Predicting Long-Term Tundra Plant Community Change In Response To Warming

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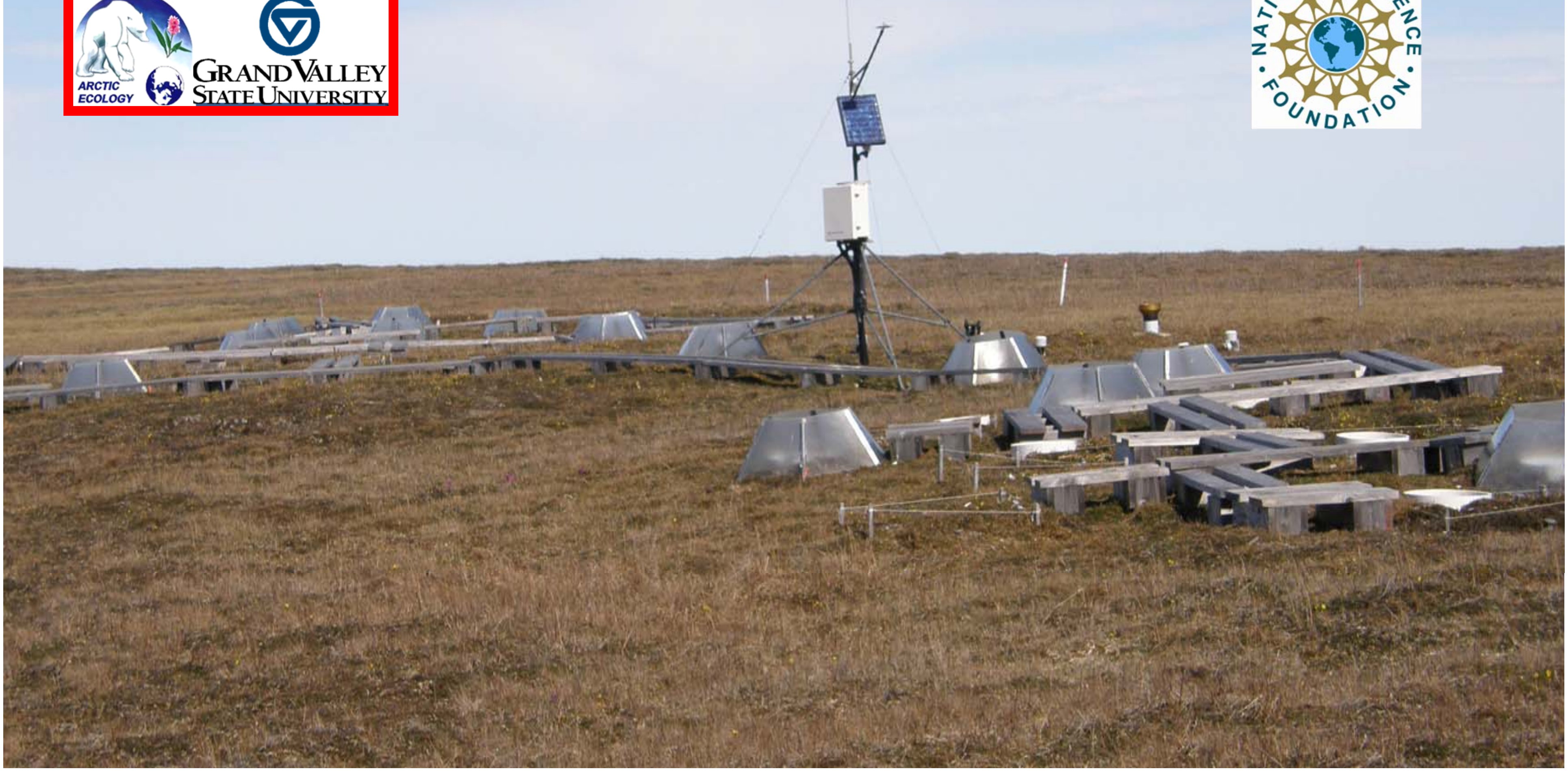
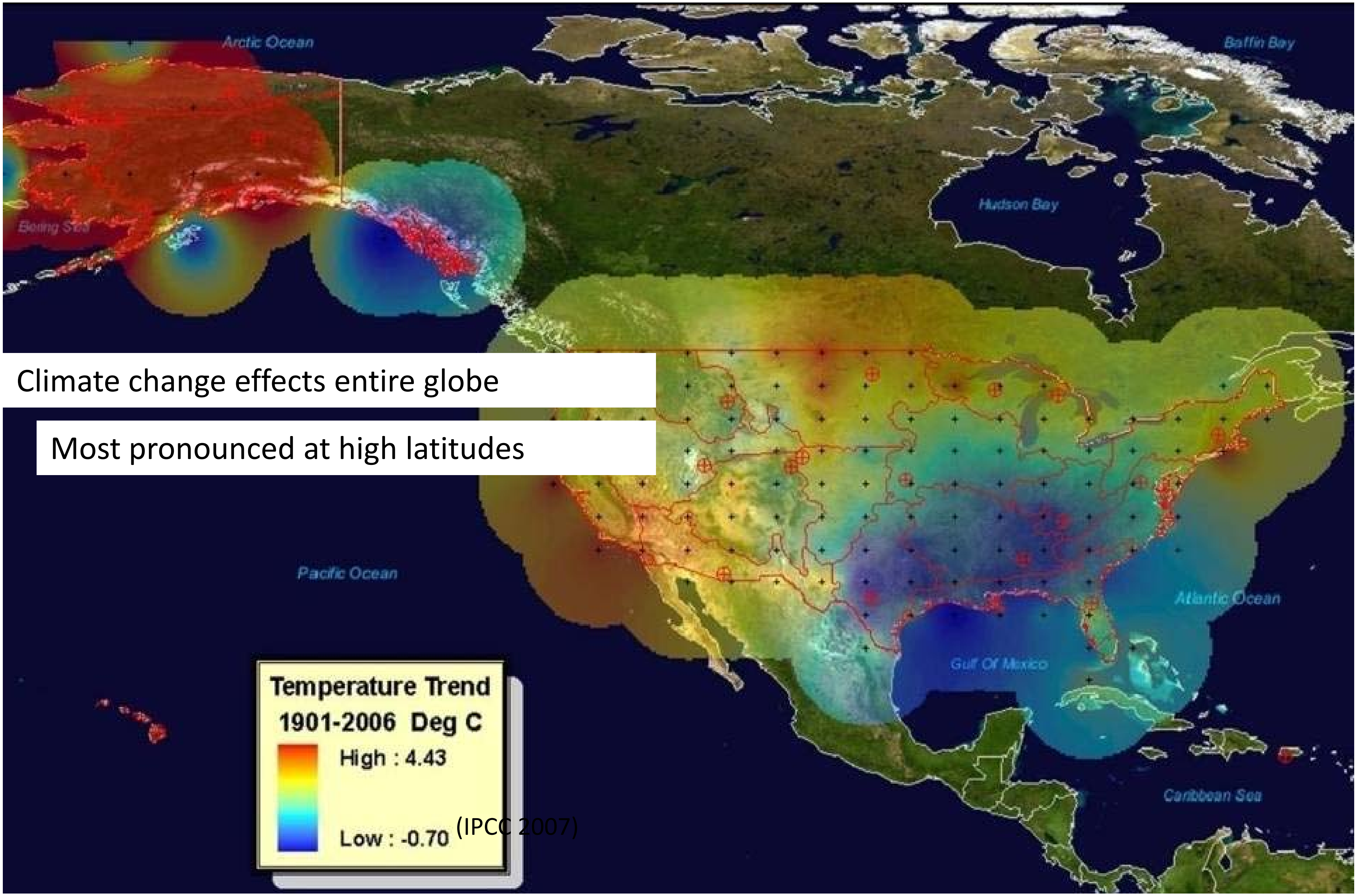


Climate Change and the Arctic



Climate change effects entire globe

Most pronounced at high latitudes

(IPCC 2007)

Effects of Warming on Tundra Plants

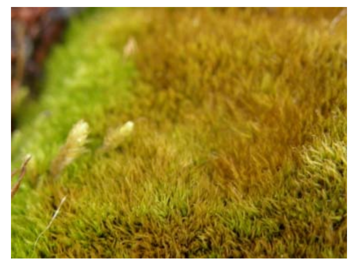
Even small variations in the environment effect community composition and water/nutrient cycling

(Chapin and Shaver, 1985)

Warming shifts community control from facilitation to competition

Graminoids and Shrubs often increase in response to warming, while bryophytes and lichens decrease

(Arft et al, 1999; Hobie and Chapin, 1998)



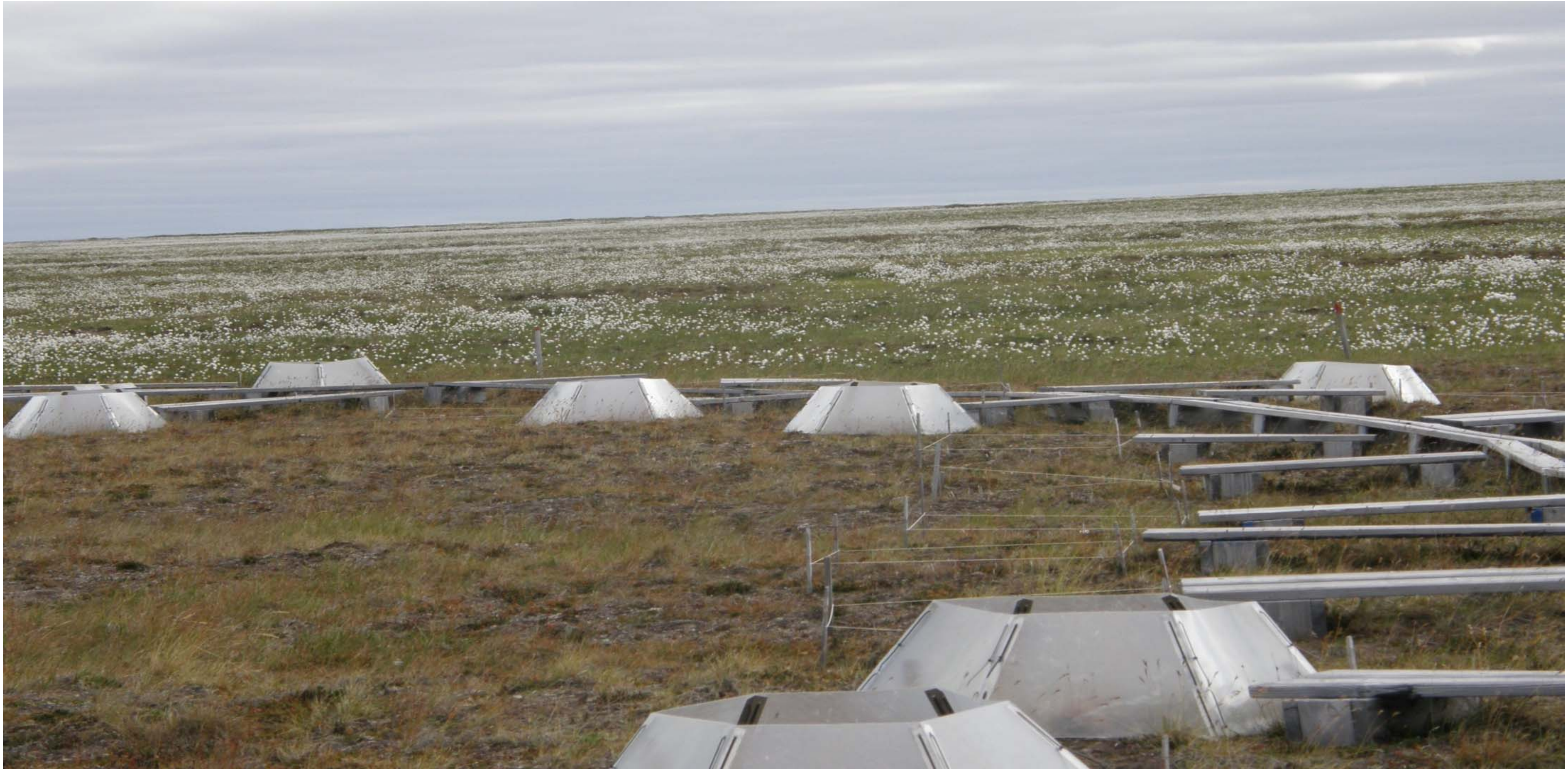
Why do we care?

Plant communities influence other cycles in tundra ecosystems

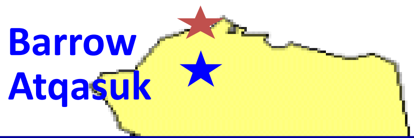
For this study:

We looked the ability of initial and secondary warming responses to predict changes in plant communities over longer time periods

Specifically in diversity indices and individual plant growth forms



Site Locations

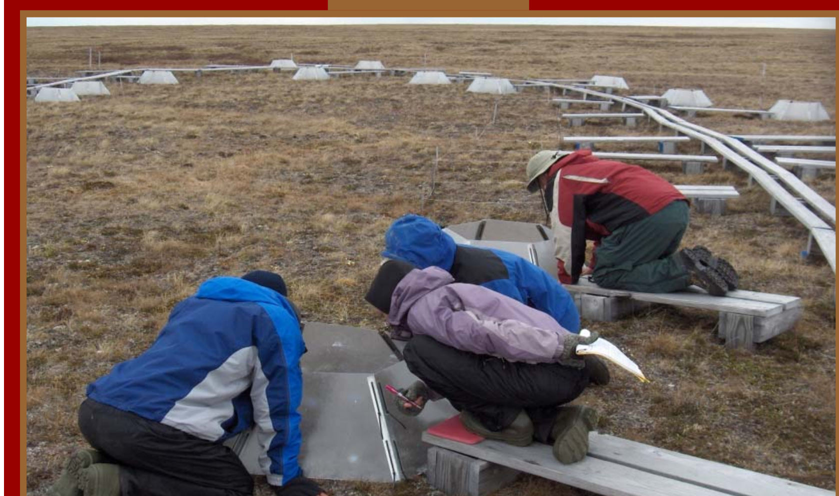


Barrow

DRY

Atqasuk

WET



Site Setup and Warming

24 Warmed and 24 Control plots

All plots are $1m^2$

Open-Top Chambers (OTC)

Warms air temp 1-3^{o}C

Established between 1994-96

Point Frame Method

3 Samplings

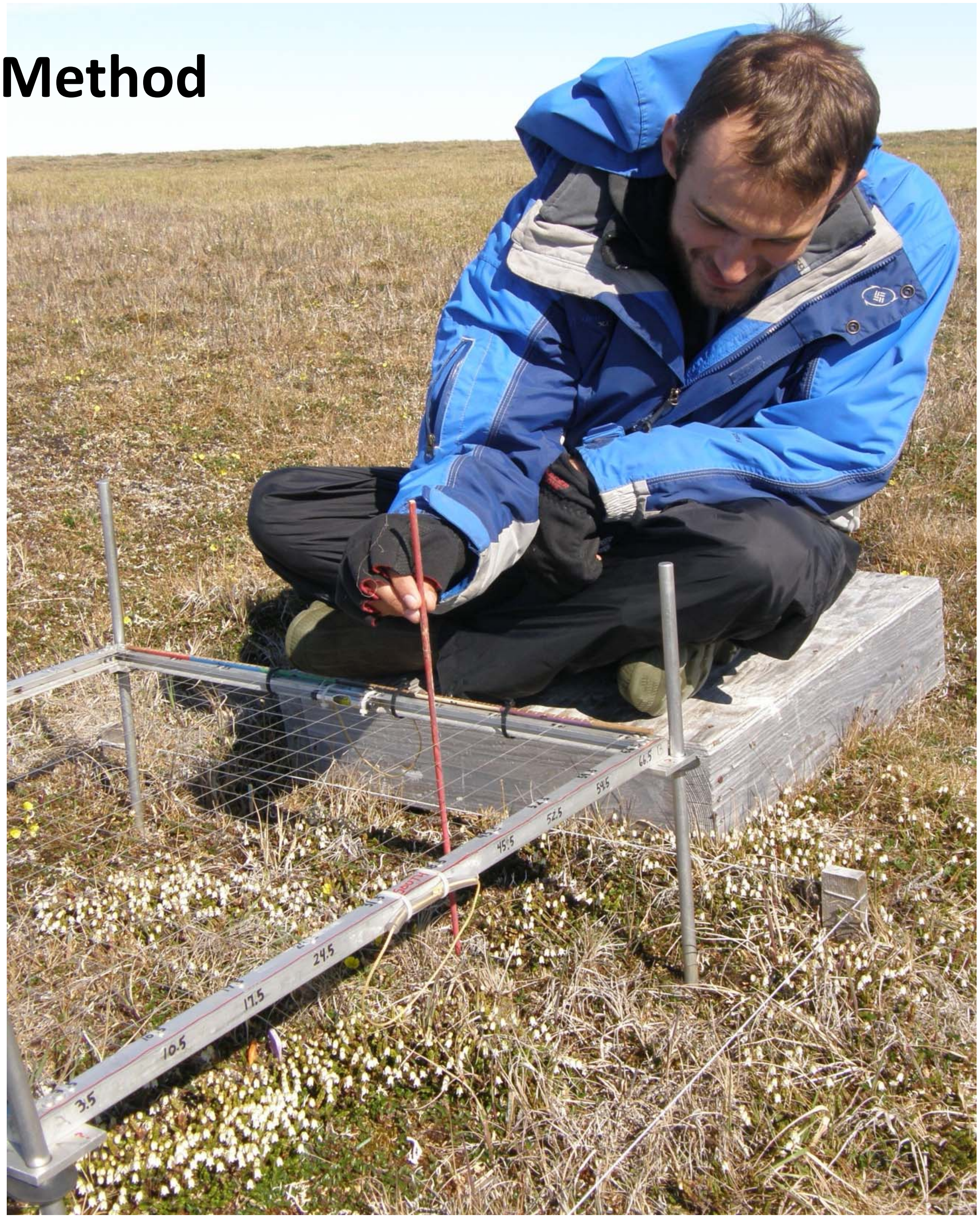
Summers of 1995-96, 2000, and 2007-08

Same 2 weeks each year

Point Frame Grid
-75cm by 75cm
-100 points

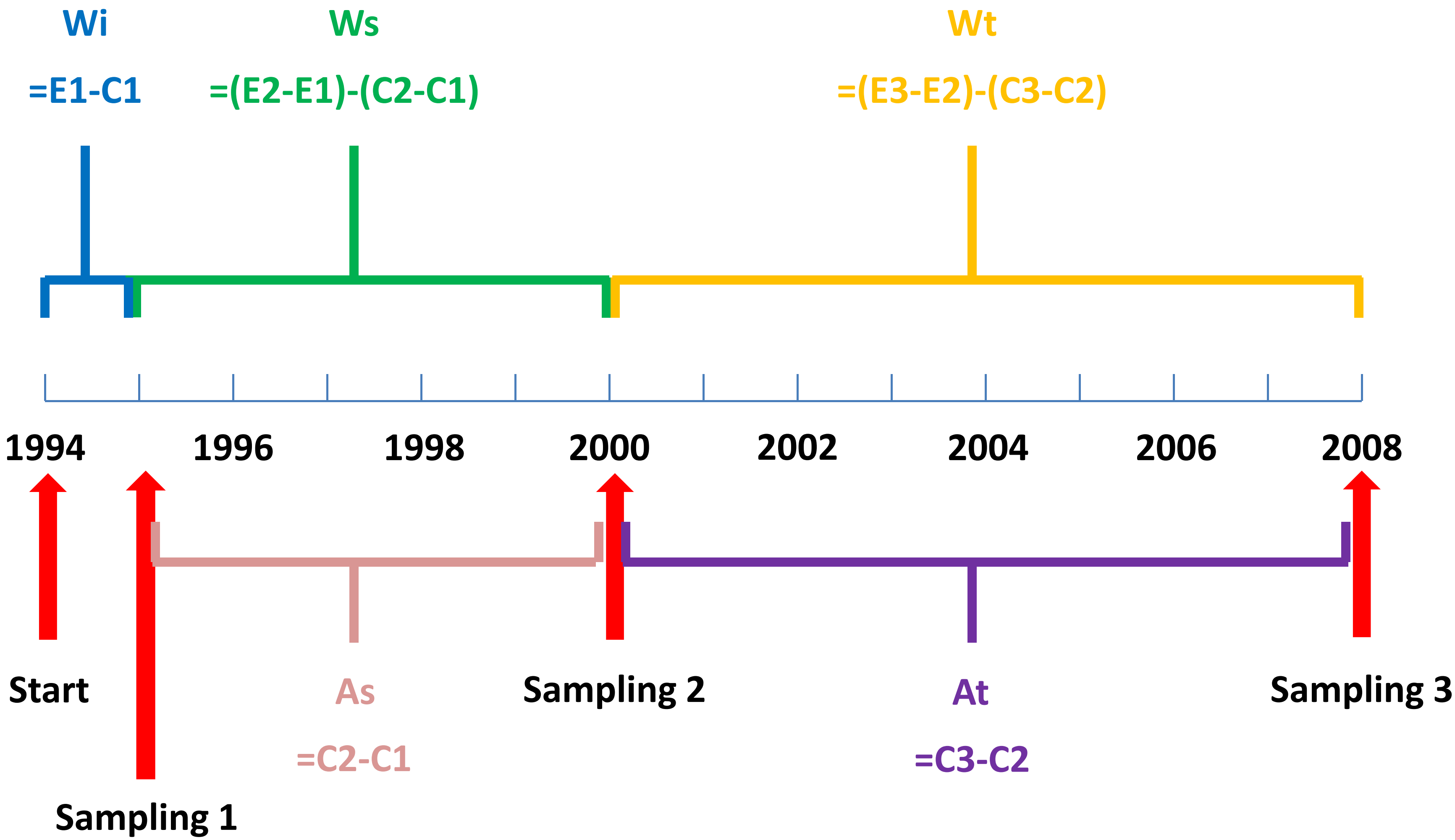
Measurements
-At each point
Top and Bottom contact
Species
Live/Dead Status
Height

(Hollister et al, 2005)



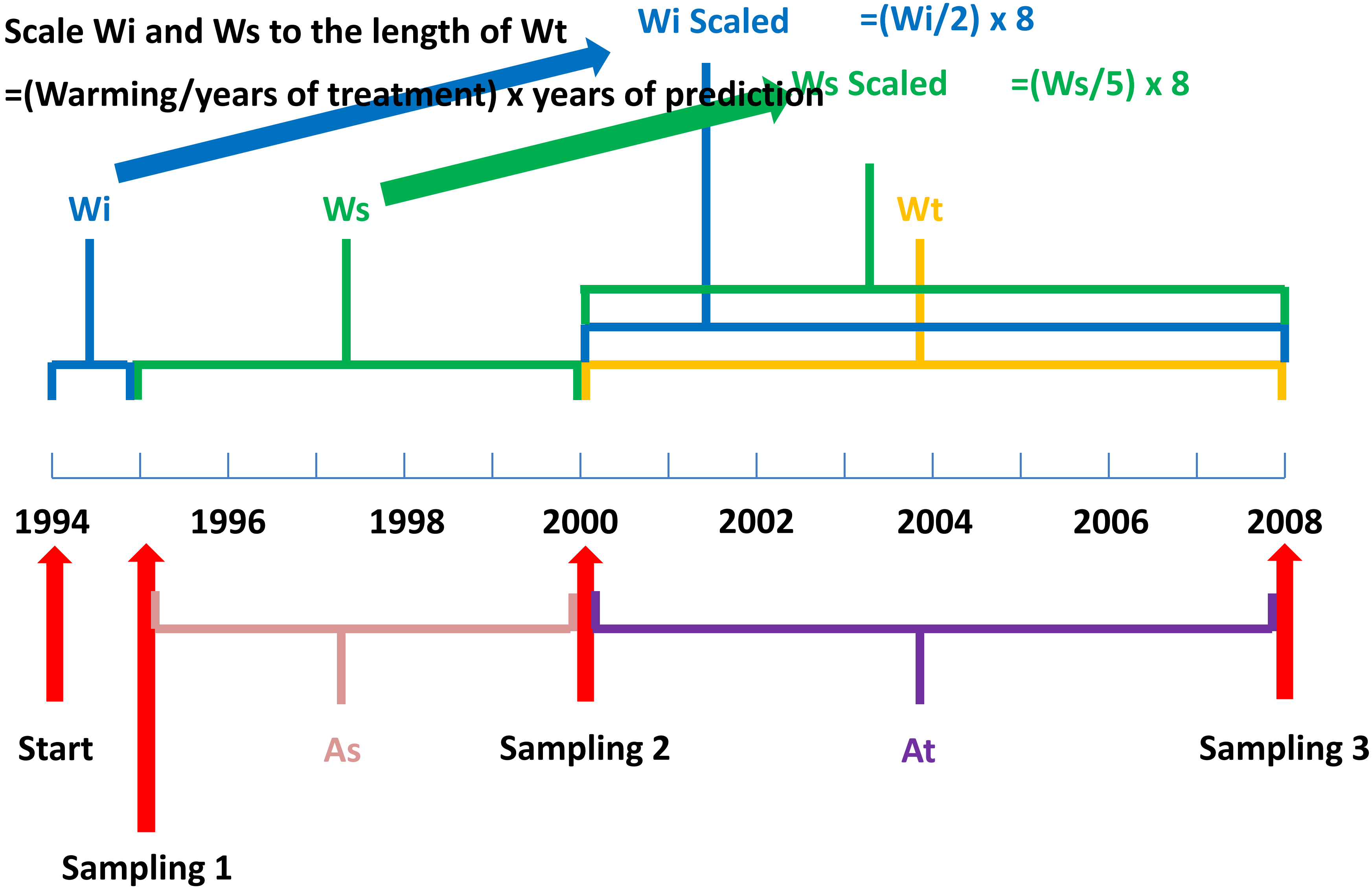
Calculating Estimates For Predictions

Used plant cover averages at each site for each growth form



Let's use the Barrow Dry Site as an example

Calculating Estimates For Predictions

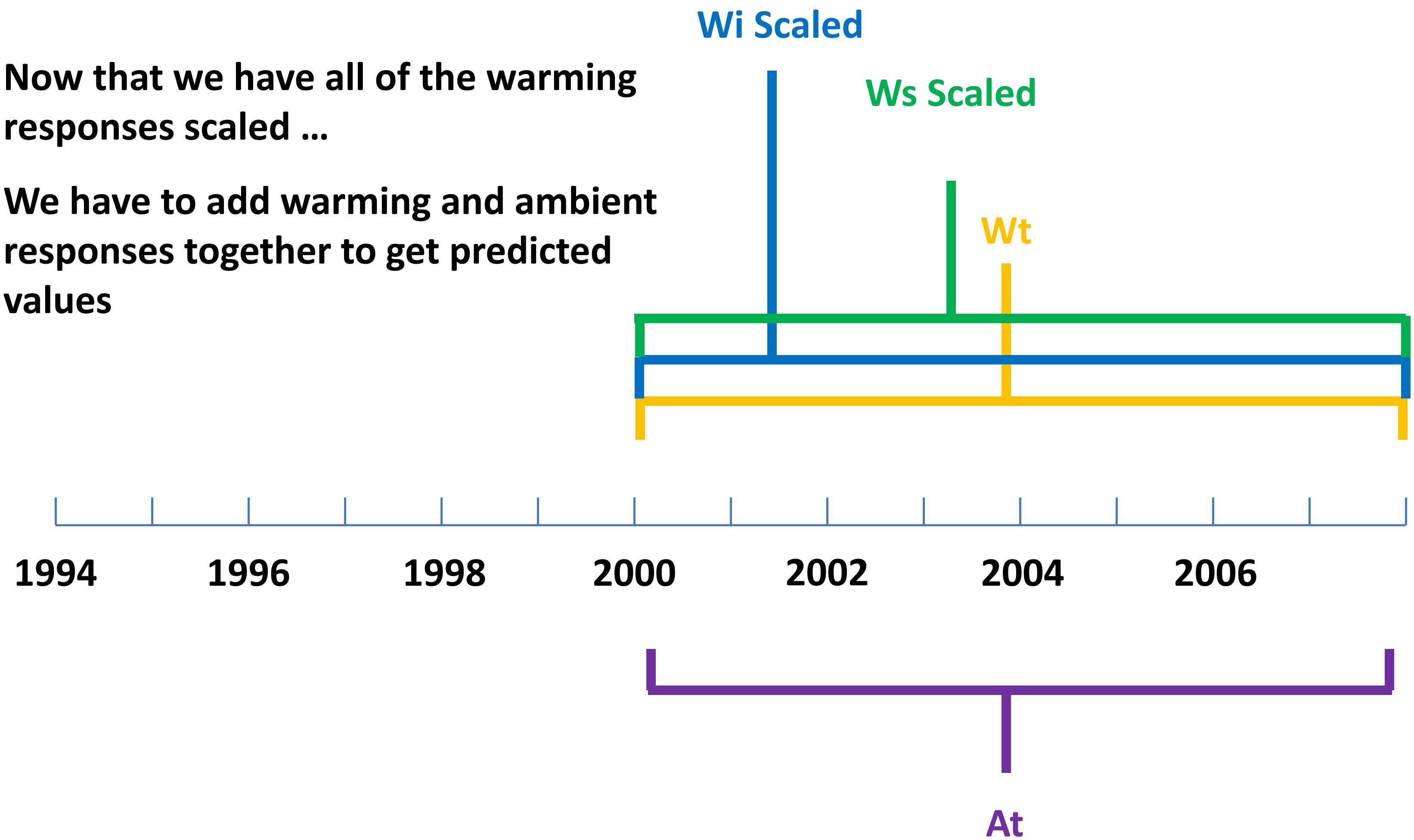


Let's use the Barrow Dry Site as an example

Calculating Estimates For Predictions

Now that we have all of the warming responses scaled …

We have to add warming and ambient responses together to get predicted values



To which we also compared:

E3

WiPredictor = E2 + Wi Scaled + At

WsPredictor = E2 + Ws Scaled + At

WtPredictor= E2 + Wt + At

Diversity Indices

Diversity Index	E3	WtP	WiP	WsP
		Atqasuk Dry Site		
Alive	96.13 A	96.13 A	134.75 B	86.77 A
Dead	31.83 A	31.83 A	42.94 B	31.49 A
Canopy Height	1.36 A	1.36 A	0.80 B	1.20 A
Richness	15.38 A	15.38 A	15.42 A	15.85 A
Simpson	0.88 A	0.88 A	0.69 B	0.87 A
		Atqasuk Wet Site		
Alive	141.38 A	141.38 A	115.85 B	139.70 A
Dead	27.63 A	27.63 A	50.98 C	31.51 A
Canopy Height	7.97 A	7.97 A	8.34 A	6.79 A
Richness	11.29 A	11.29 A	8.85 B	10.68 A
Simpson	0.79 A	0.79 A	0.80 A	0.73 A
		Barrow Dry Site		
Alive	92.42 A	92.42 A	86.92 A	63.19 B
Dead	48.21 A	48.21 A	55.38 C	41.32 B
Canopy Height	1.65 A	1.65 A	1.27 A	2.84 B
Richness	16.96 A	16.96 A	15.71 A	16.82 A
Simpson	0.83 A	0.83 A	0.15 C	0.71 A
		Barrow Wet Site		
Alive	78.42 A	78.42 A	62.63 AB	46.99 B
Dead	85.96 A	85.96 A	96.08 B	88.68 AB
Canopy Height	4.04 A	4.04 A	6.60 B	3.04 C
Richness	14.79 A	14.79 A	13.42 A	17.18 C
Simpson	0.81 A	0.81 A	0.48 C	0.72 A

Diversity Indices

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Atqasuk Dry Site				
Alive	96.13 A	96.13 A	134.75 B	86.77 A
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Atqasuk Wet Site				
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Canopy Height	7.97 A	7.97 A	8.34 A	6.79 A
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Both WiP and WsP were poor predictors and inconsistent

WsP is a slightly better predictor overall

WsP was much better predictor in Atqasuk

Now let’s look at Growth Forms

Growth Form	E3		WtP		WiP		WsP	
Atqasuk Dry Site								
Deciduous Shrubs	0.46	A	0.46	A	-0.48	B	0.91	A
Evergreen Shrubs	33.00	A	33.00	A	41.52	AB	43.93	B
Forbs	1.54	A	1.54	A	1.44	A	2.02	A
Graminoids	15.88	AB	15.88	AB	17.06	A	10.57	C
Bryophytes	7.88	AB	7.88	AB	11.19	A	4.11	B
Lichens	37.38	AB	37.38	AB	64.02	C	25.23	A
Atqasuk Wet Site								
Deciduous Shrubs	6.96	A	6.96	A	1.10	B	9.42	A
Forbs	0.17	A	0.17	A	0.35	A	-0.08	A
Graminoids	39.96	A	39.96	A	32.23	B	45.86	A
Bryophytes	94.08	A	94.08	A	82.06	B	85.20	B
Lichens	0.21	A	0.21	A	-0.04	AB	-0.63	B
Barrow Dry Site								
Deciduous Shrubs	20.00	A	20.00	A	19.79	A	14.90	A
Evergreen Shrubs	23.08	A	23.08	A	36.63	B	21.85	A
Forbs	10.92	A	10.92	A	4.96	B	5.13	B
Graminoids	16.25	A	16.25	A	17.88	A	17.04	A
Bryophytes	6.29	A	6.29	A	-5.50	C	1.39	AB
Lichens	15.88	A	15.88	A	13.17	AB	2.89	C
Barrow Wet Site								
Deciduous Shrubs	1.75	A	1.75	A	1.29	A	1.36	A
Forbs	15.71	A	15.71	A	2.96	B	12.63	A
Graminoids	43.00	A	43.00	A	43.13	A	32.99	A
Bryophytes	16.08	A	16.08	A	14.67	A	-3.30	B
Lichens	1.71	A	1.71	A	0.83	A	2.87	A

Now let's look at Growth Forms

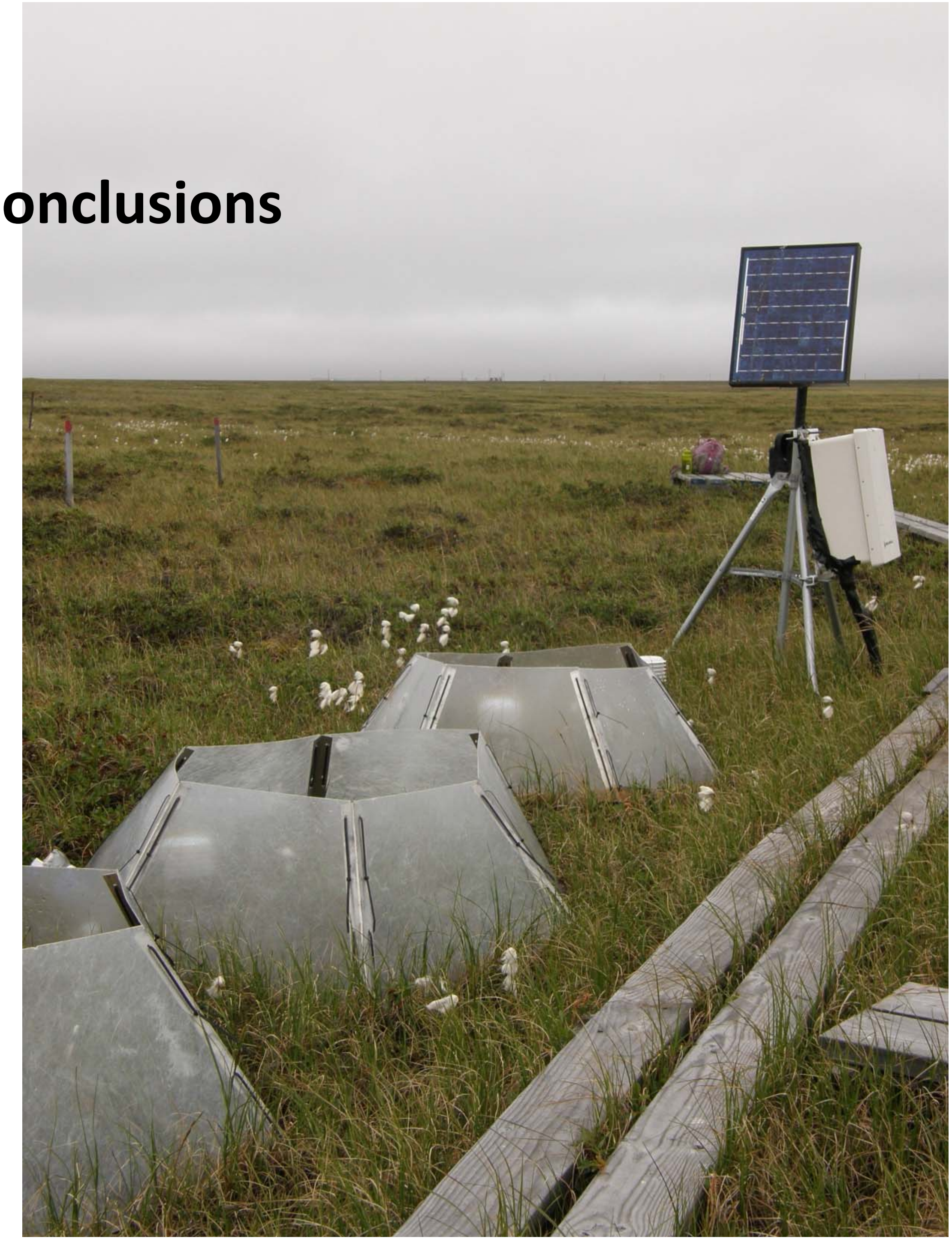
Growth Form	E3	WtP	WiP	WsP
Atqasuk Dry Site				
Deciduous Shrubs	0.46 A	0.46 A	-0.48 B	0.91 A
Evergreen Shrubs	33.00 A	33.00 A	41.52 AB	43.93 B
Forbs	1.54 A	1.54 A	1.44 A	2.02 A
Graminoids	15.88 AB	15.88 AB	17.06 A	10.57 C
Bryophytes	7.88 AB	7.88 AB	11.19 A	4.11 B
Lichens	37.38 AB	37.38 AB	64.02 C	25.23 A
Atqasuk Wet Site				
Deciduous Shrubs	6.96 A	6.96 A	1.10 B	9.42 A
Forbs	0.17 A	0.17 A	0.35 A	-0.08 A
Graminoids	39.96 A	39.96 A	32.23 B	45.86 A
Bryophytes	94.08 A	94.08 A	82.06 B	85.20 B
Lichens	0.21 A	0.21 A	-0.04 AB	-0.63 B
Barrow Dry Site				
Deciduous Shrubs	20.00 A	20.00 A	19.79 A	14.90 A
Evergreen Shrubs	23.08 A	23.08 A	36.63 B	21.85 A
Forbs	10.92 A	10.92 A	4.96 B	5.13 B
Graminoids	16.25 A	16.25 A	17.88 A	17.04 A
Bryophytes	6.29 A	6.29 A	-5.50 C	1.39 AB
Lichens	15.88 A	15.88 A	13.17 AB	2.89 C
Barrow Wet Site				
Deciduous Shrubs	1.75 A	1.75 A	1.29 A	1.36 A
Forbs	15.71 A	15.71 A	2.96 B	12.63 A
Graminoids	43.00 A	43.00 A	43.13 A	32.99 A
Bryophytes	16.08 A	16.08 A	14.67 A	-3.30 B
Lichens	1.71 A	1.71 A	0.83 A	2.87 A

No clear trend when looking at Growth Forms across sites

WiP and WsP are often poor predictors

WsP is a slightly better predictor

Conclusions



Warming responses were often different over time and site specific

Using initial and secondary warming responses as predictors were often inaccurate

Secondary warming responses were slightly better

Acknowledgements

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Questions?