Graminoid	3.0	7.3	8.2	8.0	18.0	D ⁺	4.5	12.3	19.6	17.7	29.4	D ⁺	1.4	5.0	11.4	9.7	11.4
Forb	4.5	7.7	7.7	7.6	9.2	D ⁺	4.3	6.6	12.3	11.3	10.6	.	-0.3	-1.0	4.6	3.7	1.5
Bryophyte	11.0	19.8	11.8	17.5	16.8	I	8.4	13.8	6.3	9.6	11.5	C ⁻	-2.6	-6.0	-5.5	-7.9	-5.3
Lichen	27.0	37.9	32.5	48.4	42.7	I	25.8	24.7	15.9	19.6	18.0	I	-1.3	-13.2	-16.6	-28.8	-24.7



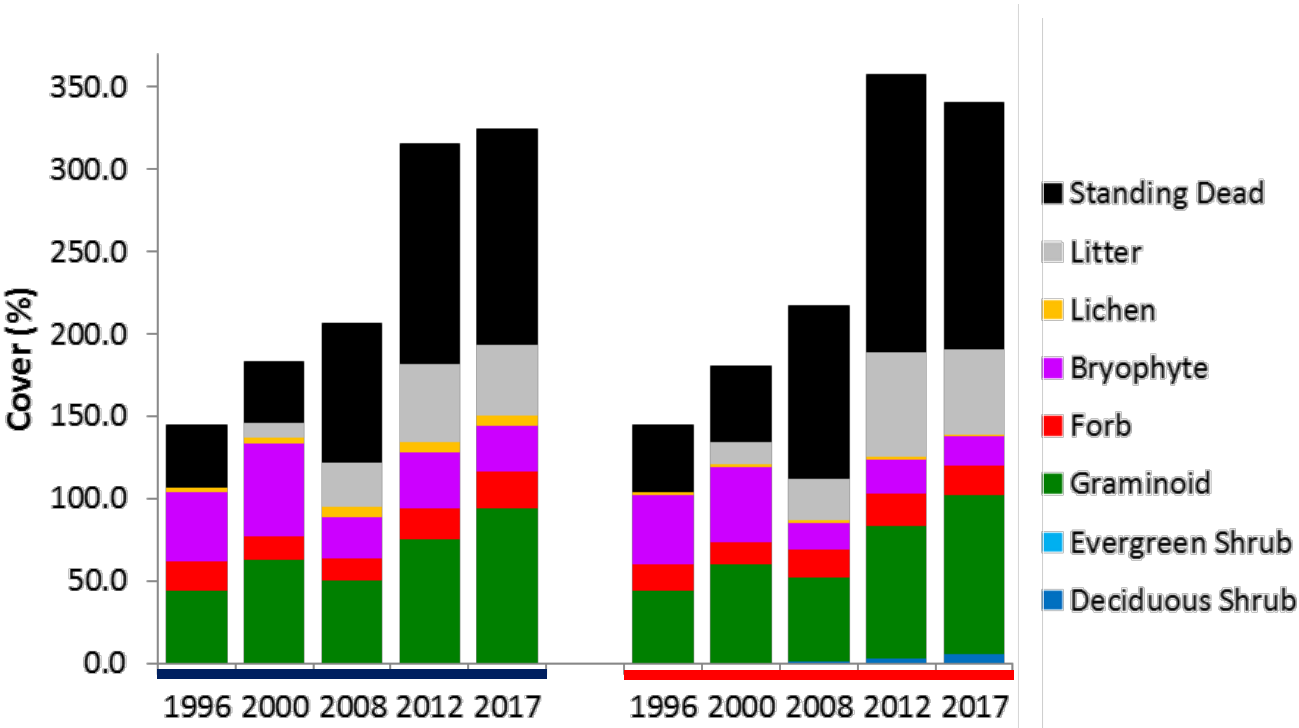


Utqiagvik Wet



Utqiagvik Wet

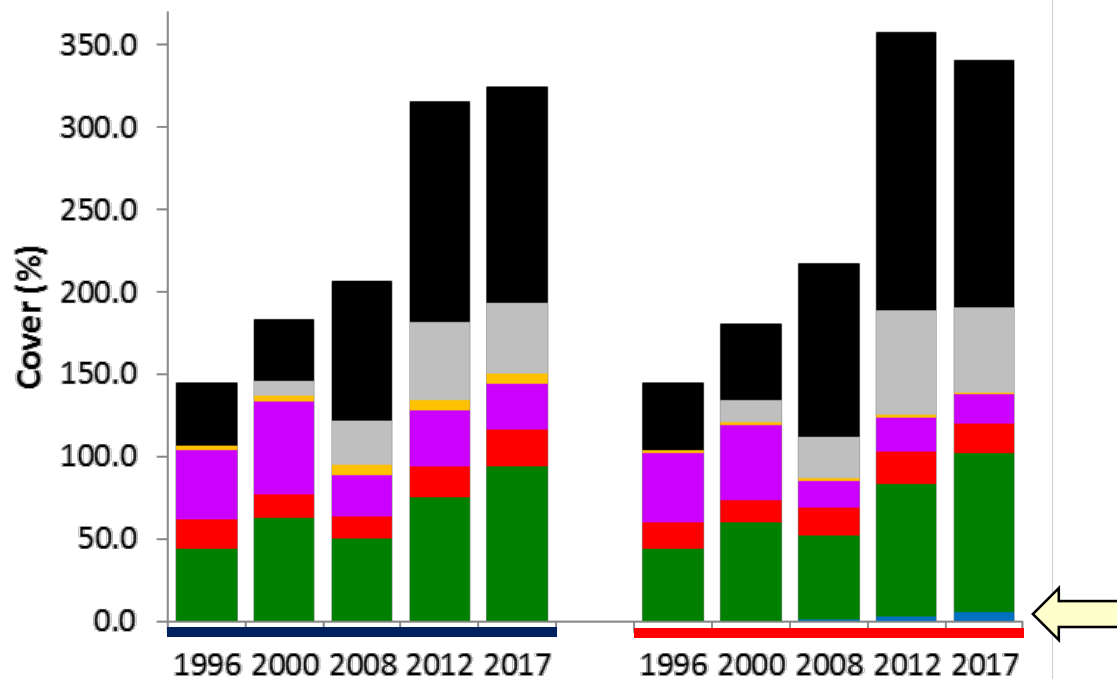
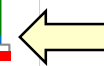
Taxa	C1	C2	C3	C4	C5		E1	E2	E3	E4	E5		W1	W2	W3	W4	W5
Utqiagvik wet (BW) site																	
Deciduous Shrub	0.2	0.0	0.0	0.3	1.0	I	0.3	0.7	1.8	3.8	6.1	D ⁺	0.2	0.6	1.8	3.5	5.1
Graminoid	43.3	63.0	50.6	75.6	93.6	D ⁺	44.4	60.4	51.3	80.0	96.6	.	1.1	-2.5	0.7	4.5	3.0
Forb	17.8	14.6	14.0	19.1	22.3	.	15.6	13.1	16.5	19.5	18.2	.	-2.2	-1.5	2.5	0.4	-4.1
Bryophyte	42.0	56.4	25.1	34.0	27.6	I	42.0	45.6	16.1	20.7	17.5	C ⁻	0.0	-10.8	-9.0	-13.3	-10.1
Lichen	2.5	3.3	5.5	6.0	6.1	.	1.8	1.8	1.8	1.9	1.1	D ⁻	-0.8	-1.5	-3.8	-4.2	-5.0



Utqiagvik Wet

Taxa	C1	C2	C3	C4	C5		E1	E2	E3	E4	E5		W1	W2	W3	W4	W5
Utqiagvik wet (BW) site																	
Deciduous Shrub	0.2	0.0	0.0	0.3	1.0	I	0.3	0.7	1.8	3.8	6.1	D ⁺	0.2	0.6	1.8	3.5	5.1
Graminoid	43.3	63.0	50.6	75.6	93.6	D ⁺	44.4	60.4	51.3	80.0	96.6	.	1.1	-2.5	0.7	4.5	3.0
Forb	17.8	14.6	14.0	19.1	22.3	.	15.6	13.1	16.5	19.5	18.2	.	-2.2	-1.5	2.5	0.4	-4.1
Bryophyte	42.0	56.4	25.1	34.0	27.6	I	42.0	45.6	16.1	20.7	17.5	C ⁻	0.0	-10.8	-9.0	-13.3	-10.1
Lichen	2.5	3.3	5.5	6.0	6.1	.	1.8	1.8	1.8	1.9	1.1	D ⁻	-0.8	-1.5	-3.8	-4.2	-5.0

Deciduous Shrubs are

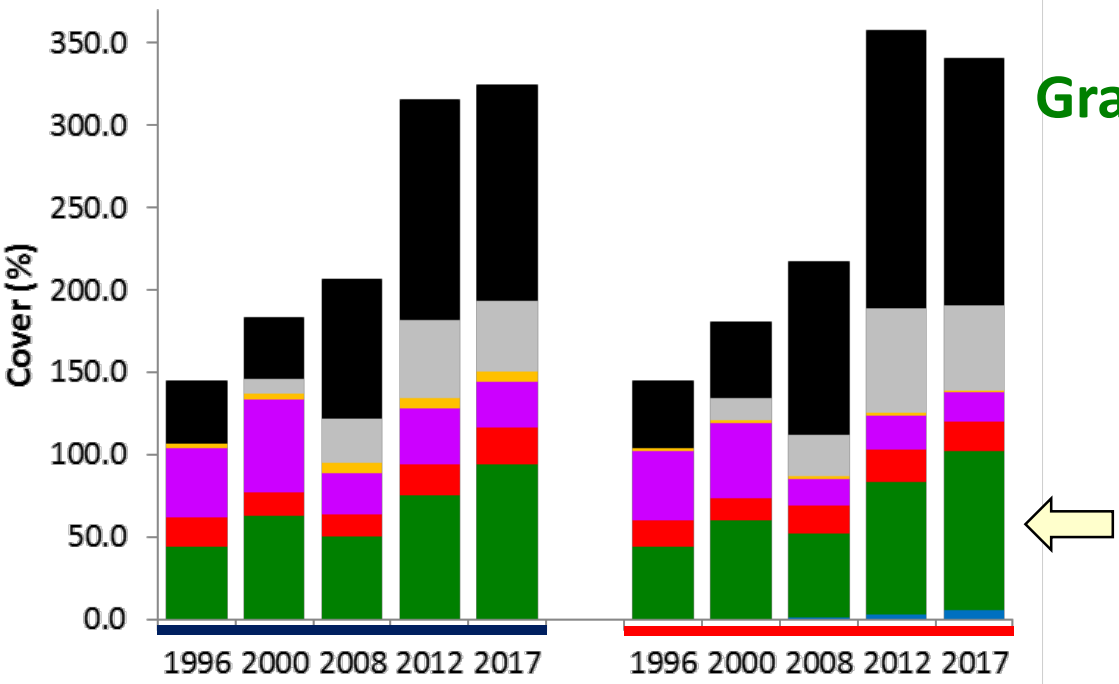


Utqiagvik Wet

Taxa	C1	C2	C3	C4	C5		E1	E2	E3	E4	E5		W1	W2	W3	W4	W5
Utqiagvik wet (BW) site																	
Deciduous Shrub	0.2	0.0	0.0	0.3	1.0	I	0.3	0.7	1.8	3.8	6.1	D ⁺	0.2	0.6	1.8	3.5	5.1
Graminoid	43.3	63.0	50.6	75.6	93.6	D ⁺	44.4	60.4	51.3	80.0	96.6	.	1.1	-2.5	0.7	4.5	3.0
Forb	17.8	14.6	14.0	19.1	22.3	.	15.6	13.1	16.5	19.5	18.2	.	-2.2	-1.5	2.5	0.4	-4.1
Bryophyte	42.0	56.4	25.1	34.0	27.6	I	42.0	45.6	16.1	20.7	17.5	C ⁻	0.0	-10.8	-9.0	-13.3	-10.1
Lichen	2.5	3.3	5.5	6.0	6.1	.	1.8	1.8	1.8	1.9	1.1	D ⁻	-0.8	-1.5	-3.8	-4.2	-5.0

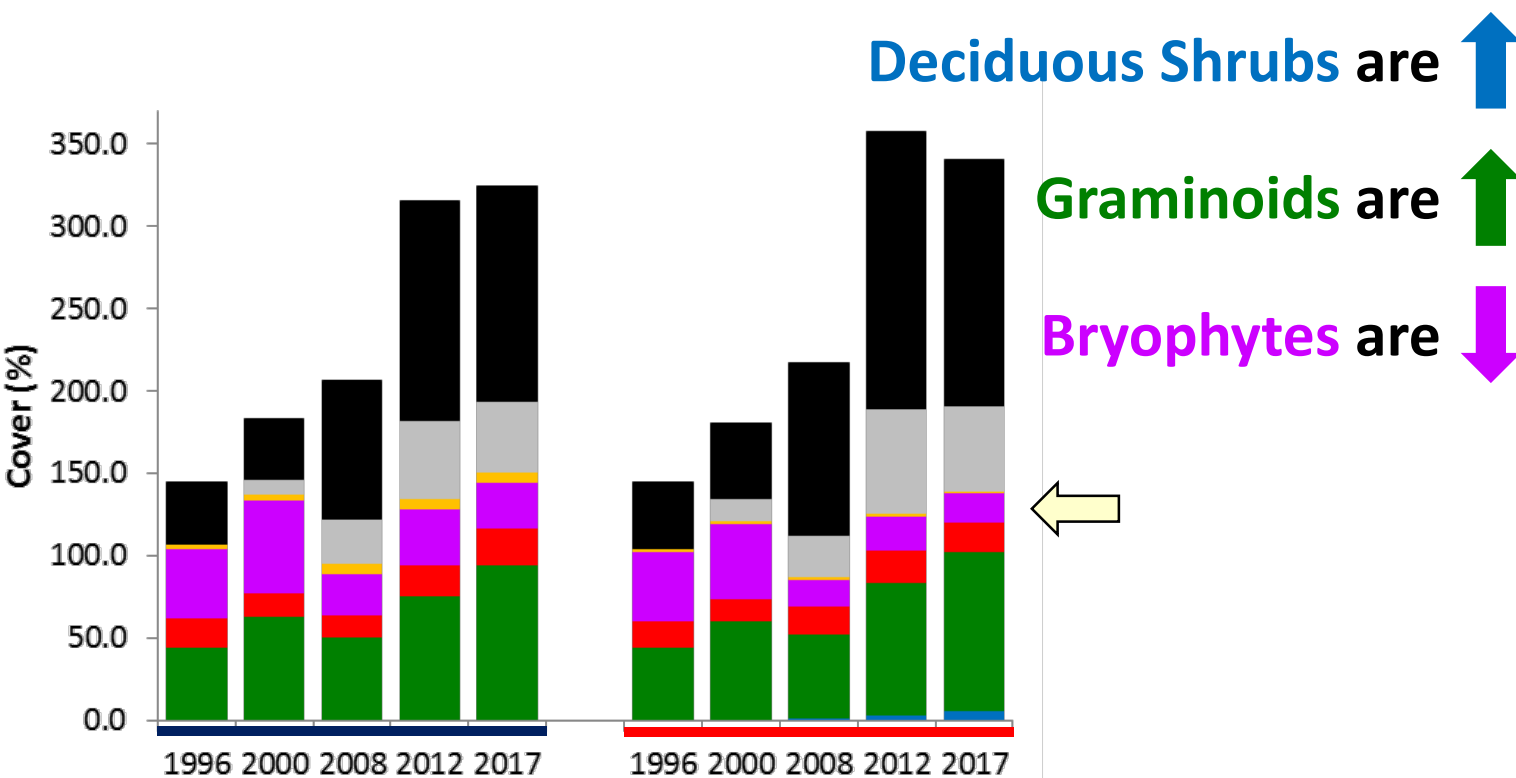
Deciduous Shrubs are 

Graminoids are 



Utqiagvik Wet

Taxa	C1	C2	C3	C4	C5		E1	E2	E3	E4	E5		W1	W2	W3	W4	W5
Utqiagvik wet (BW) site																	
Deciduous Shrub	0.2	0.0	0.0	0.3	1.0	I	0.3	0.7	1.8	3.8	6.1	D ⁺	0.2	0.6	1.8	3.5	5.1
Graminoid	43.3	63.0	50.6	75.6	93.6	D ⁺	44.4	60.4	51.3	80.0	96.6	.	1.1	-2.5	0.7	4.5	3.0
Forb	17.8	14.6	14.0	19.1	22.3	.	15.6	13.1	16.5	19.5	18.2	.	-2.2	-1.5	2.5	0.4	-4.1
Bryophyte	42.0	56.4	25.1	34.0	27.6	I	42.0	45.6	16.1	20.7	17.5	C ⁻	0.0	-10.8	-9.0	-13.3	-10.1
Lichen	2.5	3.3	5.5	6.0	6.1	.	1.8	1.8	1.8	1.9	1.1	D ⁻	-0.8	-1.5	-3.8	-4.2	-5.0

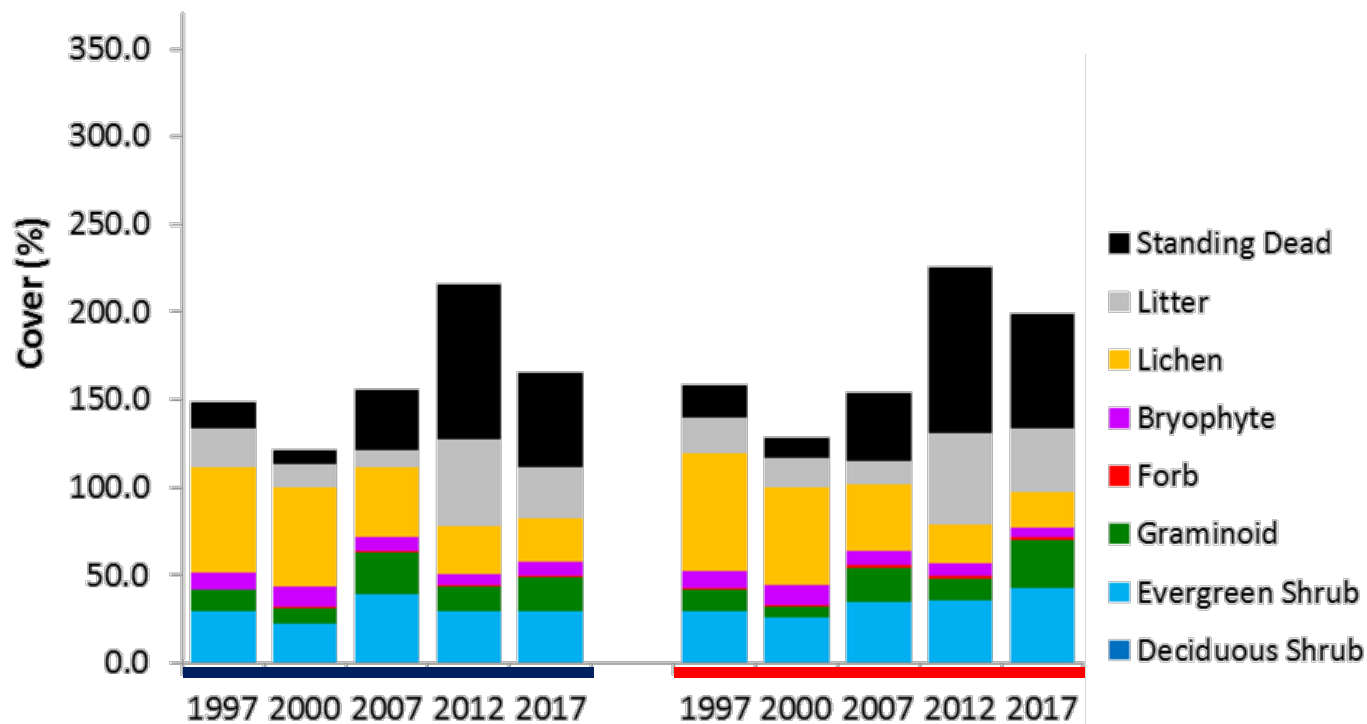


Atqasuk Dry



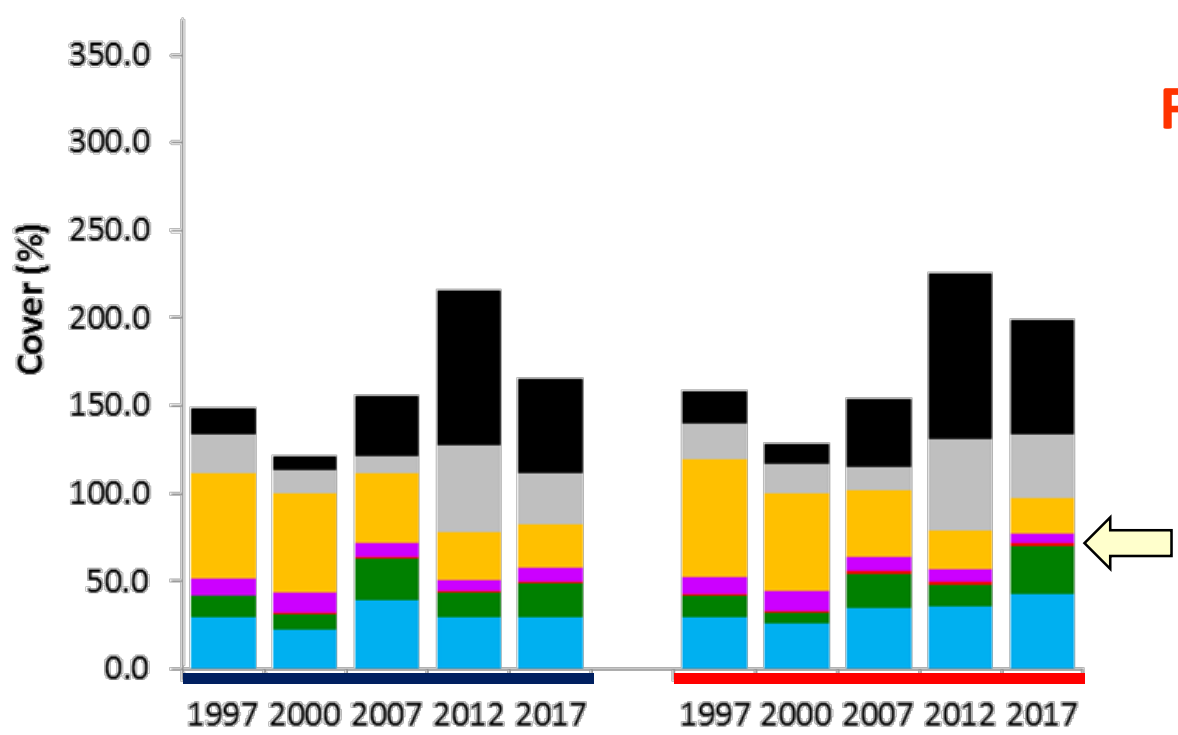
Atqasuk Dry

Taxa	C1	C2	C3	C4	C5		E1	E2	E3	E4	E5		W1	W2	W3	W4	W5
Atqasuk dry (AD) site																	
Deciduous Shrub	0.5	0.4	0.6	0.5	1.0	.	0.3	0.3	0.5	0.7	0.8	.	-0.3	-0.1	-0.2	0.2	-0.2
Evergreen Shrub	29.2	22.6	38.8	29.2	29.1		29.8	26.1	35.2	35.7	42.3		0.6	3.5	-3.6	6.5	13.3
Graminoid	12.3	9.0	24.2	14.3	19.4		12.6	6.4	19.2	12.1	27.1	.	0.4	-2.6	-5.0	-2.2	7.7
Forb	0.7	0.4	0.9	0.7	1.1	.	0.7	0.8	1.6	1.6	2.2	C ⁺	0.0	0.5	0.7	0.9	1.0
Bryophyte	9.1	12.0	7.9	6.8	7.4		9.2	11.3	7.9	7.0	5.7	.	0.1	-0.7	0.0	0.3	-1.7
Lichen	60.1	56.3	39.9	27.3	25.3	D ⁻	67.2	55.8	37.9	22.2	19.5		7.0	-0.5	-2.0	-5.1	-5.9



Atqasuk Dry

Taxa	C1	C2	C3	C4	C5		E1	E2	E3	E4	E5		W1	W2	W3	W4	W5
Atqasuk dry (AD) site																	
Deciduous Shrub	0.5	0.4	0.6	0.5	1.0	.	0.3	0.3	0.5	0.7	0.8	.	-0.3	-0.1	-0.2	0.2	-0.2
Evergreen Shrub	29.2	22.6	38.8	29.2	29.1	I	29.8	26.1	35.2	35.7	42.3	I	0.6	3.5	-3.6	6.5	13.3
Graminoid	12.3	9.0	24.2	14.3	19.4	I	12.6	6.4	19.2	12.1	27.1	.	0.4	-2.6	-5.0	-2.2	7.7
Forb	0.7	0.4	0.9	0.7	1.1	.	0.7	0.8	1.6	1.6	2.2	C⁺	0.0	0.5	0.7	0.9	1.0
Bryophyte	9.1	12.0	7.9	6.8	7.4	I	9.2	11.3	7.9	7.0	5.7	.	0.1	-0.7	0.0	0.3	-1.7
Lichen	60.1	56.3	39.9	27.3	25.3	D ⁻	67.2	55.8	37.9	22.2	19.5	I	7.0	-0.5	-2.0	-5.1	-5.9

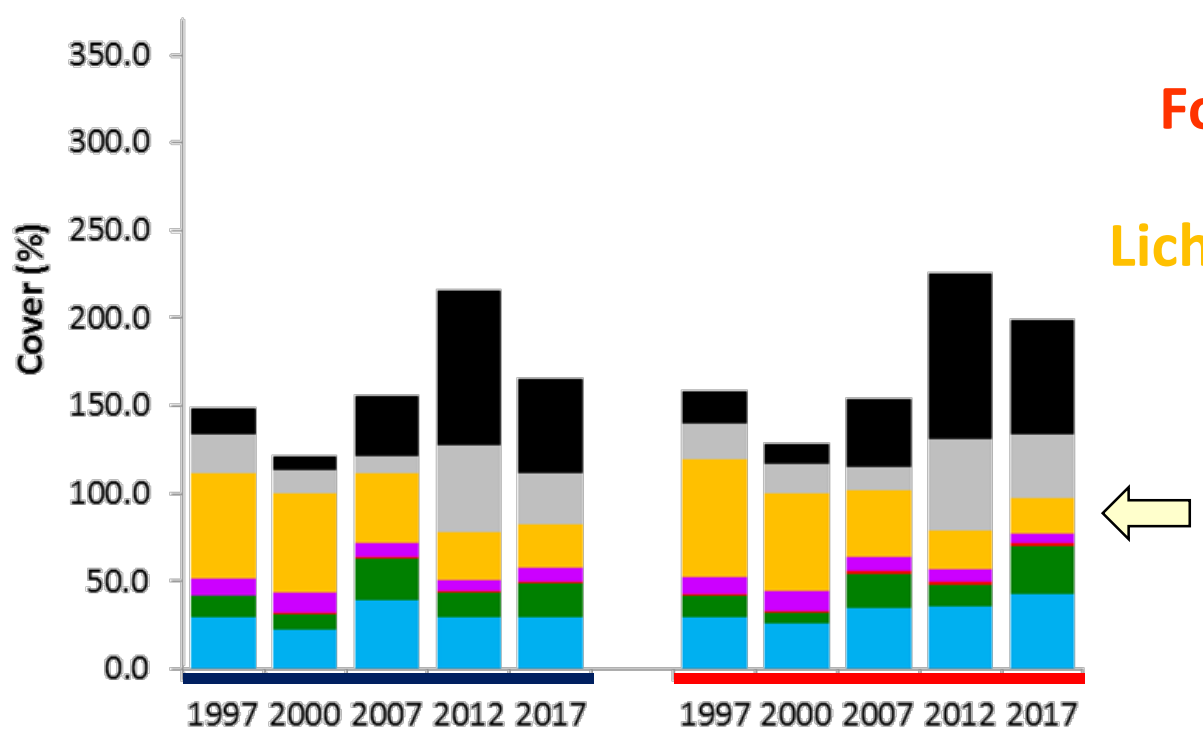


Forbs are ↑



Atqasuk Dry

Taxa	C1	C2	C3	C4	C5		E1	E2	E3	E4	E5		W1	W2	W3	W4	W5
Atqasuk dry (AD) site																	
Deciduous Shrub	0.5	0.4	0.6	0.5	1.0	.	0.3	0.3	0.5	0.7	0.8	.	-0.3	-0.1	-0.2	0.2	-0.2
Evergreen Shrub	29.2	22.6	38.8	29.2	29.1		29.8	26.1	35.2	35.7	42.3		0.6	3.5	-3.6	6.5	13.3
Graminoid	12.3	9.0	24.2	14.3	19.4		12.6	6.4	19.2	12.1	27.1	.	0.4	-2.6	-5.0	-2.2	7.7
Forb	0.7	0.4	0.9	0.7	1.1	.	0.7	0.8	1.6	1.6	2.2	C ⁺	0.0	0.5	0.7	0.9	1.0
Bryophyte	9.1	12.0	7.9	6.8	7.4		9.2	11.3	7.9	7.0	5.7	.	0.1	-0.7	0.0	0.3	-1.7
Lichen	60.1	56.3	39.9	27.3	25.3	D ⁻	67.2	55.8	37.9	22.2	19.5		7.0	-0.5	-2.0	-5.1	-5.9



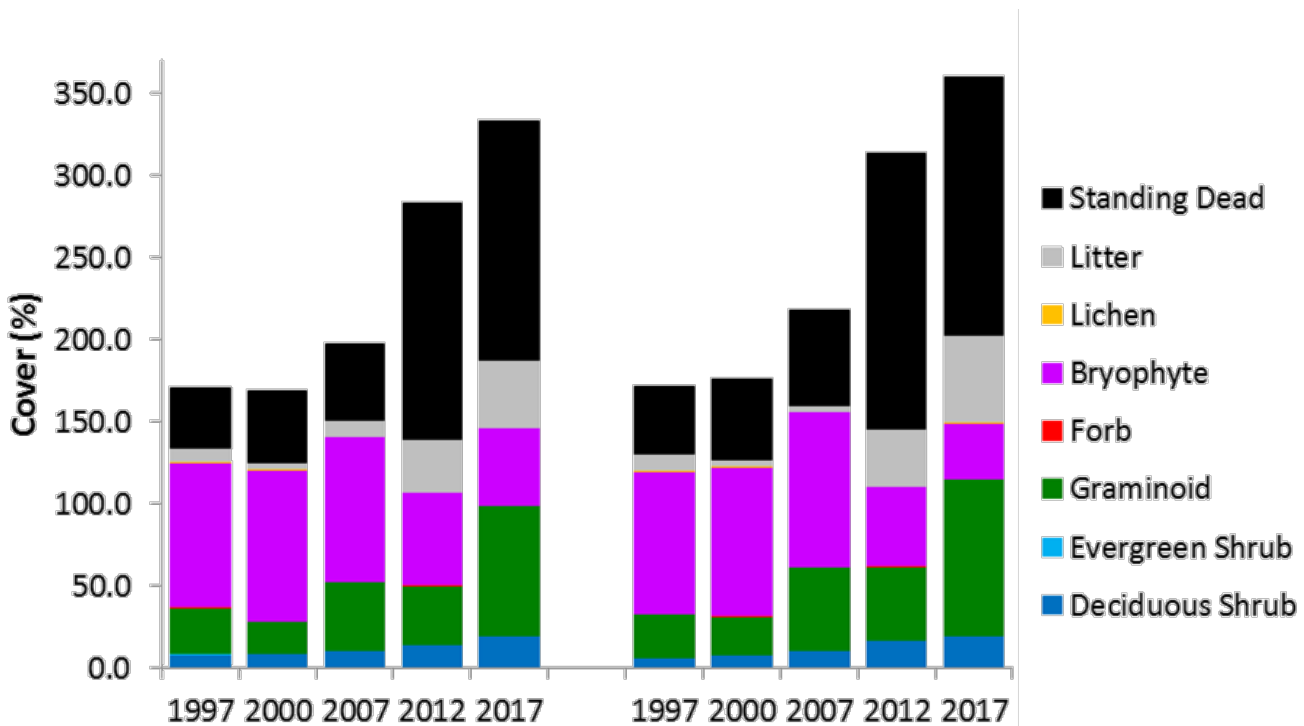


Atqasuk Wet



Atqasuk Wet

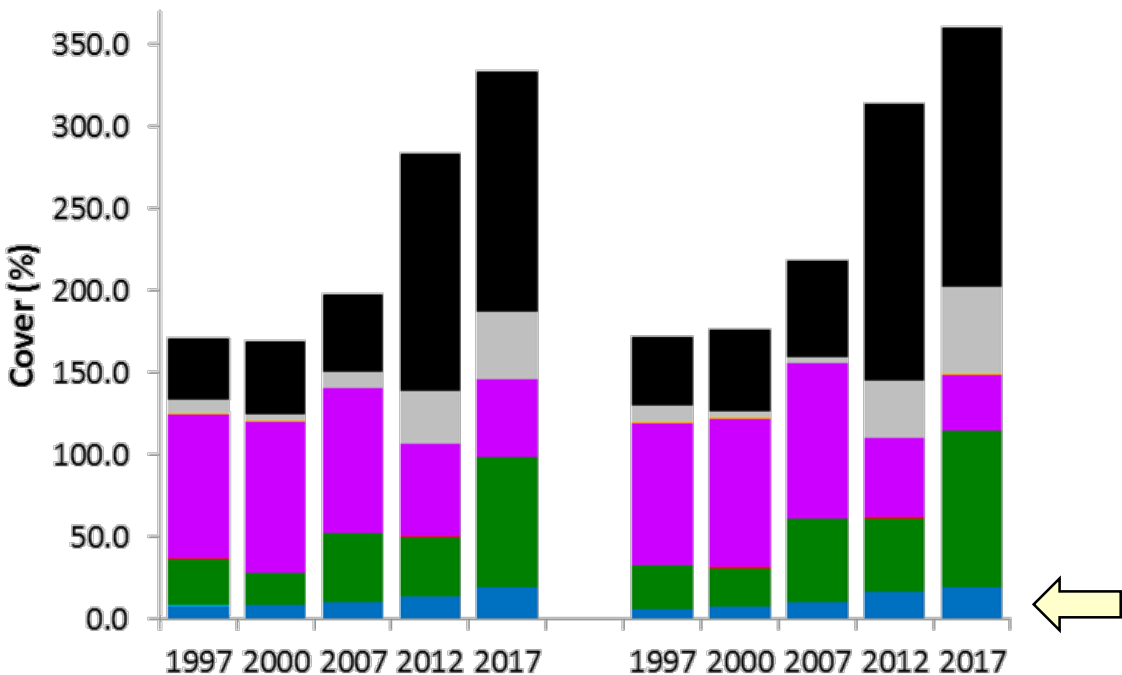
Taxa	C1	C2	C3	C4	C5		E1	E2	E3	E4	E5		W1	W2	W3	W4	W5
Atqasuk wet (AW) site																	
Deciduous Shrub	8.0	8.6	10.8	14.3	19.8	D ⁺	6.2	8.0	10.3	17.3	19.9	.	-1.8	-0.6	-0.4	3.0	0.1
Graminoid	27.8	19.7	41.8	36.0	79.0	D ⁺	26.5	23.6	50.9	44.5	94.9	I	-1.3	3.9	9.1	8.5	15.9
Forb	0.5	0.5	0.5	0.3	0.6	.	0.5	0.3	0.3	0.6	0.3	.	0.0	-0.1	-0.3	0.3	-0.3
Bryophyte	87.8	91.8	87.8	56.1	47.0	D ⁻	86.7	90.8	95.0	48.3	33.7	I	-1.1	-1.1	7.3	-7.8	-13.3
Lichen	1.0	0.6	0.3	0.7	0.0	I	1.0	0.3	0.2	0.3	1.5	C ⁻	0.0	-0.3	-0.1	-0.4	1.5



Atqasuk Wet

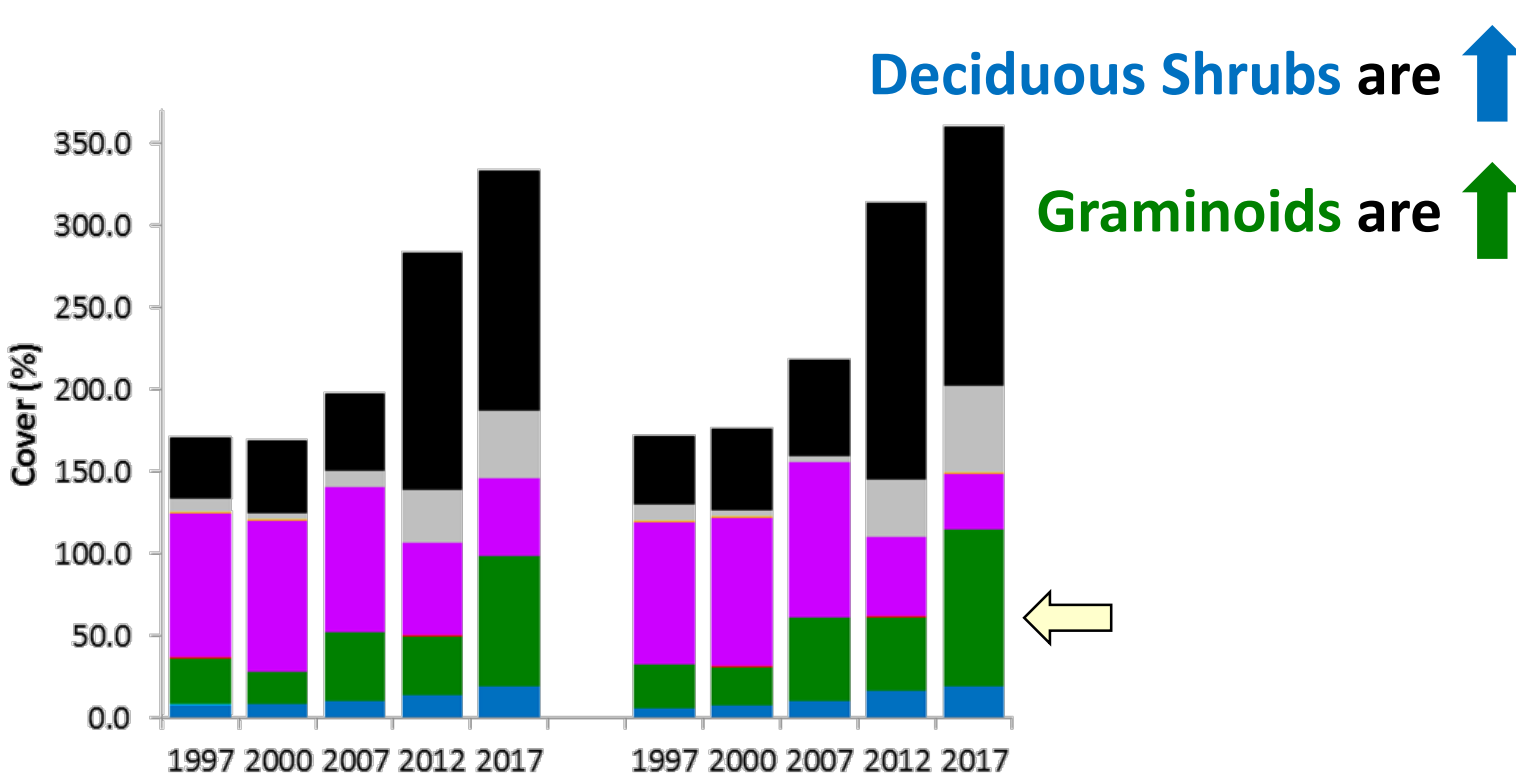
Taxa	C1	C2	C3	C4	C5		E1	E2	E3	E4	E5		W1	W2	W3	W4	W5
Atqasuk wet (AW) site																	
Deciduous Shrub	8.0	8.6	10.8	14.3	19.8	D ⁺	6.2	8.0	10.3	17.3	19.9	.	-1.8	-0.6	-0.4	3.0	0.1
Graminoid	27.8	19.7	41.8	36.0	79.0	D ⁺	26.5	23.6	50.9	44.5	94.9	I	-1.3	3.9	9.1	8.5	15.9
Forb	0.5	0.5	0.5	0.3	0.6	.	0.5	0.3	0.3	0.6	0.3	.	0.0	-0.1	-0.3	0.3	-0.3
Bryophyte	87.8	91.8	87.8	56.1	47.0	D ⁻	86.7	90.8	95.0	48.3	33.7	I	-1.1	-1.1	7.3	-7.8	-13.3
Lichen	1.0	0.6	0.3	0.7	0.0	I	1.0	0.3	0.2	0.3	1.5	C ⁻	0.0	-0.3	-0.1	-0.4	1.5

Deciduous Shrubs are



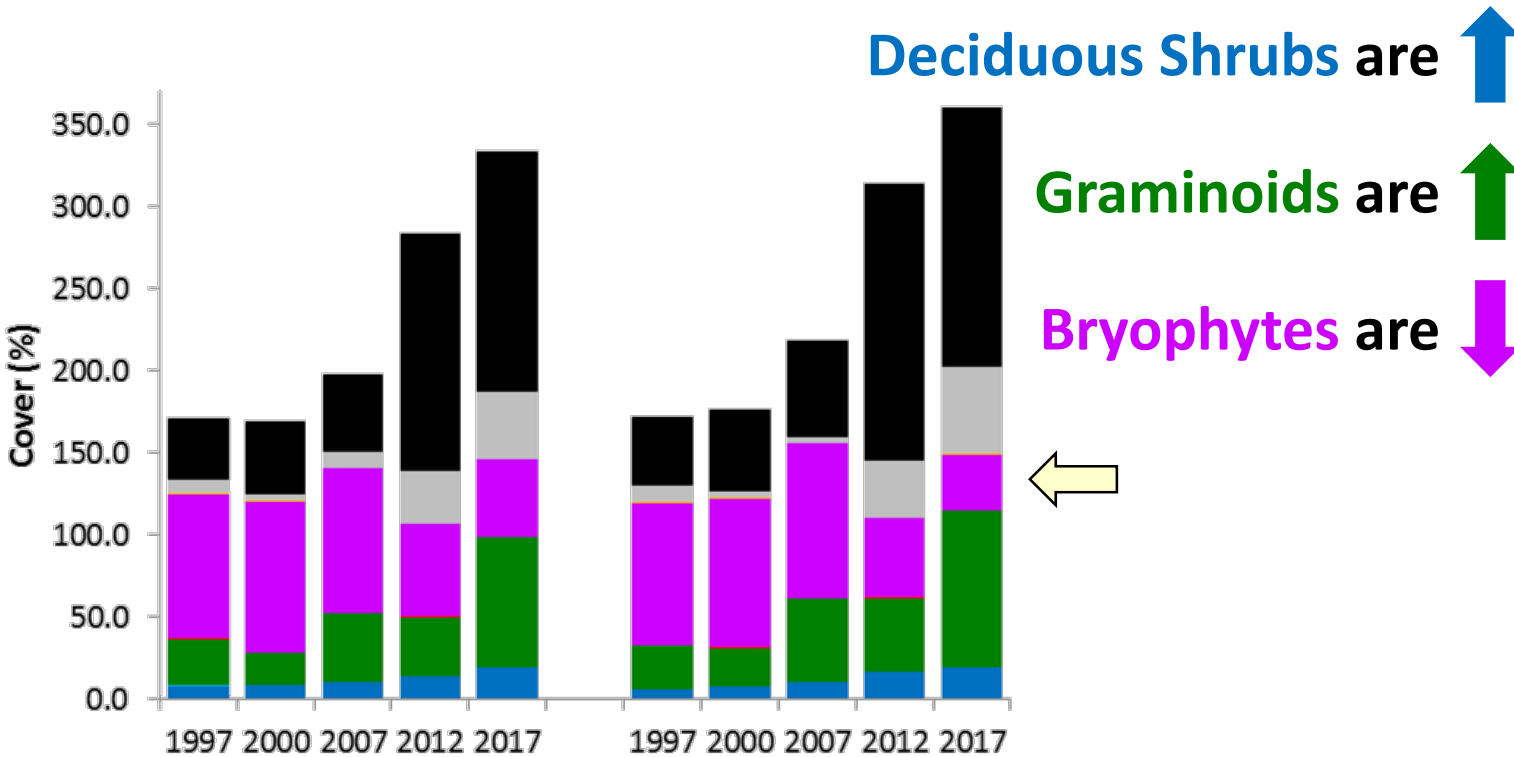
Atqasuk Wet

Taxa	C1	C2	C3	C4	C5		E1	E2	E3	E4	E5		W1	W2	W3	W4	W5
Atqasuk wet (AW) site																	
Deciduous Shrub	8.0	8.6	10.8	14.3	19.8	D ⁺	6.2	8.0	10.3	17.3	19.9	.	-1.8	-0.6	-0.4	3.0	0.1
Graminoid	27.8	19.7	41.8	36.0	79.0	D ⁺	26.5	23.6	50.9	44.5	94.9	I	-1.3	3.9	9.1	8.5	15.9
Forb	0.5	0.5	0.5	0.3	0.6	.	0.5	0.3	0.3	0.6	0.3	.	0.0	-0.1	-0.3	0.3	-0.3
Bryophyte	87.8	91.8	87.8	56.1	47.0	D ⁻	86.7	90.8	95.0	48.3	33.7	I	-1.1	-1.1	7.3	-7.8	-13.3
Lichen	1.0	0.6	0.3	0.7	0.0	I	1.0	0.3	0.2	0.3	1.5	C ⁻	0.0	-0.3	-0.1	-0.4	1.5



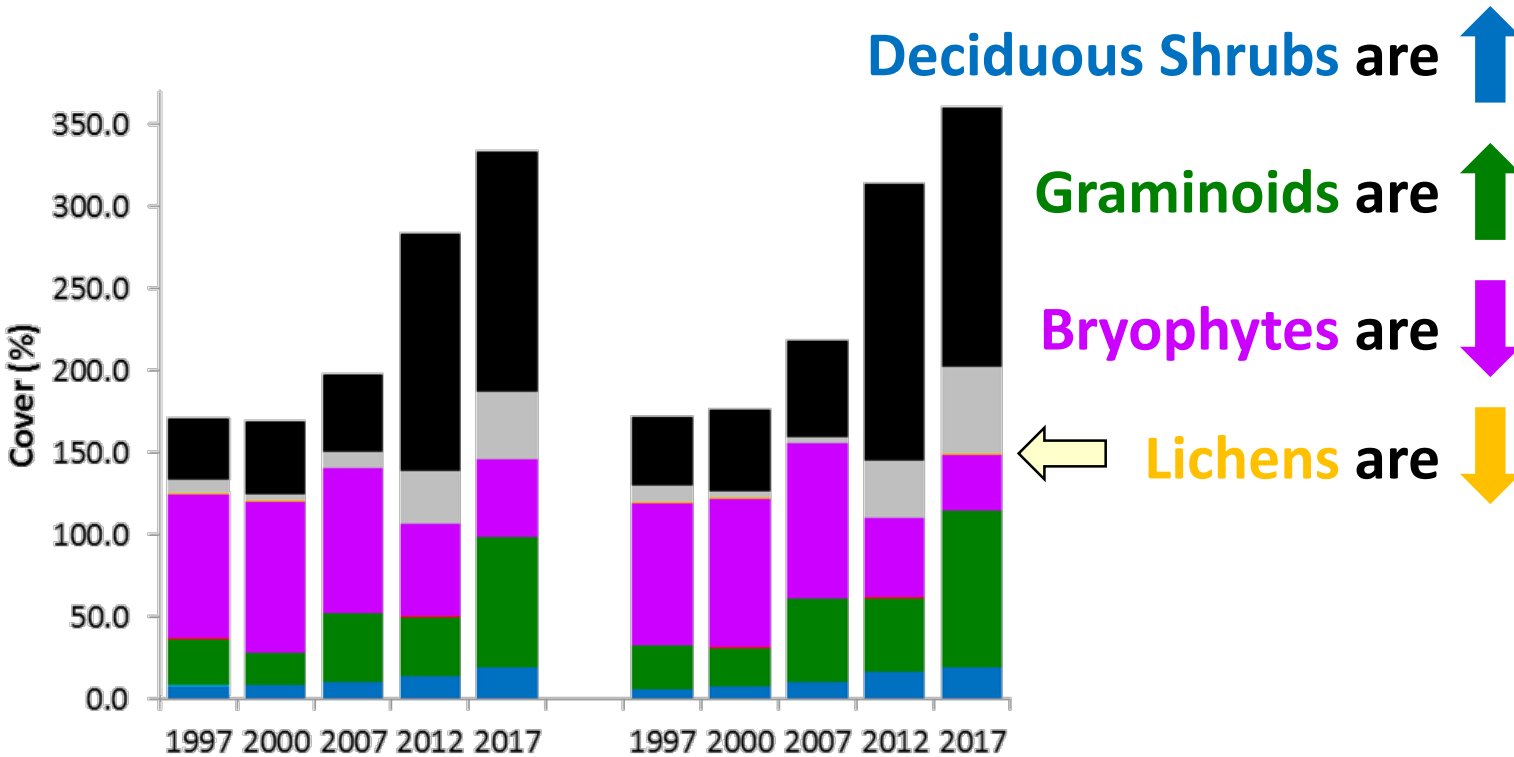
Atqasuk Wet

Taxa	C1	C2	C3	C4	C5		E1	E2	E3	E4	E5		W1	W2	W3	W4	W5
Atqasuk wet (AW) site																	
Deciduous Shrub	8.0	8.6	10.8	14.3	19.8	D ⁺	6.2	8.0	10.3	17.3	19.9	.	-1.8	-0.6	-0.4	3.0	0.1
Graminoid	27.8	19.7	41.8	36.0	79.0	D ⁺	26.5	23.6	50.9	44.5	94.9	I	-1.3	3.9	9.1	8.5	15.9
Forb	0.5	0.5	0.5	0.3	0.6	.	0.5	0.3	0.3	0.6	0.3	.	0.0	-0.1	-0.3	0.3	-0.3
Bryophyte	87.8	91.8	87.8	56.1	47.0	D ⁻	86.7	90.8	95.0	48.3	33.7	I	-1.1	-1.1	7.3	-7.8	-13.3
Lichen	1.0	0.6	0.3	0.7	0.0	I	1.0	0.3	0.2	0.3	1.5	C ⁻	0.0	-0.3	-0.1	-0.4	1.5



Atqasuk Wet

Taxa	C1	C2	C3	C4	C5		E1	E2	E3	E4	E5		W1	W2	W3	W4	W5
Atqasuk wet (AW) site																	
Deciduous Shrub	8.0	8.6	10.8	14.3	19.8	D ⁺	6.2	8.0	10.3	17.3	19.9	.	-1.8	-0.6	-0.4	3.0	0.1
Graminoid	27.8	19.7	41.8	36.0	79.0	D ⁺	26.5	23.6	50.9	44.5	94.9	I	-1.3	3.9	9.1	8.5	15.9
Forb	0.5	0.5	0.5	0.3	0.6	.	0.5	0.3	0.3	0.6	0.3	.	0.0	-0.1	-0.3	0.3	-0.3
Bryophyte	87.8	91.8	87.8	56.1	47.0	D ⁻	86.7	90.8	95.0	48.3	33.7	I	-1.1	-1.1	7.3	-7.8	-13.3
Lichen	1.0	0.6	0.3	0.7	0.0	I	1.0	0.3	0.2	0.3	1.5	C ⁻	0.0	-0.3	-0.1	-0.4	1.5

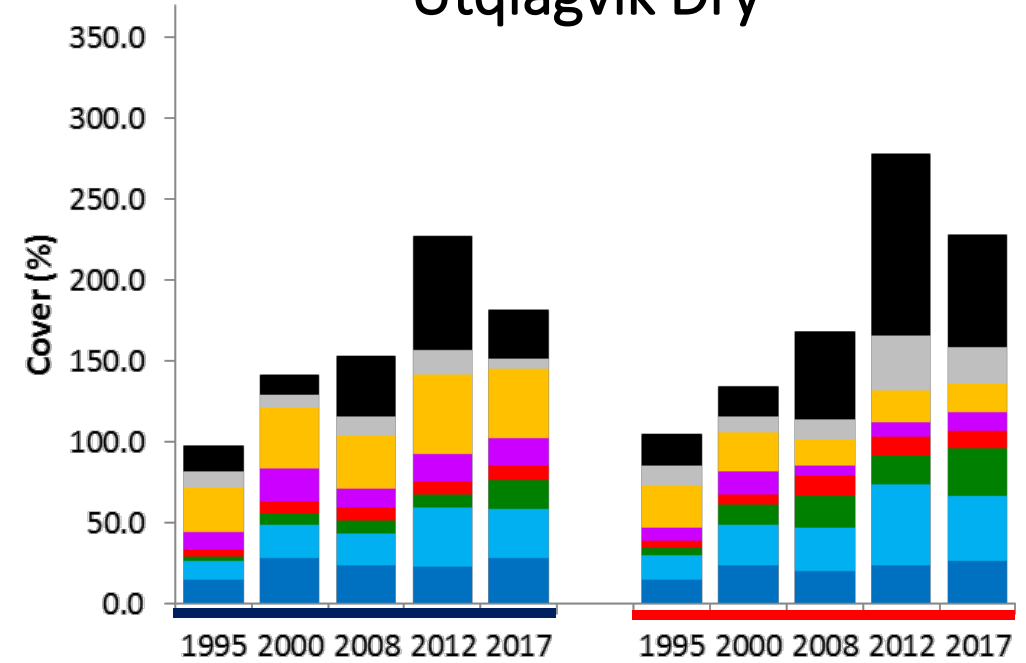


Summary

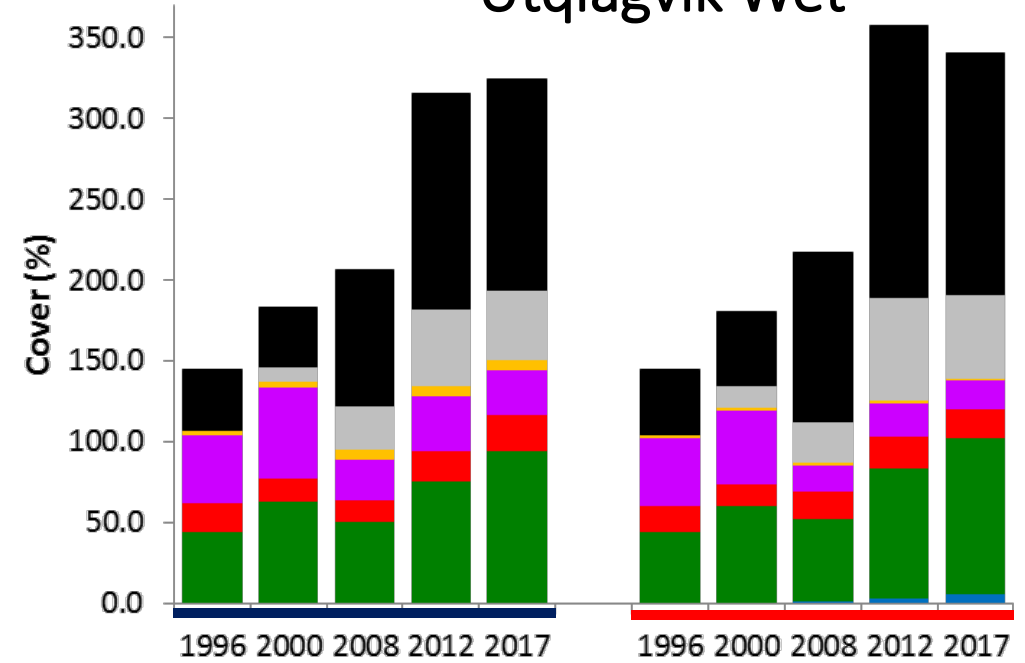
Across all sites...



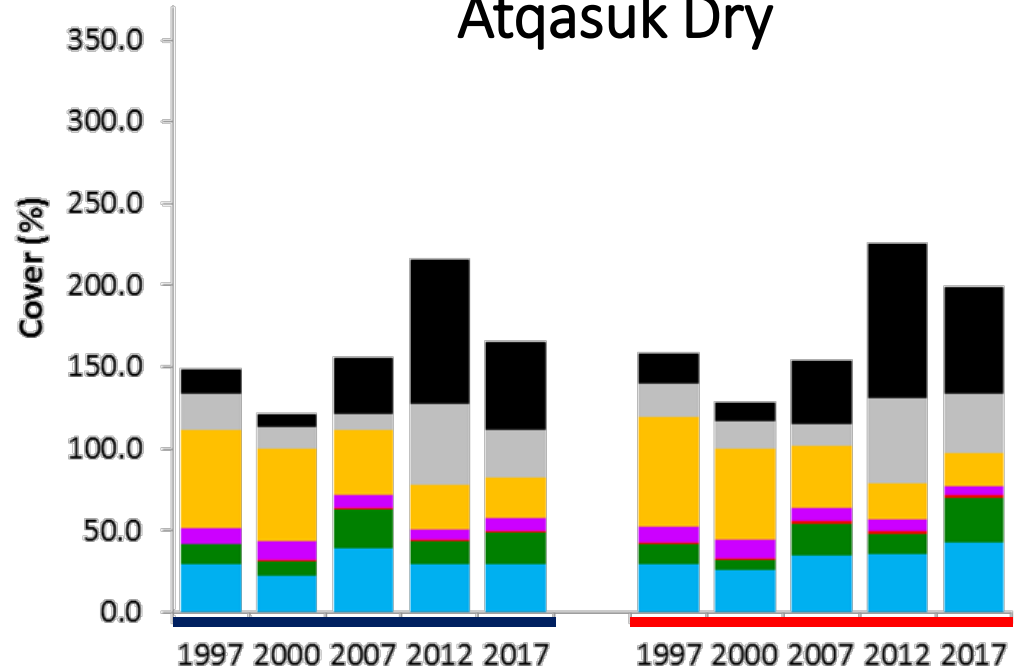
Utqiagvik Dry



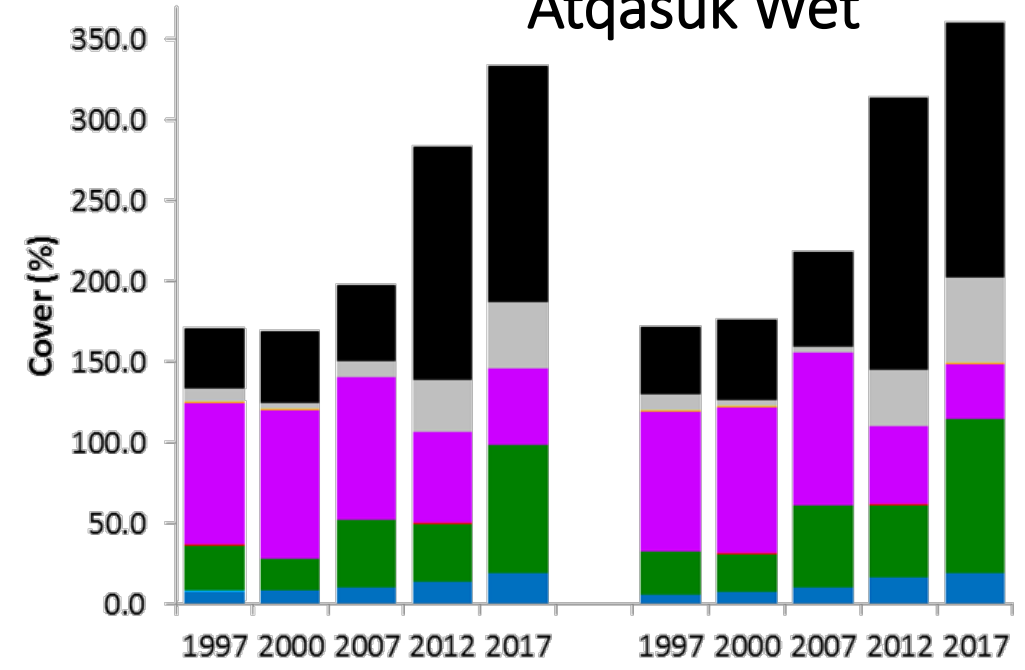
Utqiagvik Wet



Atqasuk Dry



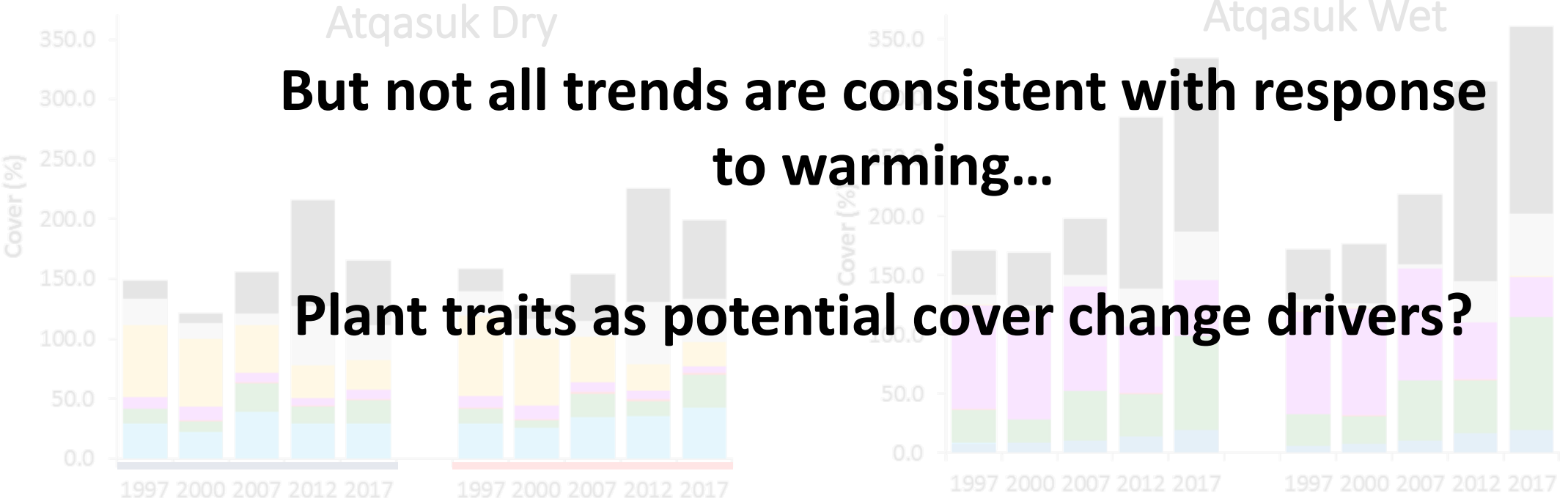
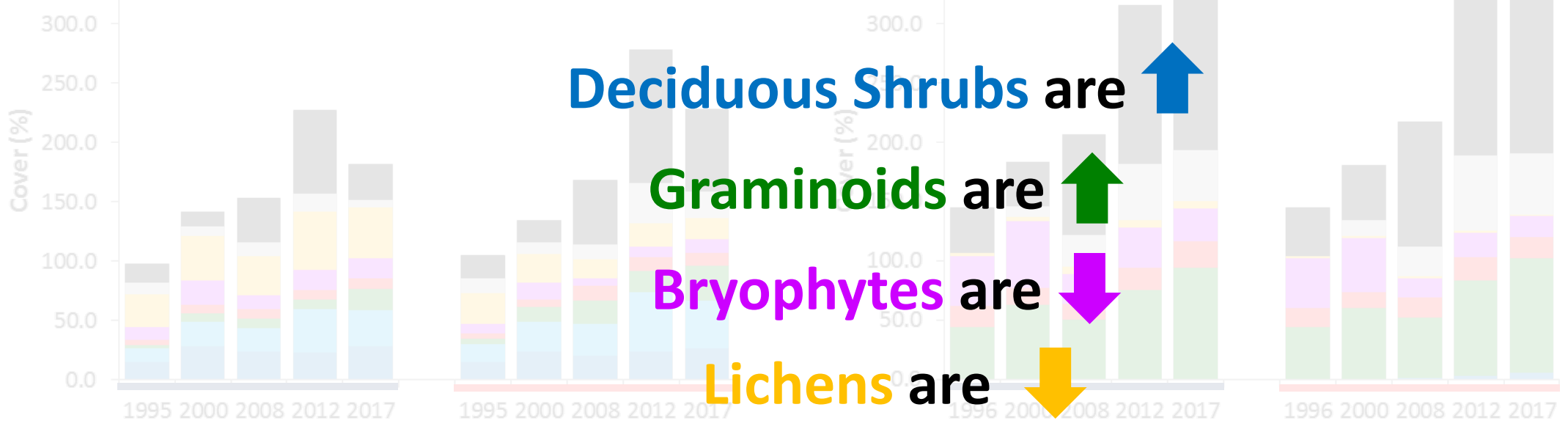
Atqasuk Wet



- Standing Dead
- Litter
- Lichen
- Bryophyte
- Forb
- Graminoid
- Evergreen Shrub
- Deciduous Shrub



Across all sites...



People that made this work possible



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Taxa	C1	C2	C3	C4	C5		E1	E2	E3	E4	E5		W1	W2	W3	W4	W5
Utqiagvik dry (BD) site																	
Deciduous Shrub	15.0	28.5	24.5	23.0	28.3	I	14.9	24.3	20.0	24.1	27.2	.	-0.1	-4.2	-4.4	1.1	-1.2
Evergreen Shrub	11.4	20.4	19.5	37.1	30.3	D ⁺	15.2	24.8	27.7	50.2	40.2	C ⁺	3.8	4.4	8.2	13.0	9.9
Graminoid	3.0	7.3	8.2	8.0	18.0	D ⁺	4.5	12.3	19.6	17.7	29.4	D ⁺	1.4	5.0	11.4	9.7	11.4
Forb	4.5	7.7	7.7	7.6	9.2	D ⁺	4.3	6.6	12.3	11.3	10.6	.	-0.3	-1.0	4.6	3.7	1.5
Bryophyte	11.0	19.8	11.8	17.5	16.8	I	8.4	13.8	6.3	9.6	11.5	C ⁻	-2.6	-6.0	-5.5	-7.9	-5.3
Lichen	27.0	37.9	32.5	48.4	42.7	I	25.8	24.7	15.9	19.6	18.0	I	-1.3	-13.2	-16.6	-28.8	-24.7
Utqiagvik wet (BW) site																	
Deciduous Shrub	0.2	0.0	0.0	0.3	1.0	I	0.3	0.7	1.8	3.8	6.1	D ⁺	0.2	0.6	1.8	3.5	5.1
Graminoid	43.3	63.0	50.6	75.6	93.6	D ⁺	44.4	60.4	51.3	80.0	96.6	.	1.1	-2.5	0.7	4.5	3.0
Forb	17.8	14.6	14.0	19.1	22.3	.	15.6	13.1	16.5	19.5	18.2	.	-2.2	-1.5	2.5	0.4	-4.1
Bryophyte	42.0	56.4	25.1	34.0	27.6	I	42.0	45.6	16.1	20.7	17.5	C ⁻	0.0	-10.8	-9.0	-13.3	-10.1
Lichen	2.5	3.3	5.5	6.0	6.1	.	1.8	1.8	1.8	1.9	1.1	D ⁻	-0.8	-1.5	-3.8	-4.2	-5.0
Taxa	C1	C2	C3	C4	C5		E1	E2	E3	E4	E5		W1	W2	W3	W4	W5
Atqasuk dry (AD) site																	
Deciduous Shrub	0.5	0.4	0.6	0.5	1.0	.	0.3	0.3	0.5	0.7	0.8	.	-0.3	-0.1	-0.2	0.2	-0.2
Evergreen Shrub	29.2	22.6	38.8	29.2	29.1	I	29.8	26.1	35.2	35.7	42.3	I	0.6	3.5	-3.6	6.5	13.3
Graminoid	12.3	9.0	24.2	14.3	19.4	I	12.6	6.4	19.2	12.1	27.1	.	0.4	-2.6	-5.0	-2.2	7.7
Forb	0.7	0.4	0.9	0.7	1.1	.	0.7	0.8	1.6	1.6	2.2	C ⁺	0.0	0.5	0.7	0.9	1.0
Bryophyte	9.1	12.0	7.9	6.8	7.4	I	9.2	11.3	7.9	7.0	5.7	.	0.1	-0.7	0.0	0.3	-1.7
Lichen	60.1	56.3	39.9	27.3	25.3	D ⁻	67.2	55.8	37.9	22.2	19.5	I	7.0	-0.5	-2.0	-5.1	-5.9
Atqasuk wet (AW) site																	
Deciduous Shrub	8.0	8.6	10.8	14.3	19.8	D ⁺	6.2	8.0	10.3	17.3	19.9	.	-1.8	-0.6	-0.4	3.0	0.1
Graminoid	27.8	19.7	41.8	36.0	79.0	D ⁺	26.5	23.6	50.9	44.5	94.9	I	-1.3	3.9	9.1	8.5	15.9
Forb	0.5	0.5	0.5	0.3	0.6	.	0.5	0.3	0.3	0.6	0.3	.	0.0	-0.1	-0.3	0.3	-0.3
Bryophyte	87.8	91.8	87.8	56.1	47.0	D ⁻	86.7	90.8	95.0	48.3	33.7	I	-1.1	-1.1	7.3	-7.8	-13.3
Lichen	1.0	0.6	0.3	0.7	0.0	I	1.0	0.3	0.2	0.3	1.5	C ⁻	0.0	-0.3	-0.1	-0.4	1.5