Biomass, NDVI, and LAI Data and Relationships Across Spatial Scales in Arctic Tundra

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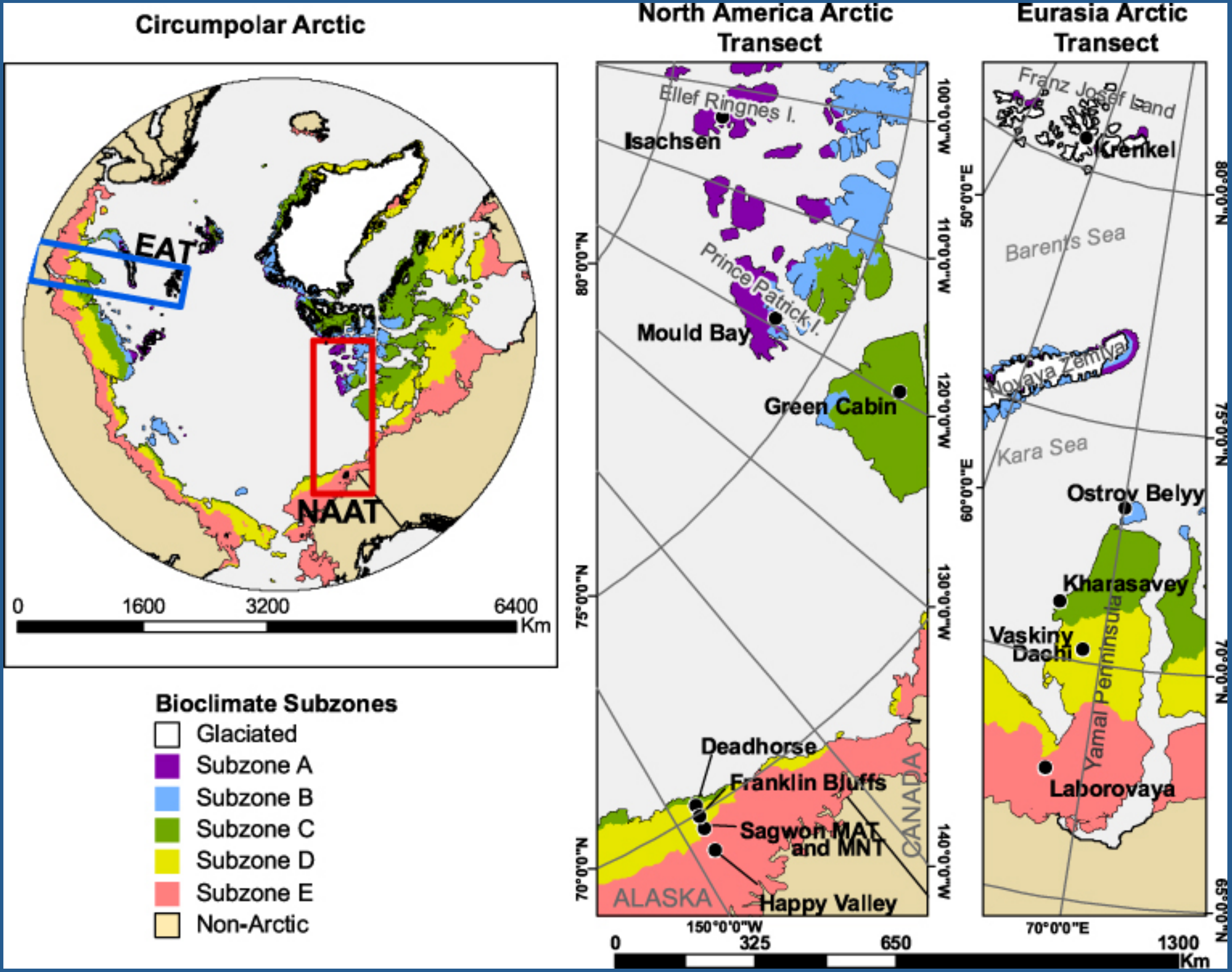
Circumpolar Scale

Data Collection Sites along the North America and Eurasia Arctic Transects



From Walker et al. 2012 (ERL)

North American Arctic Transect

Subzone A
(Isachsen)

Subzone B
(Mould Bay)

Subzone C
(Green Cabin)

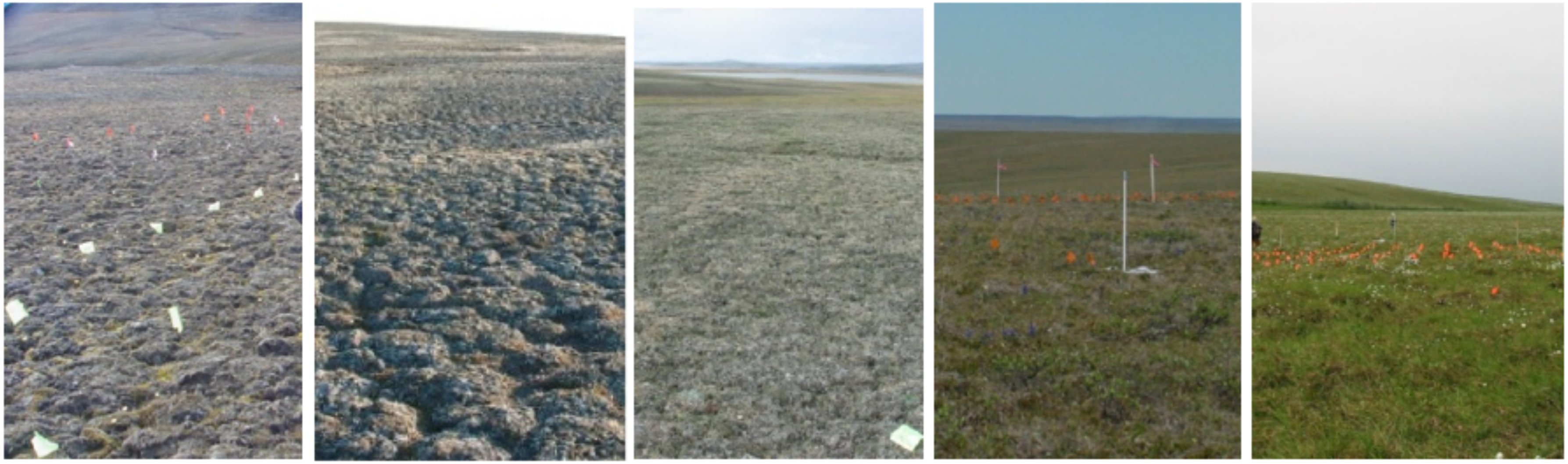
Subzone D

Subzone E

(Photos D.A. Walker and H.E. Epstein)

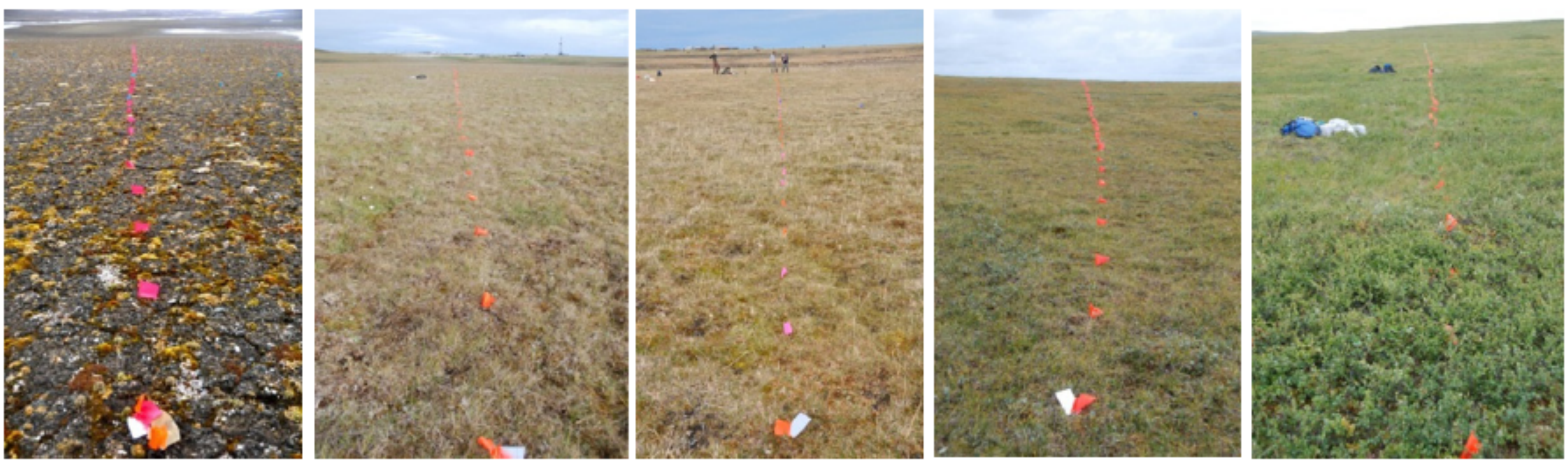
North America Arctic Transect

A - Isachsen | B - Mould Bay | C - Green Cabin | D - Sagwon MNT | E - Happy Valley

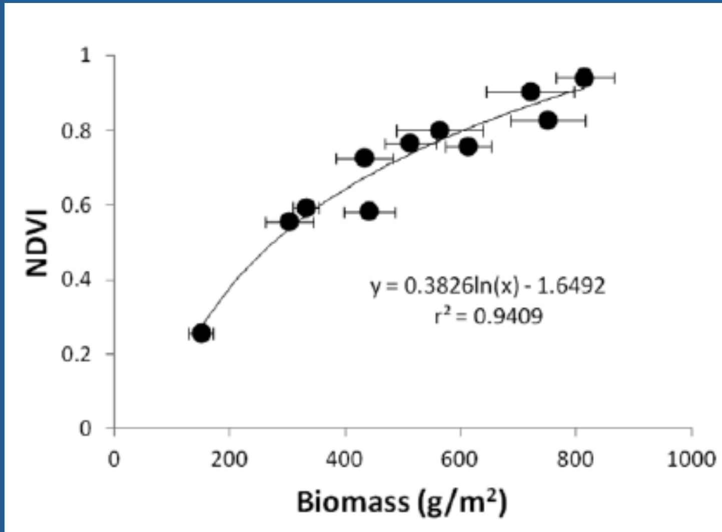


Eurasia Arctic Transect

A - Krenkel | B - Ostrov Belyy | C - Kharasavey | D - Vaskiny Dachi | E - Laborovaya

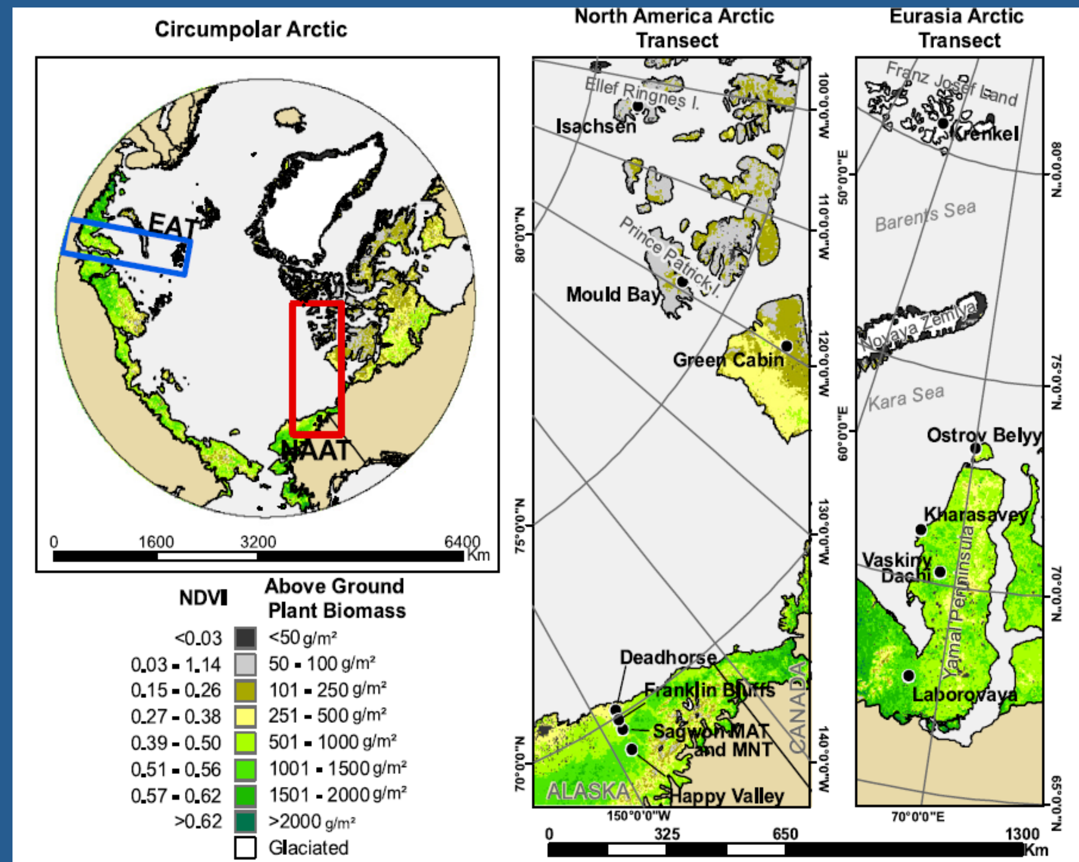


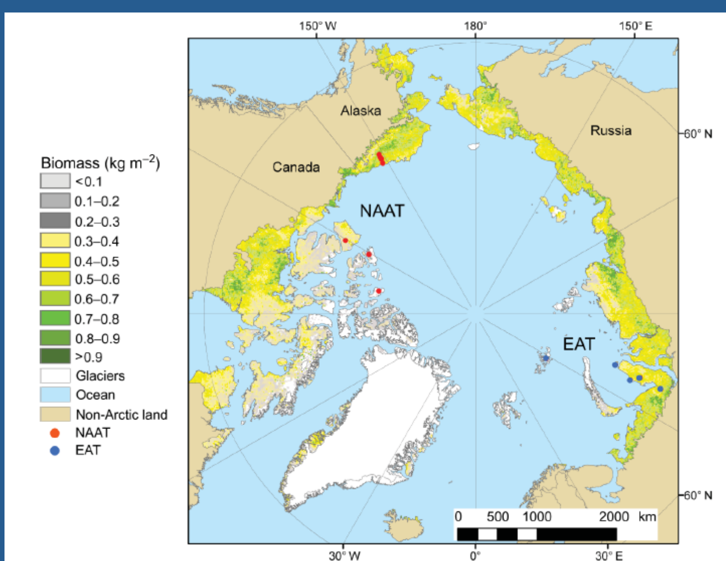
Spatial Biomass Extrapolations using Field-Based Biomass-NDVI Relationships



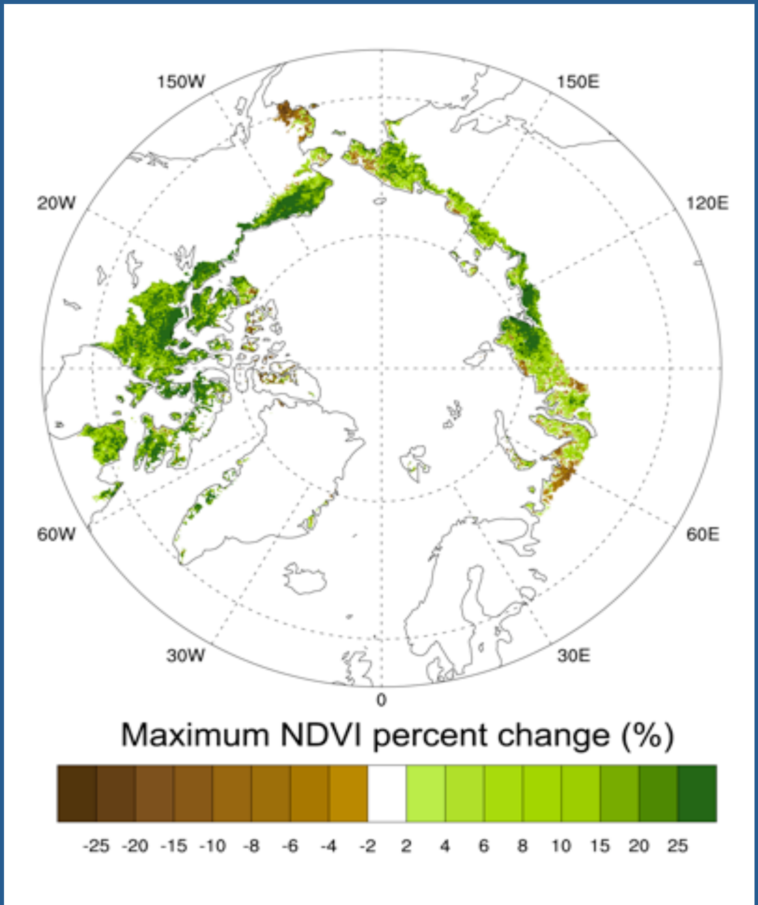
Plot-scale biomass vs. AVHRR

Raynolds et al. 2012 (RSL)
Epstein et al. 2012 (ERL)
Walker et al. 2012 (ERL)

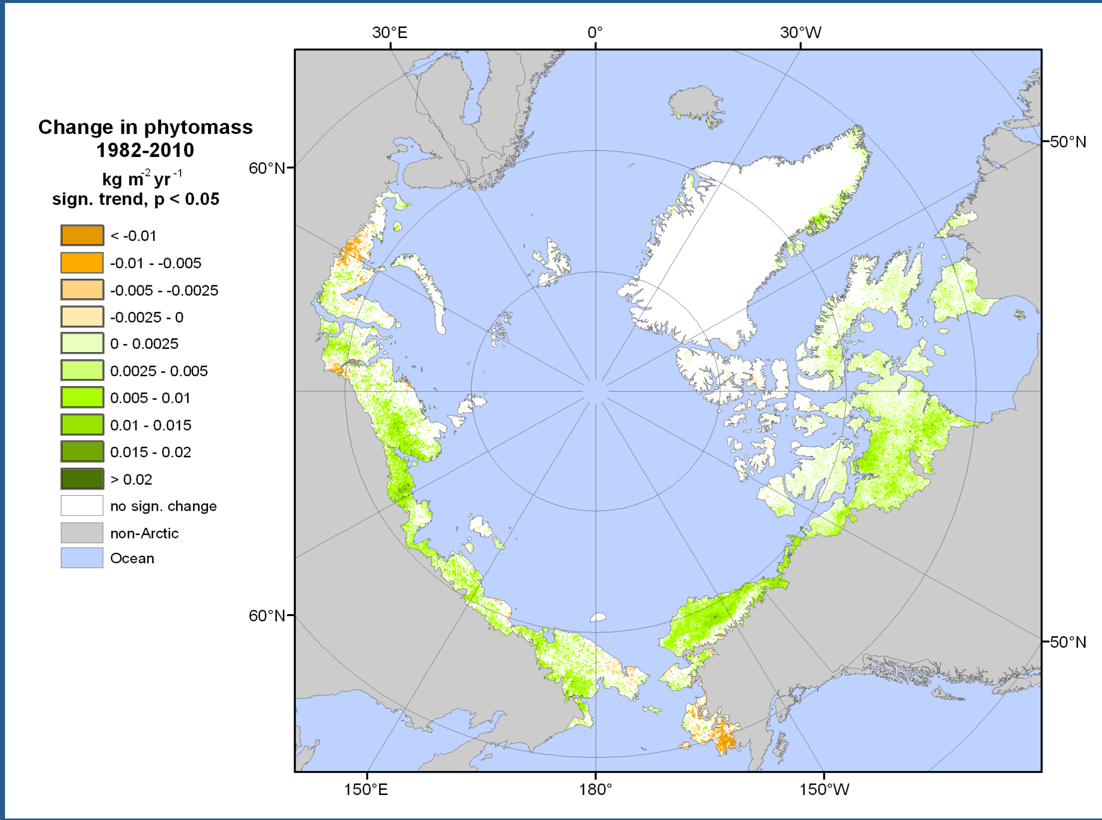




Circumpolar Aboveground Biomass Dynamics



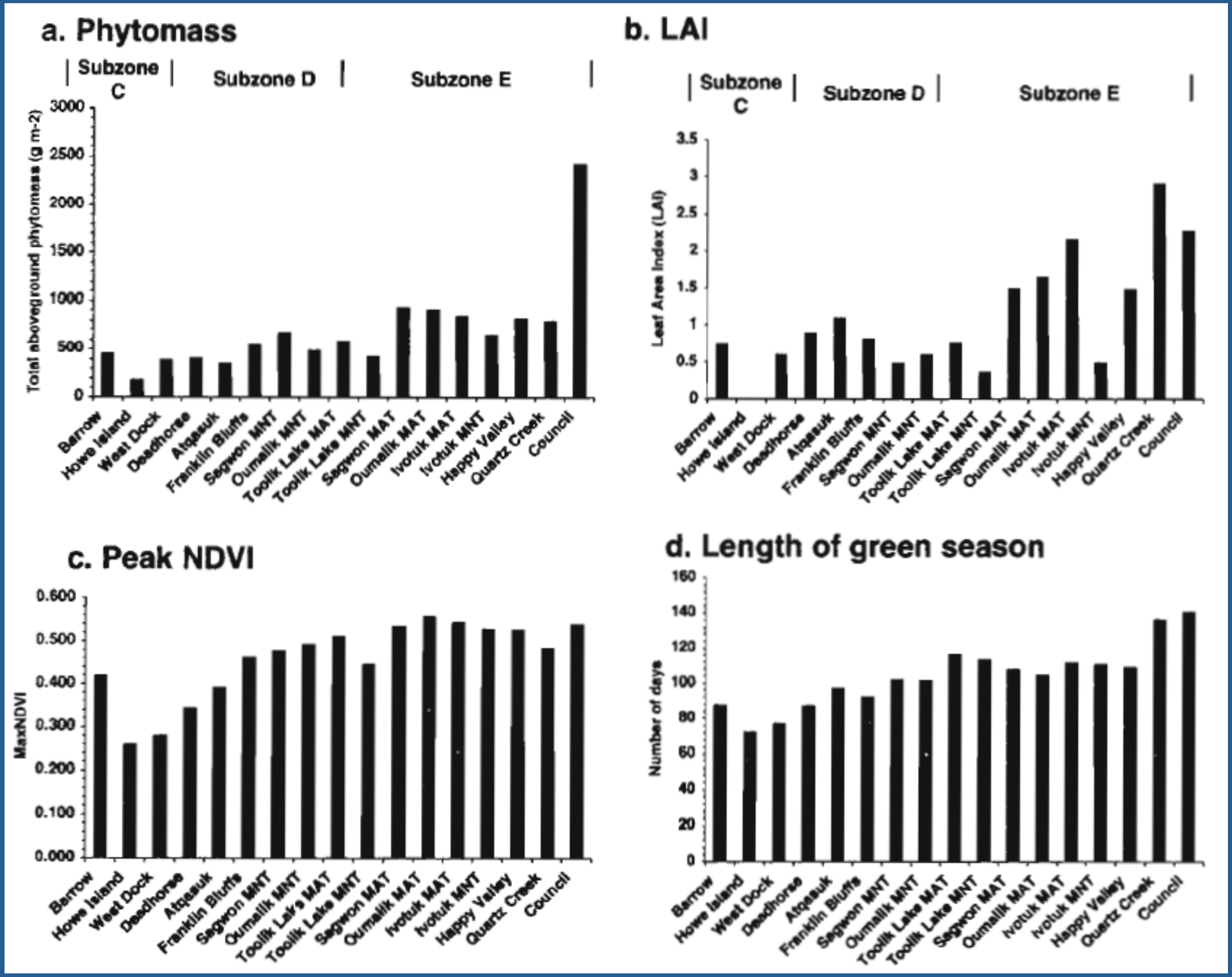
Epstein et al. 2013 (NOAA Arctic Report Card)
Bhatt et al. 2013 (Remote Sensing)



"Greening" since 1982, particularly in the mid- to Low-Arctic (20-26%)
Epstein et al. (2012 ERL)

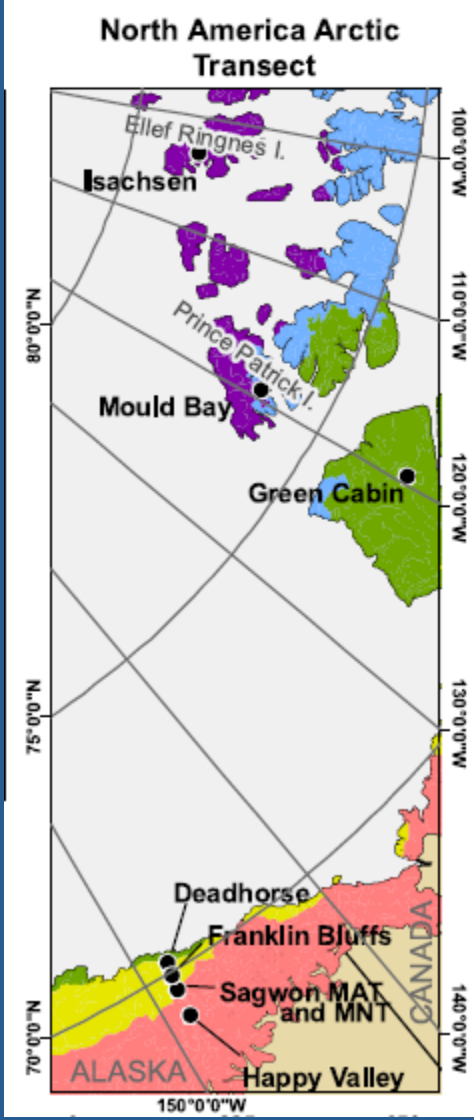
Regional Scale

Data from Primary ATLAS Sites (northern Alaska)



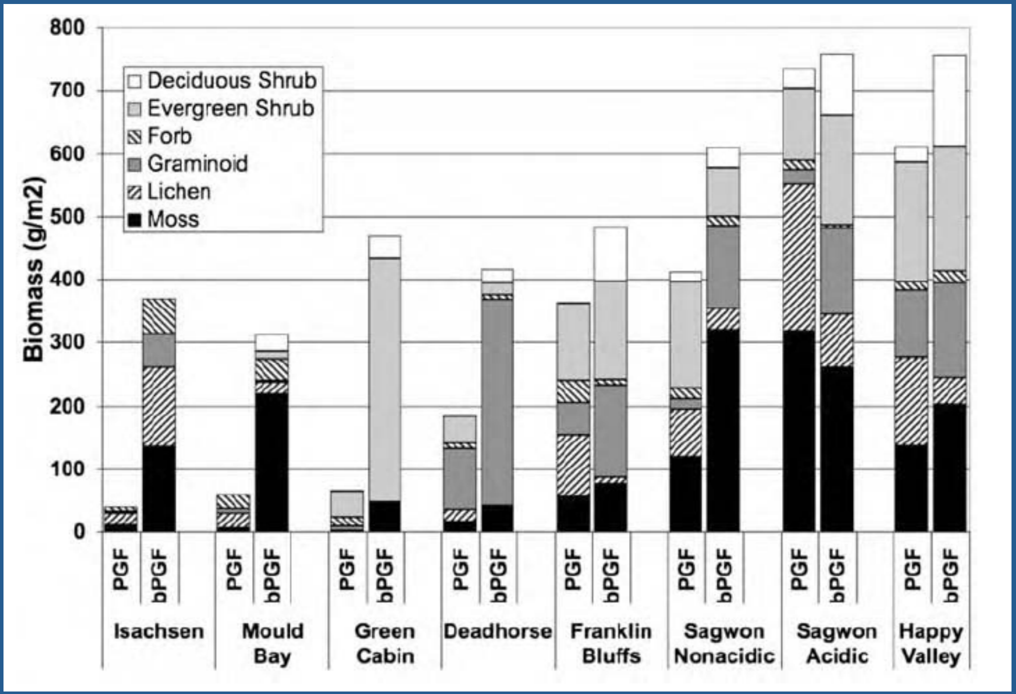
(from Walker et al. 2003 PPP)
(also Walker et al. 2003 JGR, Edwards et al. 2000 and Raynolds et al. 2002 ATLAS Data Reports)

NSF Biocomplexity of Patterned Ground – further development and completion of the North American Arctic Transect (NAAT)

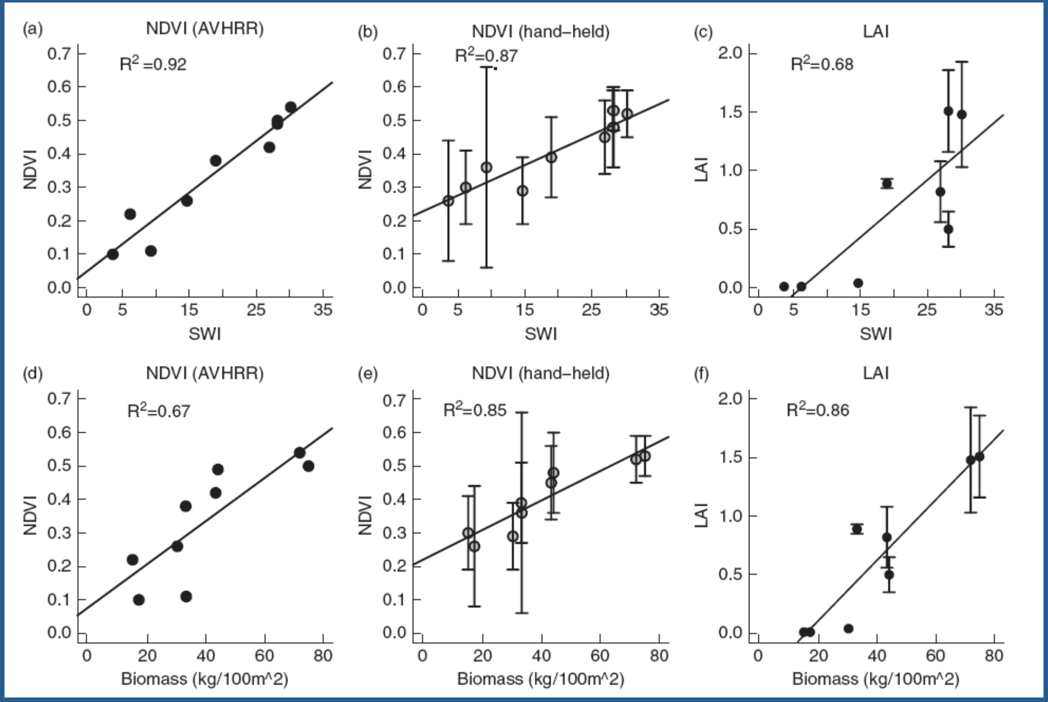


Biocomplexity of Patterned Ground
Data Report
Dalton Highway, 2001-2005

NAAT Synthesis – Biomass, NDVI, and LAI (including patterned ground)

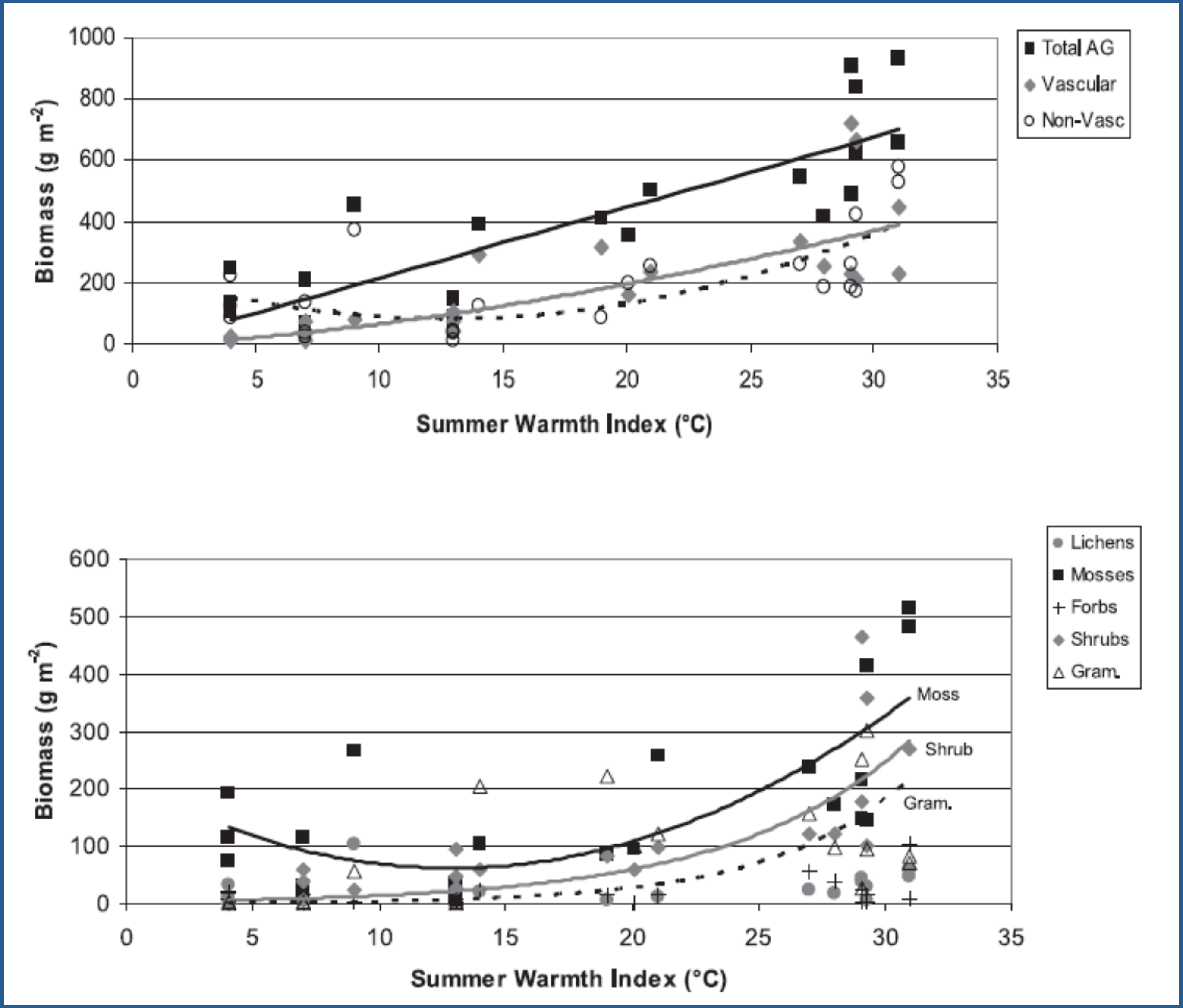


(Walker et al. 2008 JGR)



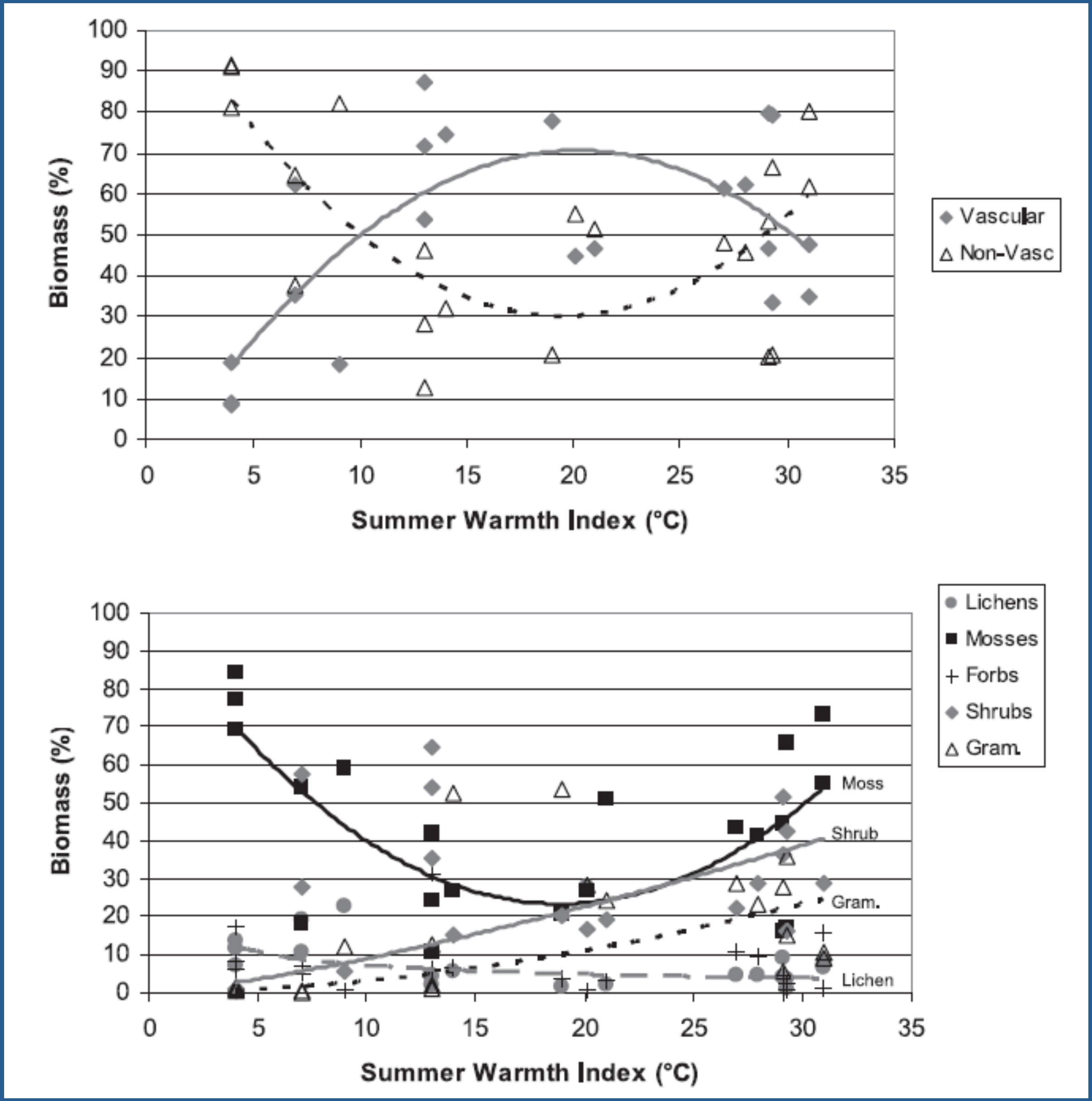
(Walker et al. 2011 AVS)

NAAT Synthesis – Vegetation Type Biomass (absolute) vs. SWI



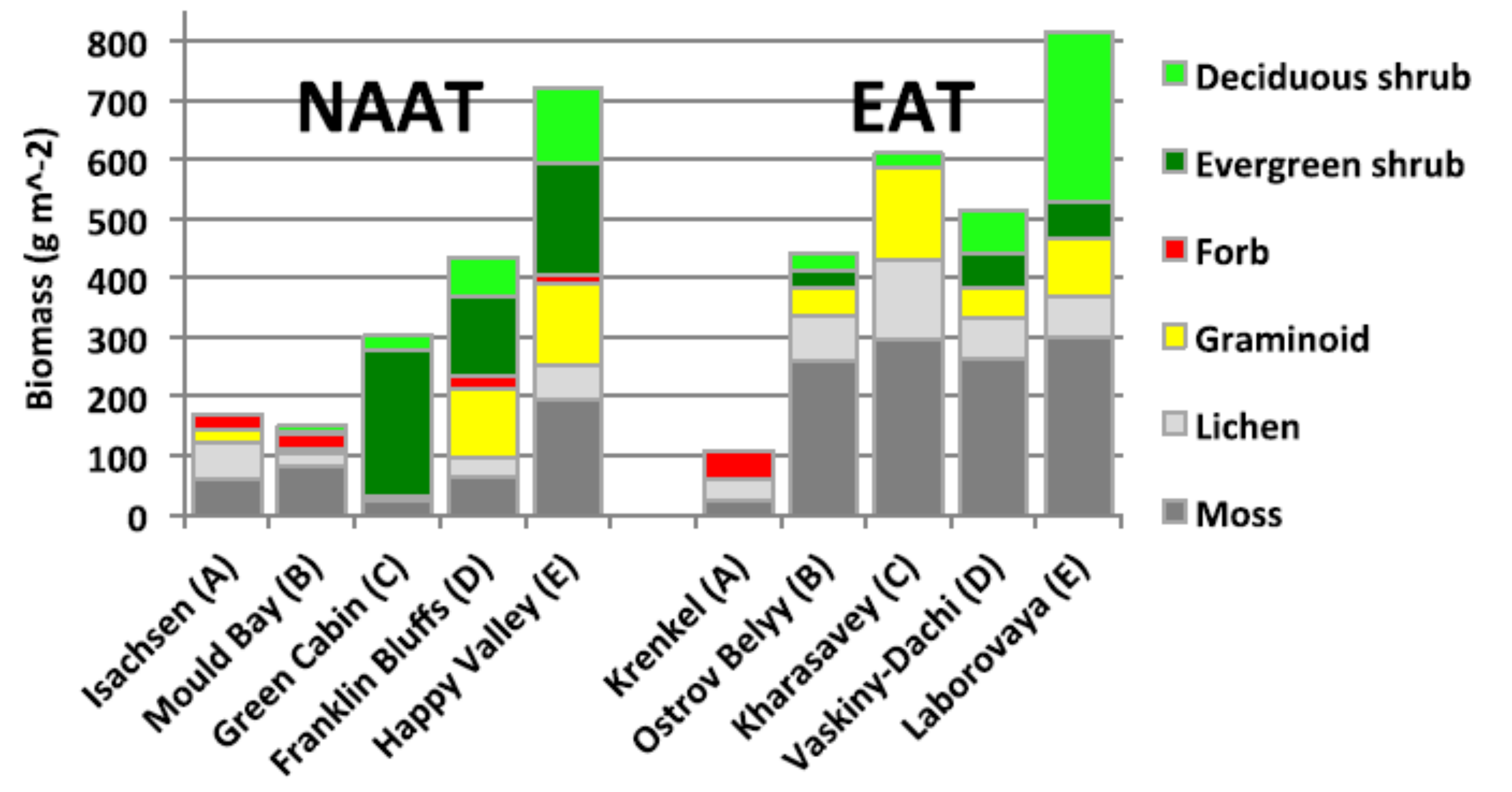
(Epstein et al. 2008 JGR)

NAAT Synthesis – Vegetation Type Biomass (relative) vs. SWI



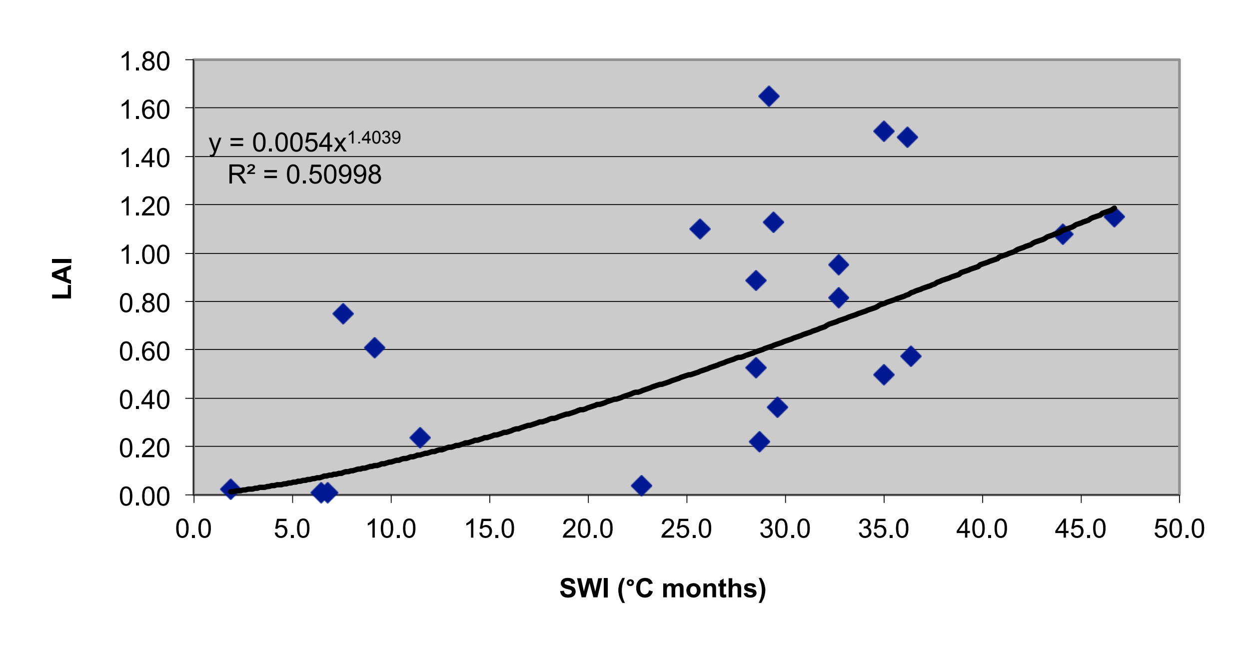
(Epstein et al. 2008 JGR)

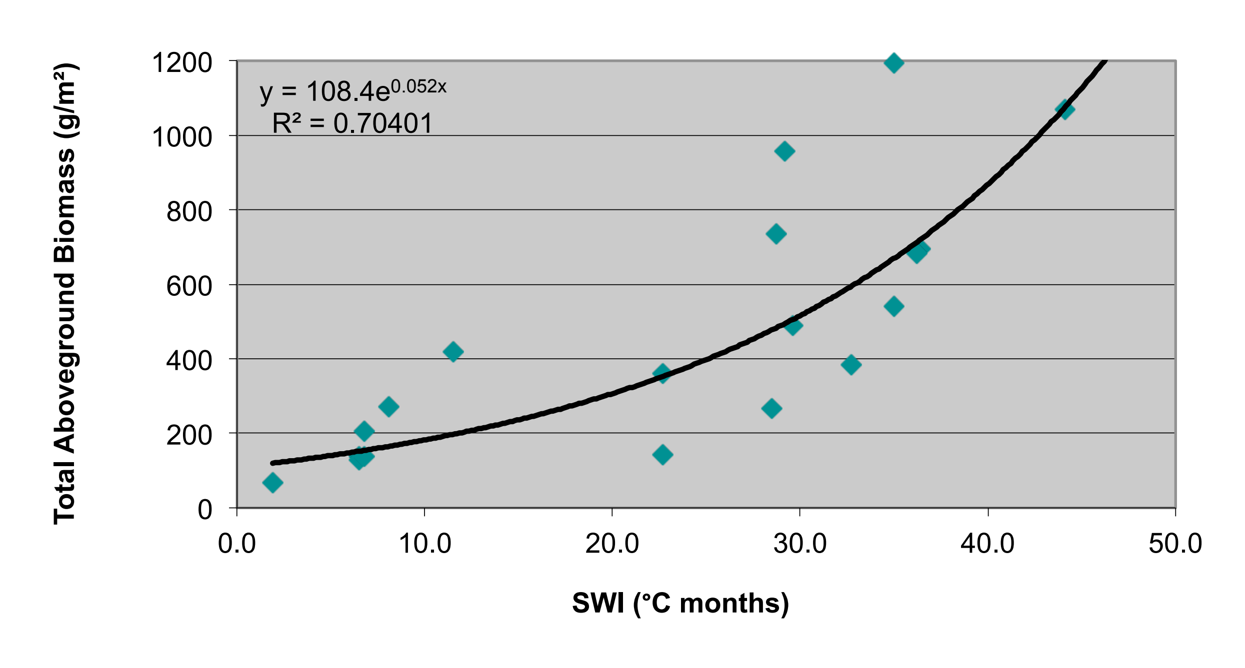
Comparison with Eurasian Arctic Transect (2007-2010)



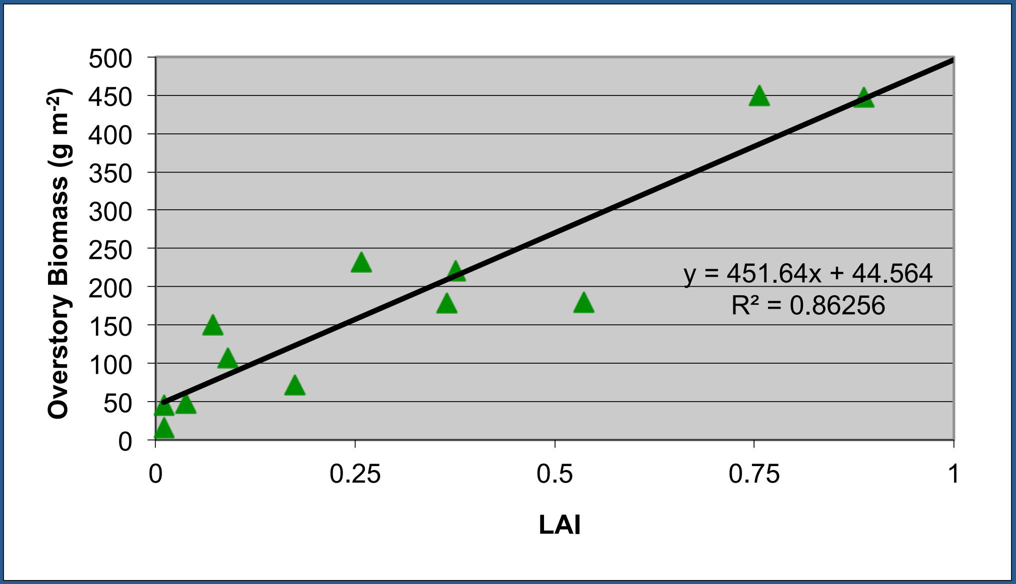
Walker et al. 2012 (ERL)

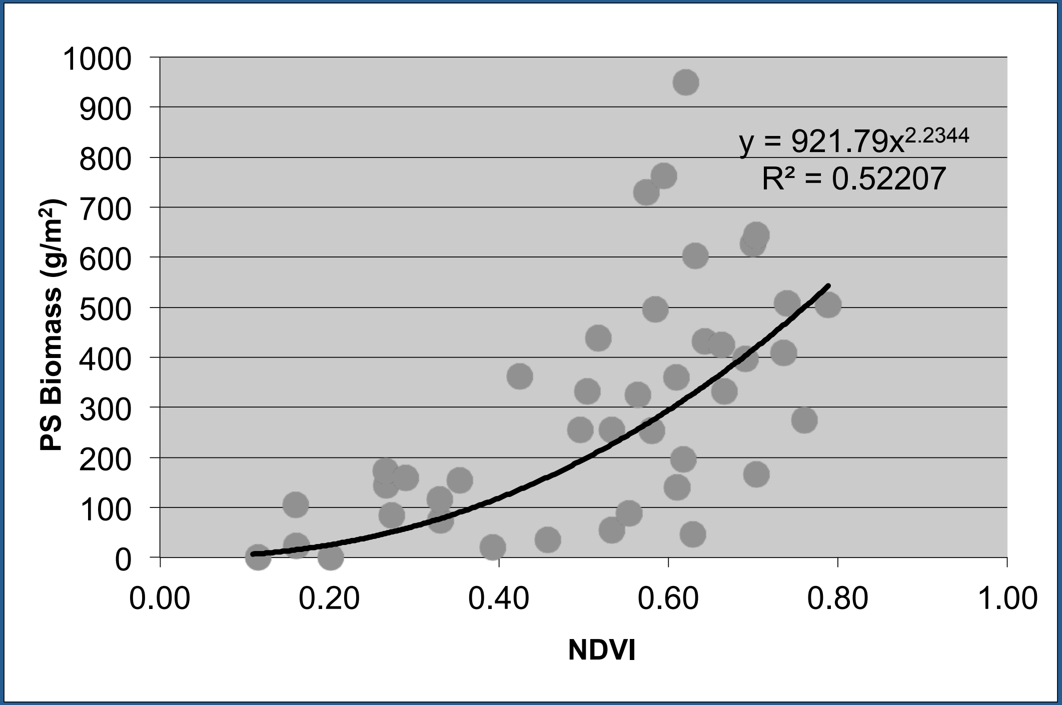
LAI and Total Aboveground Biomass along both transects





Relationships between LAI / NDVI (hand-held) and biomass



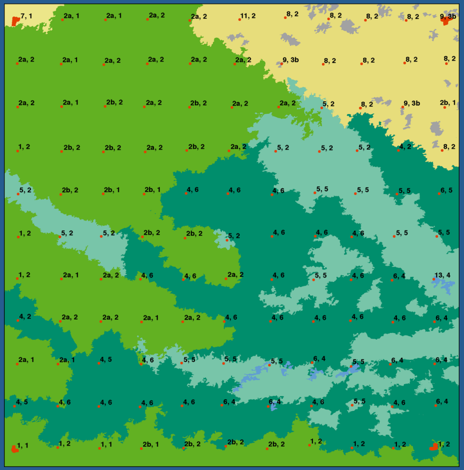


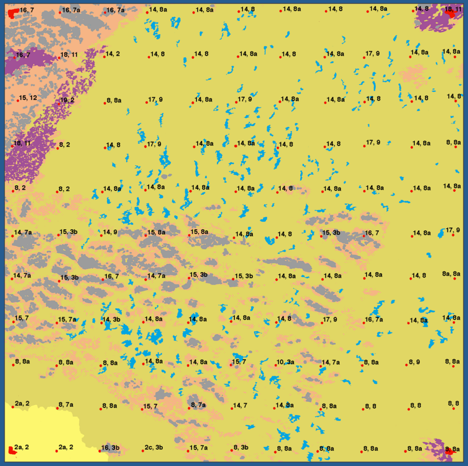
Landscape Scale

Ivotuk (Western Alaska Transect – Subzone E) 1999

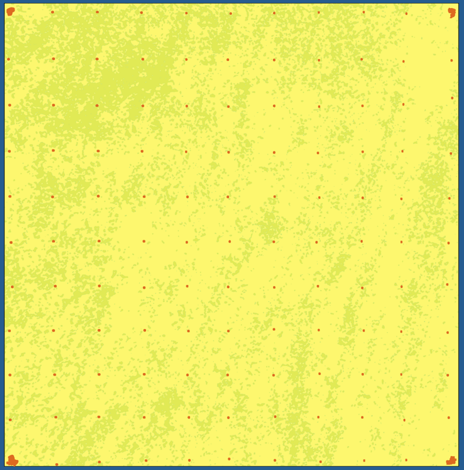
Ivotuk MAT (photo by D.A. Walker)
www.geobotany.uaf.edu/atlas/atlas_sites.html

Ivotuk Shrub Tundra

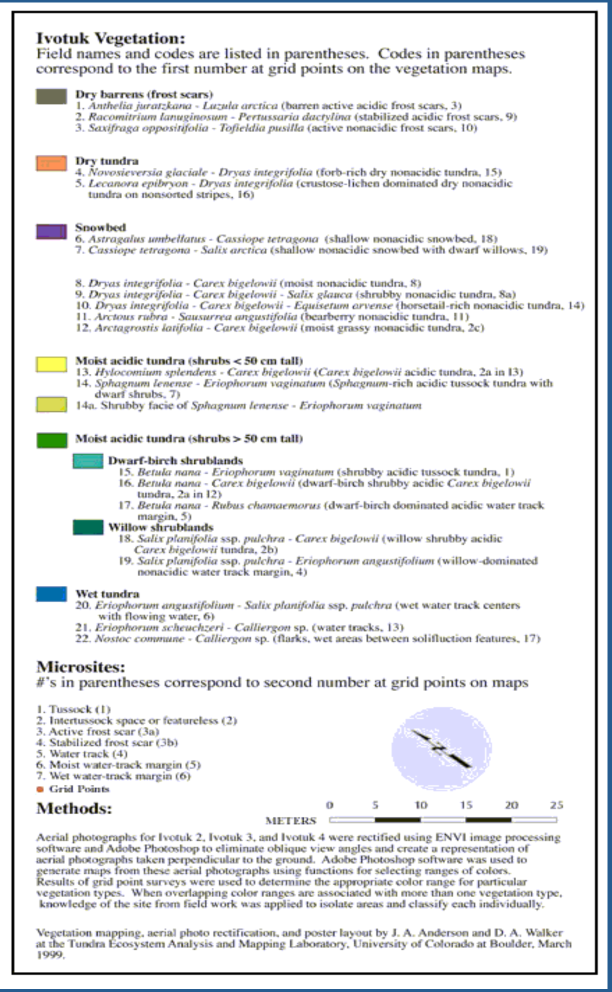




Ivotuk Mossy Tussock Tundra



Ivotuk MNT



Ivotuk Vegetation:
Field names and codes are listed in parentheses. Codes in parentheses correspond to the first number at grid points on the vegetation maps.

Dry barrens (frost scars)
1. *Anthelia juratzkana - Luzula arctica* (barren active acidic frost scars, 3)
2. *Racomitrium lanuginosum - Pertussaria dactylina* (stabilized acidic frost scars, 9)
3. *Saxifraga oppositifolia - Tofieldia pusilla* (active nonacidic frost scars, 10)

Dry tundra
4. *Novosieversia glaciale - Dryas integrifolia* (forb-rich dry nonacidic tundra, 15)
5. *Lecanora epibryon - Dryas integrifolia* (crustose-lichen dominated dry nonacidic tundra on nonsorted stripes, 16)

Snowbed
6. *Astragalus umbellatus - Cassiope tetragona* (shallow nonacidic snowbed, 18)
7. *Cassiope tetragona - Salix arctica* (shallow nonacidic snowbed with dwarf willows, 19)

8. *Dryas integrifolia - Carex bigelowii* (moist nonacidic tundra, 8)
9. *Dryas integrifolia - Carex bigelowii - Salix glauca* (shrubby nonacidic tundra, 8a)
10. *Dryas integrifolia - Carex bigelowii - Equisetum arvense* (horsetail-rich nonacidic tundra, 14)
11. *Arctous rubra - Sausurrea angustifolia* (bearberry nonacidic tundra, 11)
12. *Arctagrostis latifolia - Carex bigelowii* (moist grassy nonacidic tundra, 2c)

Moist acidic tundra (shrubs < 50 cm tall)
13. *Hylocomium splendens - Carex bigelowii* (*Carex bigelowii* acidic tundra, 2a in 13)
14. *Sphagnum lenense - Eriophorum vaginatum* (*Sphagnum*-rich acidic tussock tundra with dwarf shrubs, 7)

14a. Shrubby facie of *Sphagnum lenense - Eriophorum vaginatum*

Moist acidic tundra (shrubs > 50 cm tall)

Dwarf-birch shrublands
15. *Betula nana - Eriophorum vaginatum* (shrubby acidic tussock tundra, 1)
16. *Betula nana - Carex bigelowii* (dwarf-birch shrubby acidic *Carex bigelowii* tundra, 2a in 12)
17. *Betula nana - Rubus chamaemorus* (dwarf-birch dominated acidic water track margin, 5)

Willow shrublands
18. *Salix planifolia* ssp. *pulchra - Carex bigelowii* (willow shrubby acidic *Carex bigelowii* tundra, 2b)
19. *Salix planifolia* ssp. *pulchra - Eriophorum angustifolium* (willow-dominated nonacidic water track margin, 4)

Wet tundra
20. *Eriophorum angustifolium - Salix planifolia* ssp. *pulchra* (wet water track centers with flowing water, 6)
21. *Eriophorum scheuchzeri - Calliergon* sp. (water tracks, 13)
22. *Nostoc commune - Calliergon* sp. (flarks, wet areas between solifluction features, 17)

Microsites:
#'s in parentheses correspond to second number at grid points on maps

1. Tussock (1)
2. Intertussock space or featureless (2)
3. Active frost scar (3a)
4. Stabilized frost scar (3b)
5. Water track (4)
6. Moist water-track margin (5)
7. Wet water-track margin (6)

● Grid Points

METERS 0 5 10 15 20 25

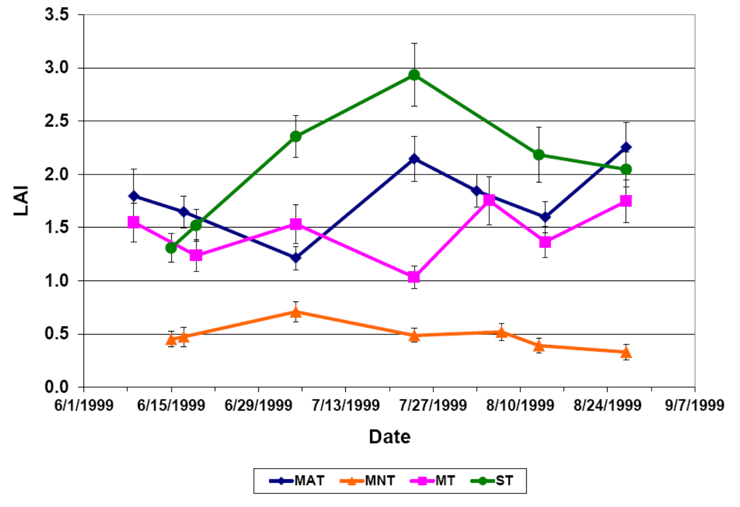
Methods:

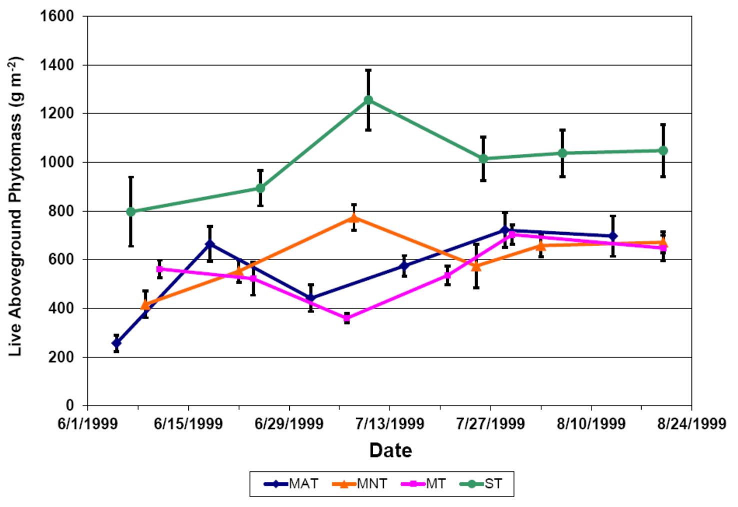
Aerial photographs for Ivotuk 2, Ivotuk 3, and Ivotuk 4 were rectified using ENVI image processing software and Adobe Photoshop to eliminate oblique view angles and create a representation of aerial photographs taken perpendicular to the ground. Adobe Photoshop software was used to generate maps from these aerial photographs using functions for selecting ranges of colors. Results of grid point surveys were used to determine the appropriate color range for particular vegetation types. When overlapping color ranges are associated with more than one vegetation type, knowledge of the site from field work was applied to isolate areas and classify each individually.

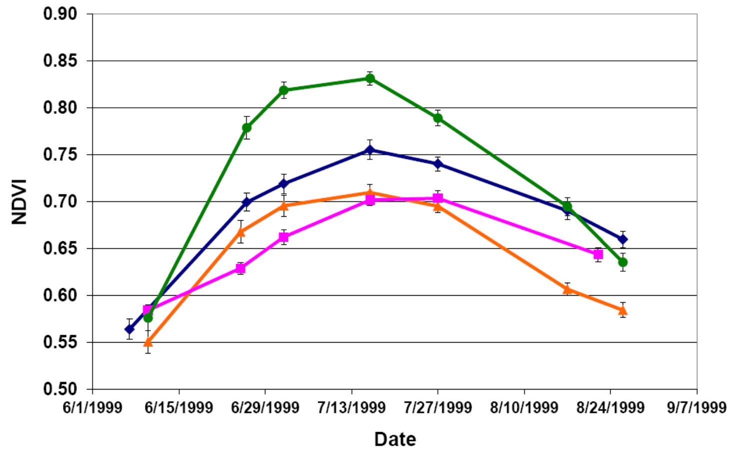
Vegetation mapping, aerial photo rectification, and poster layout by J. A. Anderson and D. A. Walker at the Tundra Ecosystem Analysis and Mapping Laboratory, University of Colorado at Boulder, March 1999.

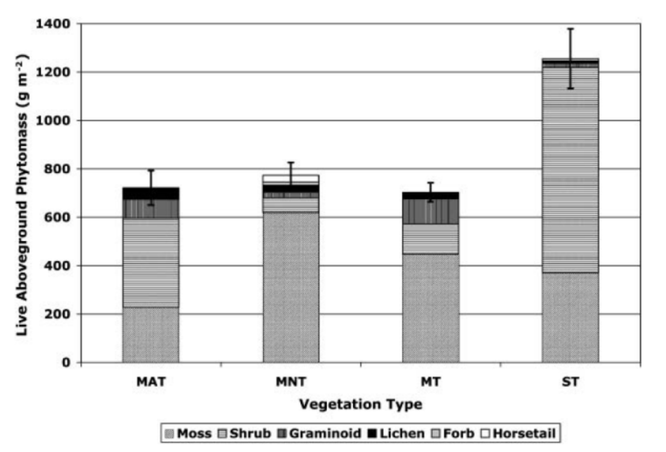
Ivotuk (Western Alaska Transect – Subzone E) 1999

- Four 100 x 100 m grids (MAT, MNT, ST, MT)
- LAI and NDVI collected bi-weekly at 20 random grid points
  (same grid points sampled at each time period)
- Biomass samples were harvested bi-weekly near 10 of the 20 random grid points
  (again, same grid points used each time period)
  (20 x 50 cm quadrats – all 20 grid points sampled at peak growing season)

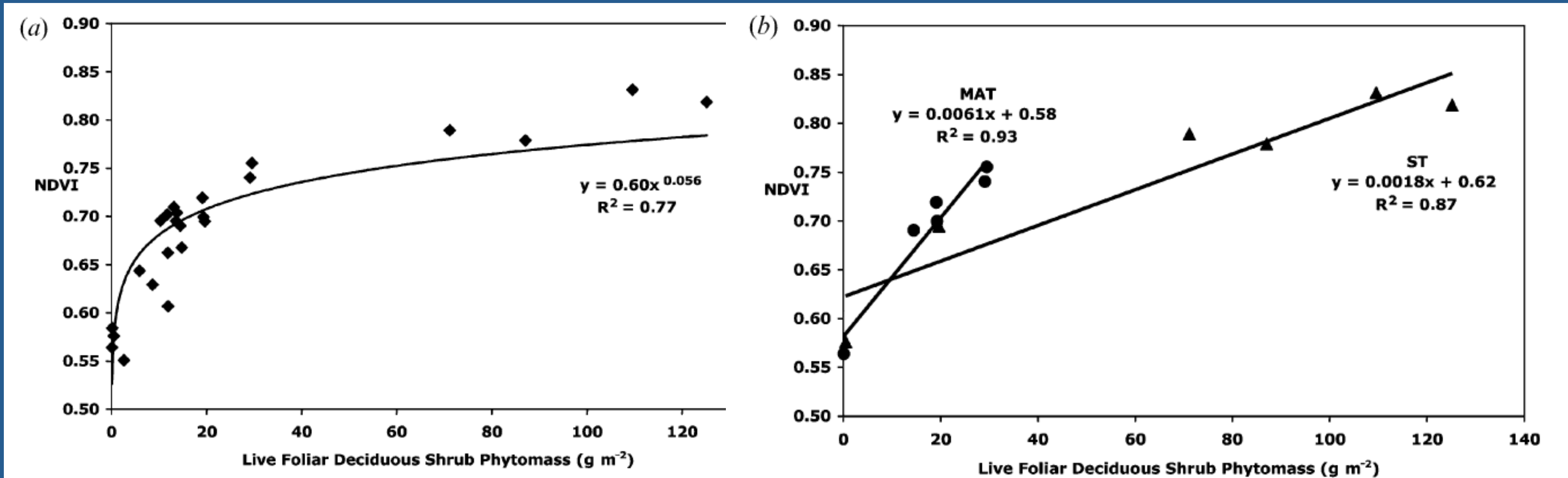


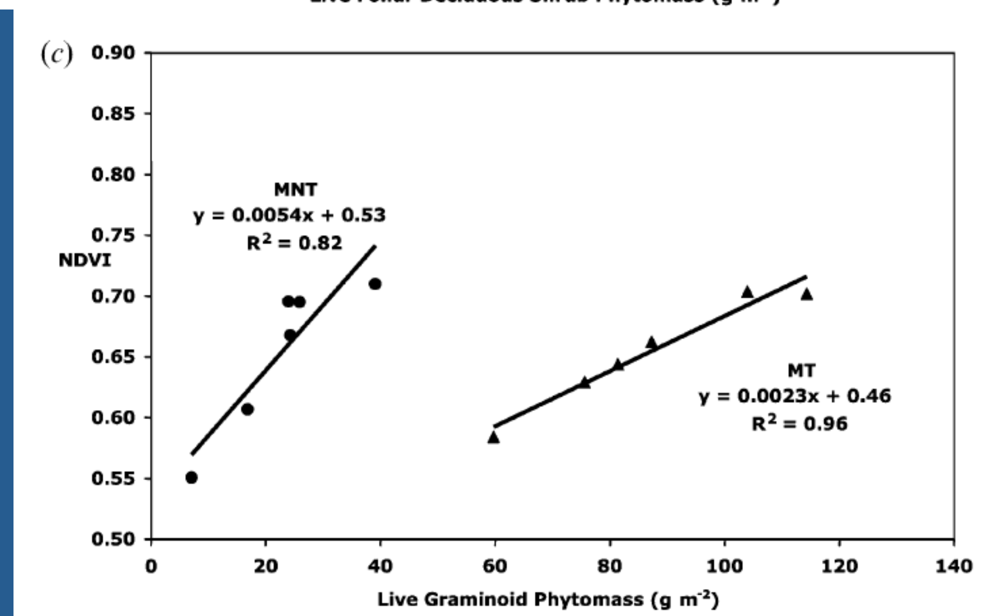






Riedel et al. 2005
(AAAR and IJRS)



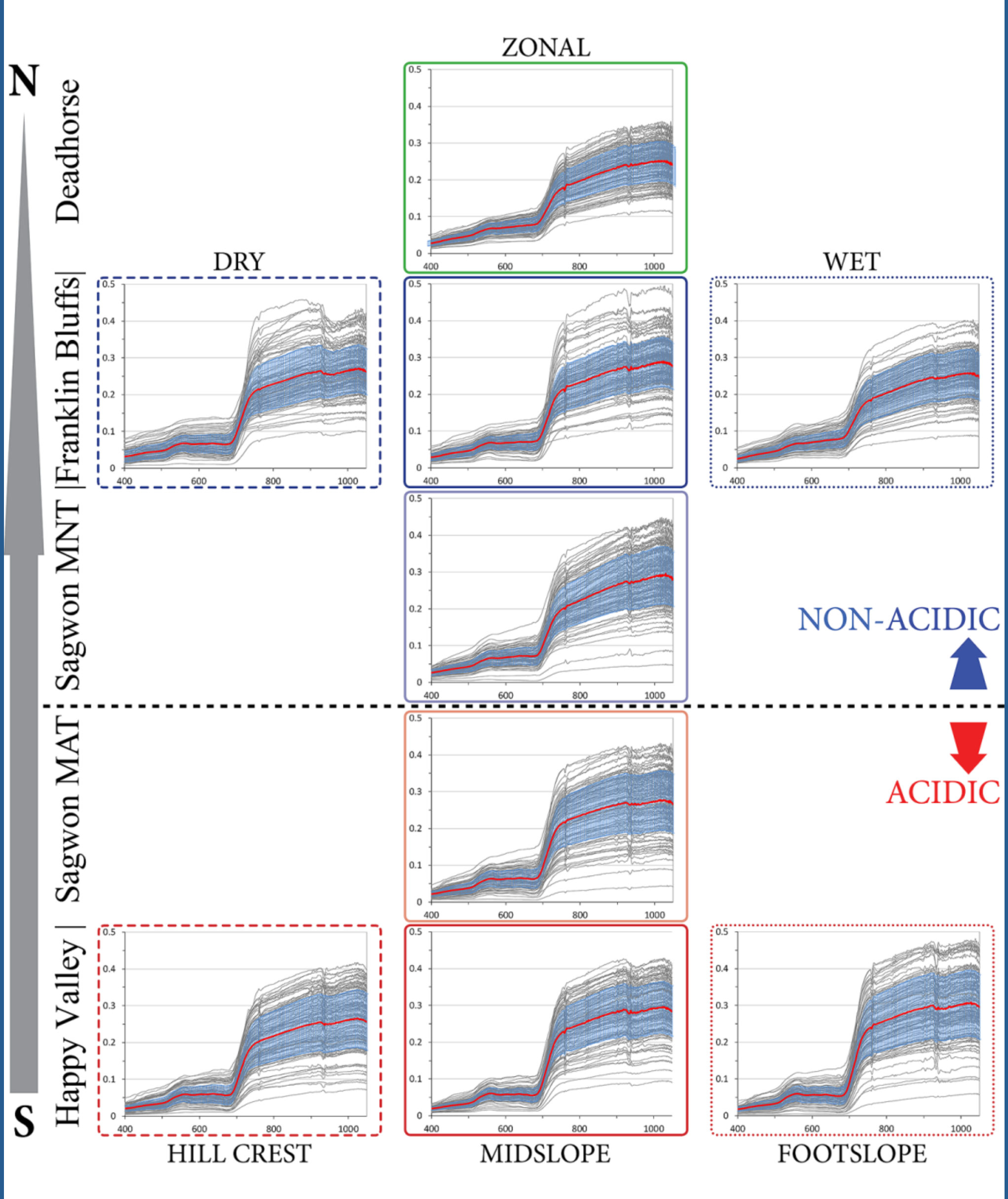


Biomass-NDVI relationships across and within plant communities

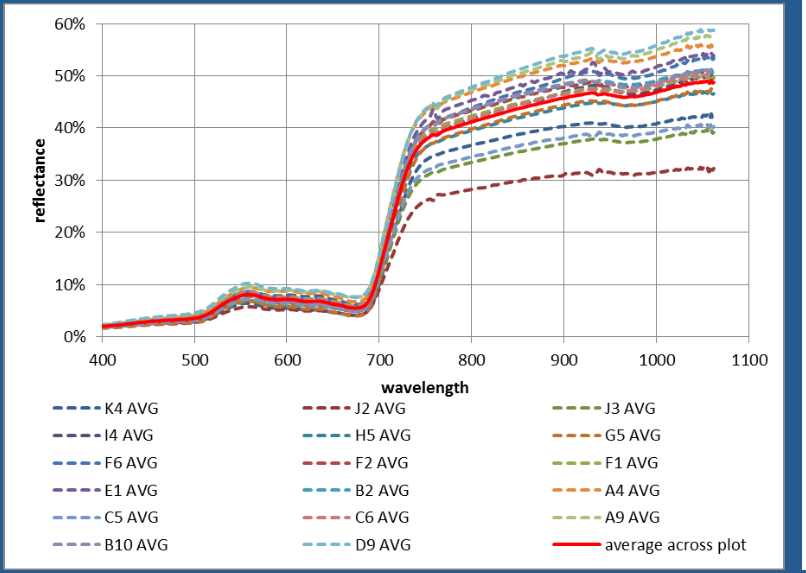
Riedel et al. 2005 (IJRS)

Hyperspectral Data

Buchhorn et al. 2013 (RS)

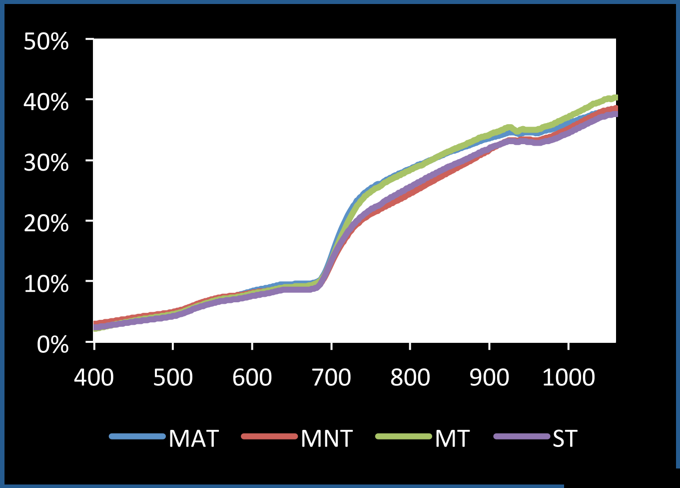


Ivotuk 1999 – Grid-point variability

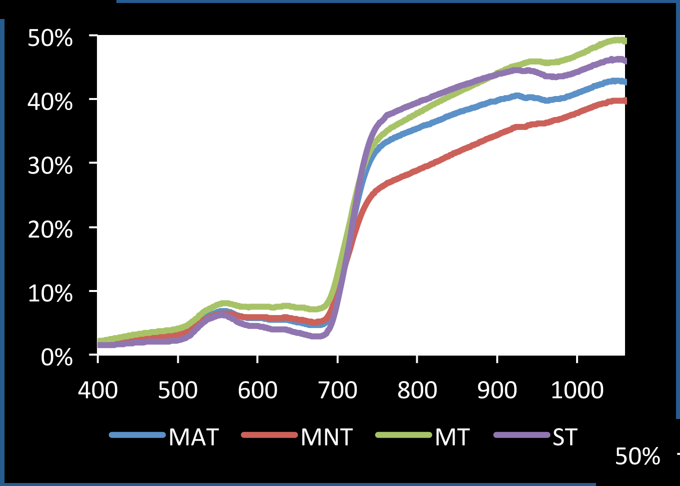


Ivotuk – 1999 Seasonal Hyperspectral Sampling

Bratsch et al. (in prep.)

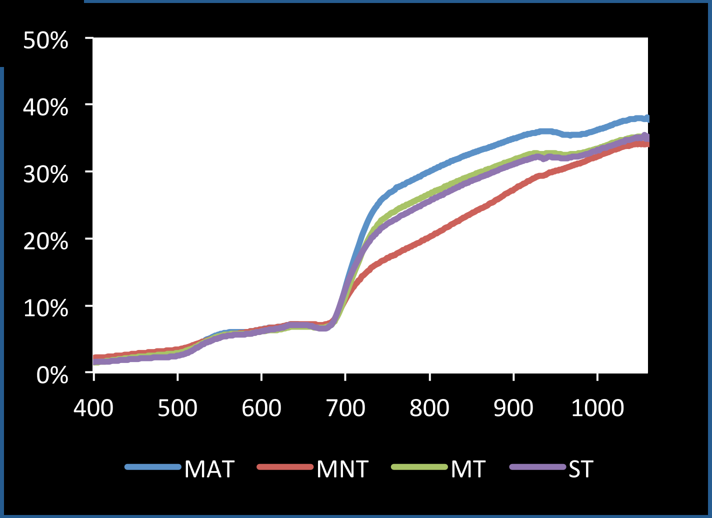


Period 1 – June 7-10



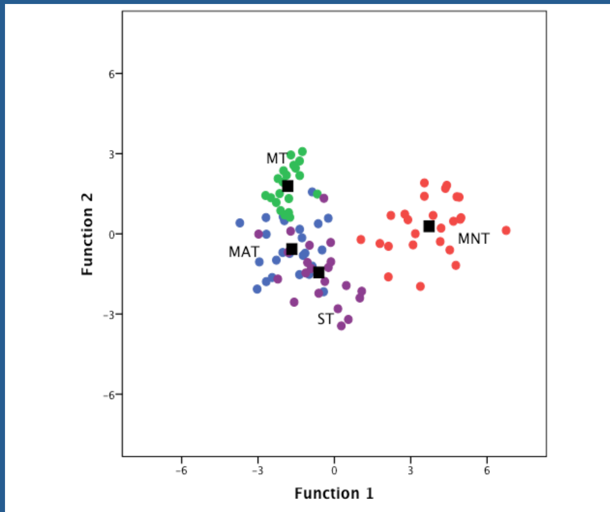
Period 4 – July 16

Period 7 – Aug. 22-26

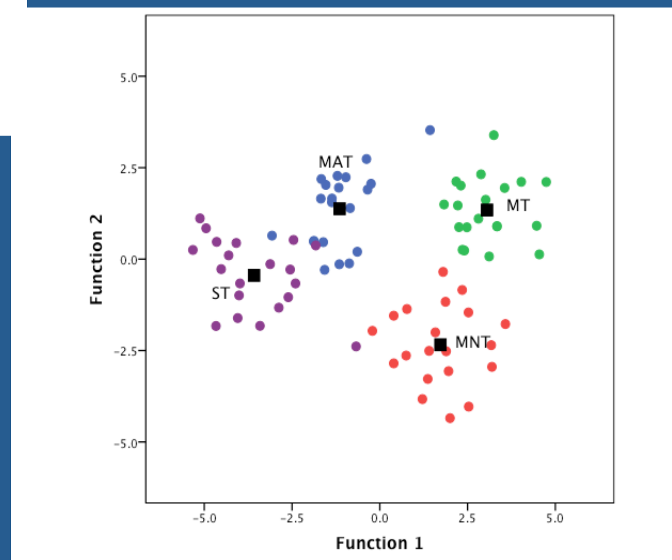


Ivotuk – 1999 Seasonal Hyperspectral Sampling
Discriminant Function Analysis

Bratsch et al. (in prep.)

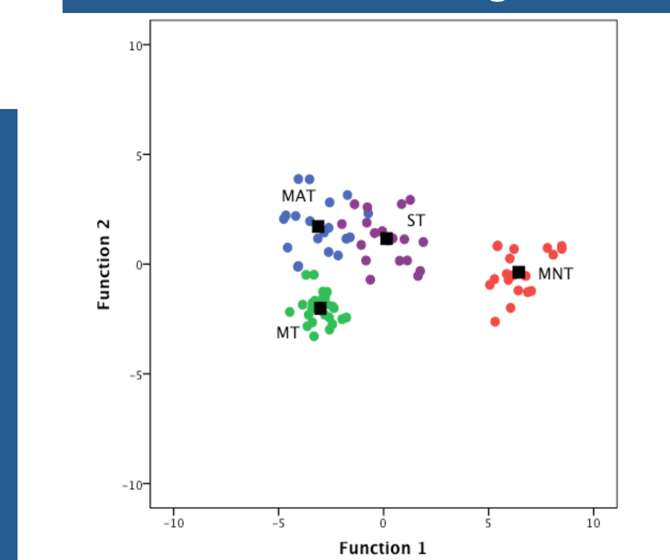


Period 1 – June 7-10
(blue, green red edge, NIR)



Period 4 – July 16
(blue, red, NIR)

(blue, green, yellow, NIR)
Period 7 – Aug. 22-26



Summary / Acknowledgements

1) Aboveground biomass, NDVI, and LAI data have been collected at a wide range of plots across northern Alaska (ATLAS, NSF Biocomplexity – NAAT), the western Canadian Archipelago (NSF Biocomplexity – NAAT) and northwestern Siberia (NASA LCLUC).

2) These data have been and can continue to be used to develop biomass-NDVI-LAI relationships across spatial scales (circumpolar, regional, landscape, plot / plant community). Synthesis of this information across the NAAT and EAT is being conducted as part of a **new NASA LCLUC project.**

3) These relationships have been and can continue to be used along with satellite-based remote sensing information to extrapolate biomass quantities and dynamics across space and time scales.

4) We have begun to use hyperspectral information to develop biomass-spectral relationships at the landscape / plant community levels, where coarser spectral indices (e.g. NDVI) are insufficient to distinguish among vegetation types (**NASA pre-ABoVE**).

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