A hierarchic review of circumpolar Arctic vegetation patterns and productivity

With a focus on the linkages between remote-sensing and plot-based studies

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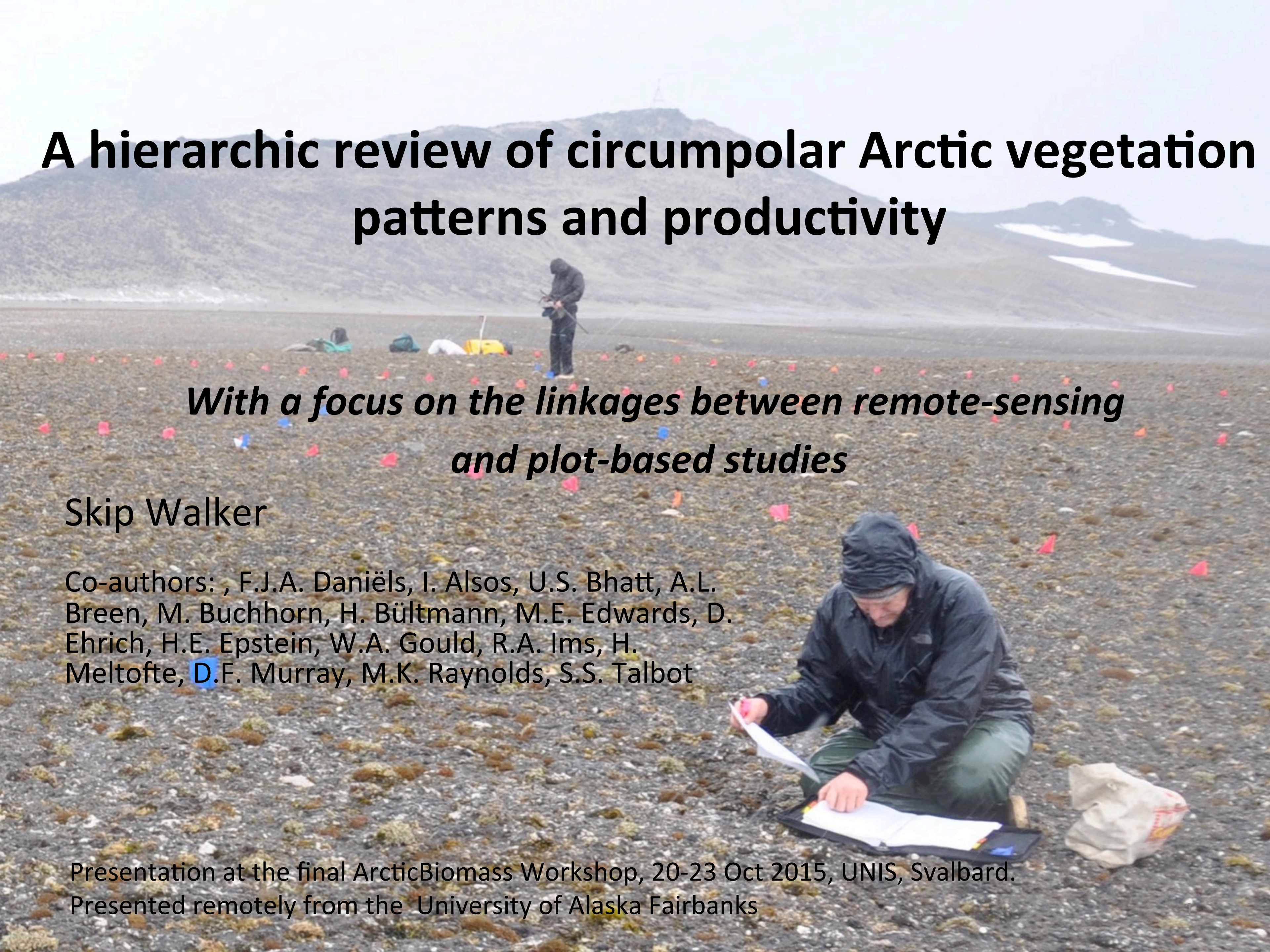


Presentation at the final ArcticBiomass Workshop, 20-23 Oct 2015, UNIS, Svalbard.
Presented remotely from the University of Alaska Fairbanks

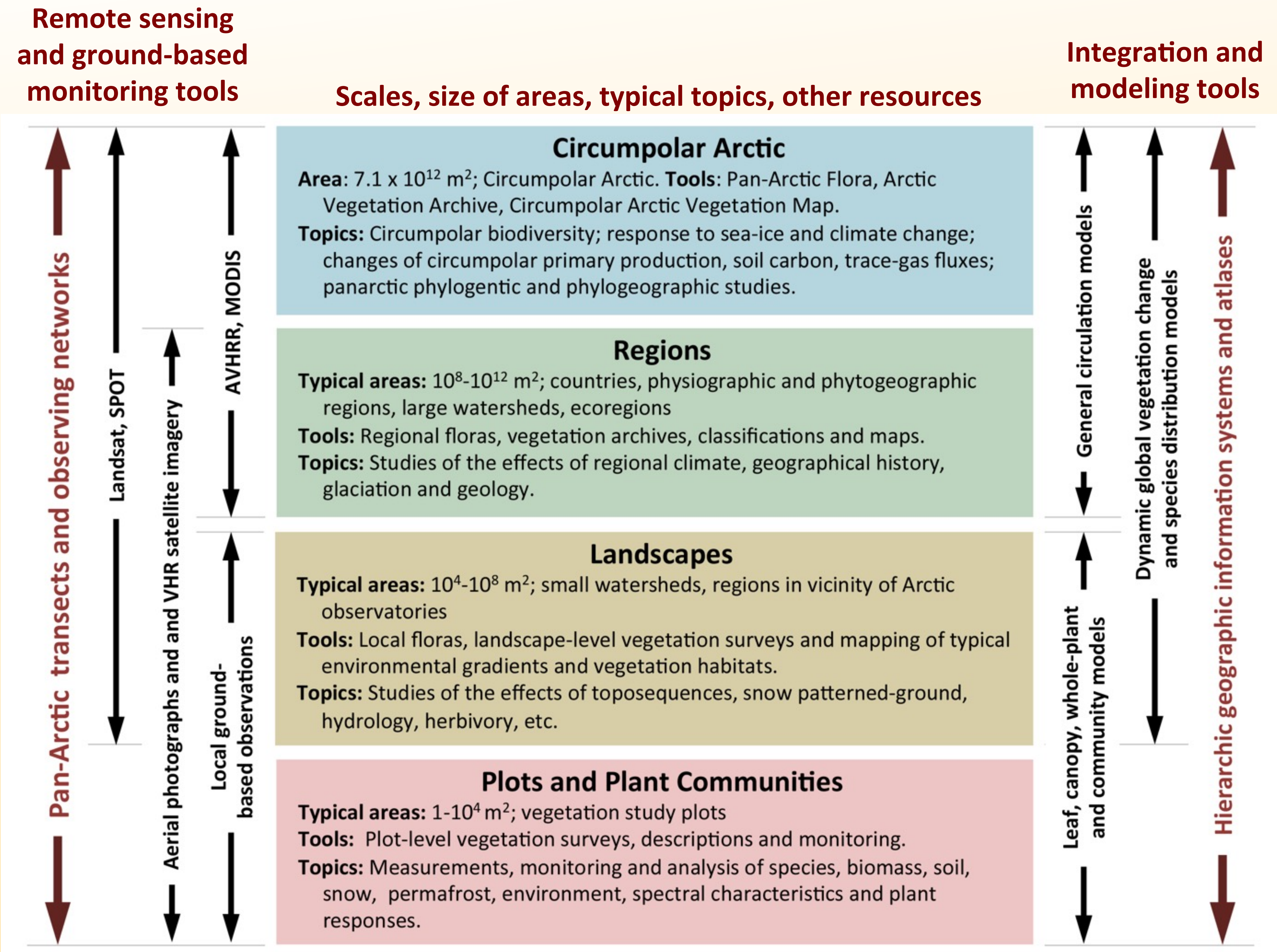
Statement of the problem

- Despite the importance of vegetation to studies of ecosystem change, all methods of studying vegetation patterns and change rely on rather sparse ground-based data collected during Arctic expeditions over the past century.
- Only a few areas have been intensively sampled and mapped, mainly in the vicinity of permanent Arctic observatories.
- Although an abundance of vegetation plot data have been collected for various projects, much of the information is project specific and is based on sampling protocols that are difficult to compare across sites.
- Many lack:
    1. Accurate location information and/or are not permanently marked, making it impossible to accurately resample these sites or link them to satellite-based observations.
    2. Accurate taxonomic information. Determinations not supported by voucher collections, particularly for the cryptogam species, which limits the extrapolation potential of spatial distribution models that use these data.
    3. Supporting photos, soil, environmental, and spectral data.

Overview of the talk

- Hierarchic framework for vegetation studies.
- Circumpolar-scale patterns:
  - Relationship of vegetation structure and NDVI to zonal patterns.
- Regional-scale patterns related to sea-ice and climate:
  - Regional patterns related to glacial history and parent material.
  - IPY Arctic transects (North America and Eurasia):
    - Methods of measuring vegetation spectral properties.
    - What we learned.
- Landscape-scale patterns.
- Plot-scale observations.
  - Arctic Vegetation Archive.
- Recommendations.

A hierarchic framework for studying Arctic vegetation

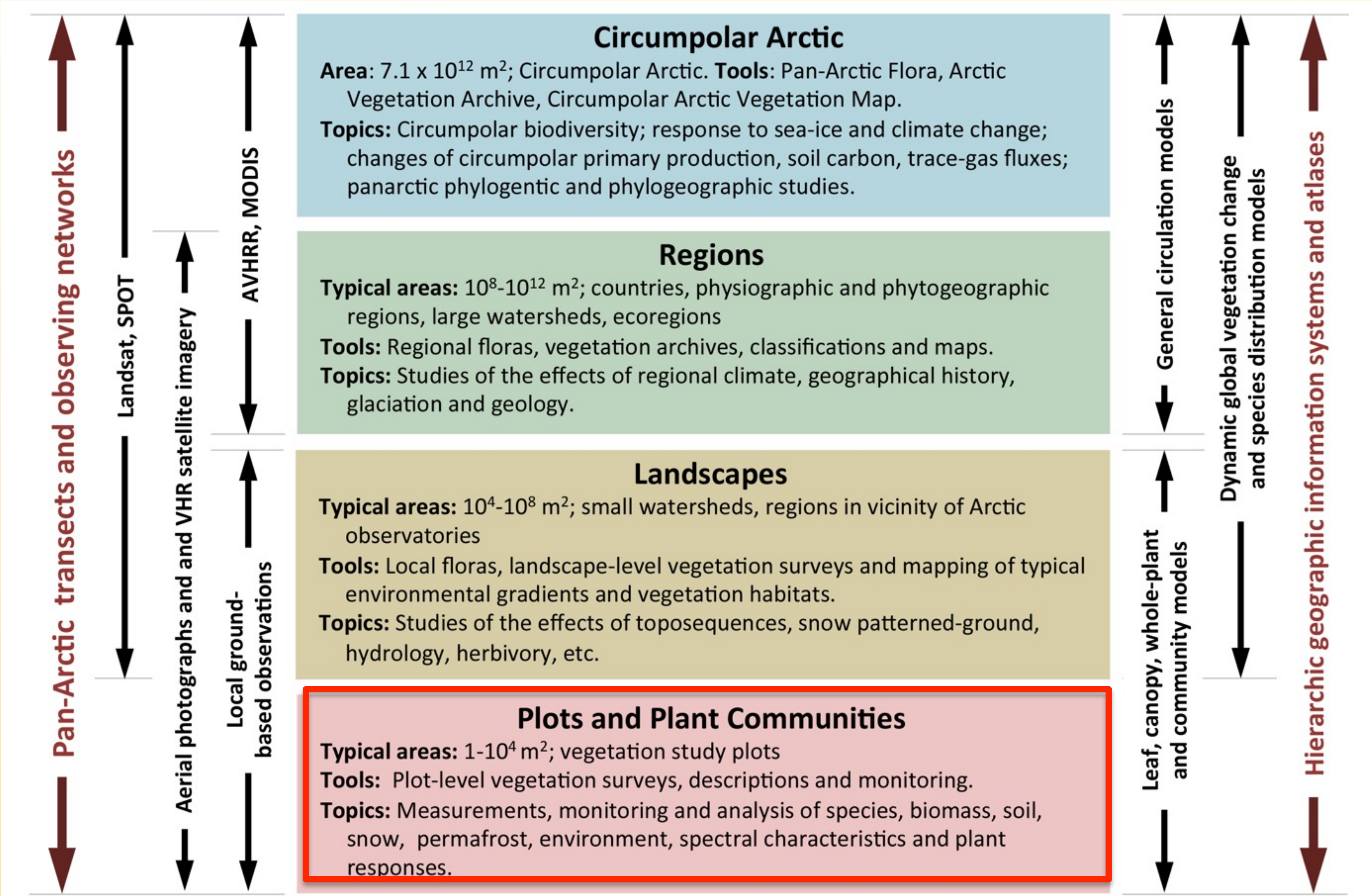


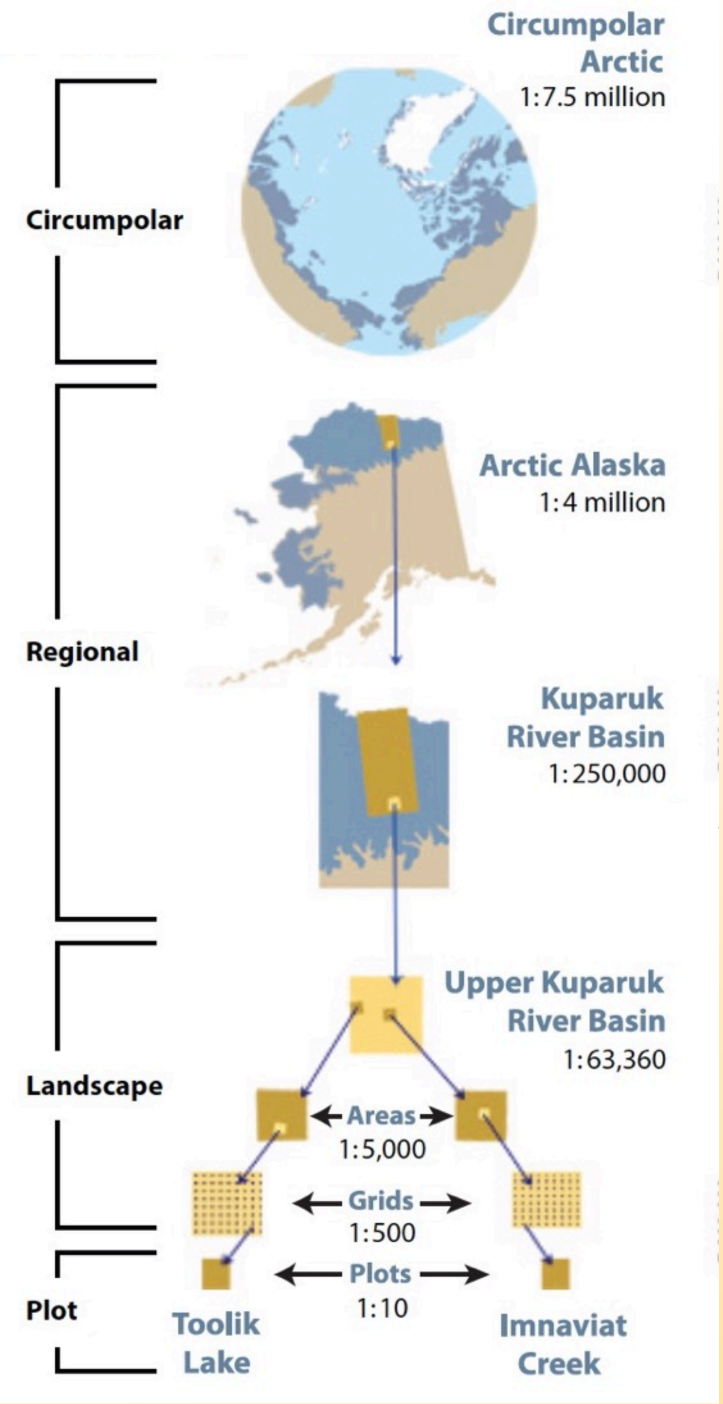
Plot-based studies of plant communities are the foundation for vegetation studies at all scales

Remote sensing and ground-based monitoring tools

Scales, size of areas, typical topics, other resources

Integration and modeling tools





Hierarchy of mapping scales for northern Alaska reflects this hierarchic framework

Circumpolar:

- Circumpolar biodiversity and productivity variation due to global climate, land temperatures, sea-ice distribution.

Regional:

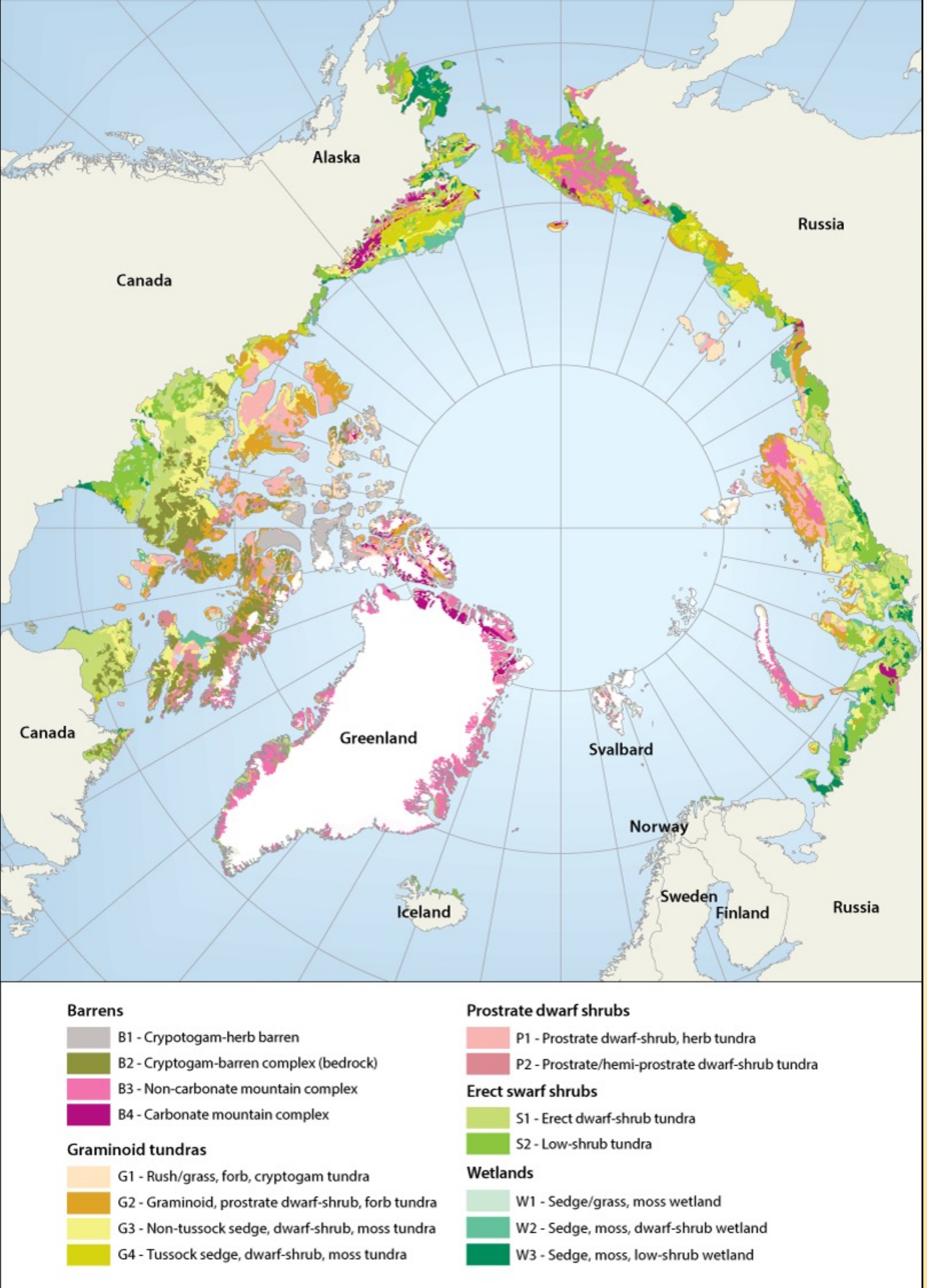
- Variation due to geology, macro-topography, climate, glacial and marine history, parent material, large-scale disturbance regimes.

Landscape:

- Variation due meso-topography, landscape water and snow distribution.

Plot:

- Variation to due to patterned ground, micro-topographic variations, small scale disturbances.



CAFF Circumpolar Vegetation studies

The Conservation of Arctic Flora and Fauna (CAFF) has promoted a Circumpolar perspective for studying the Arctic.

Some vegetation-related products include:

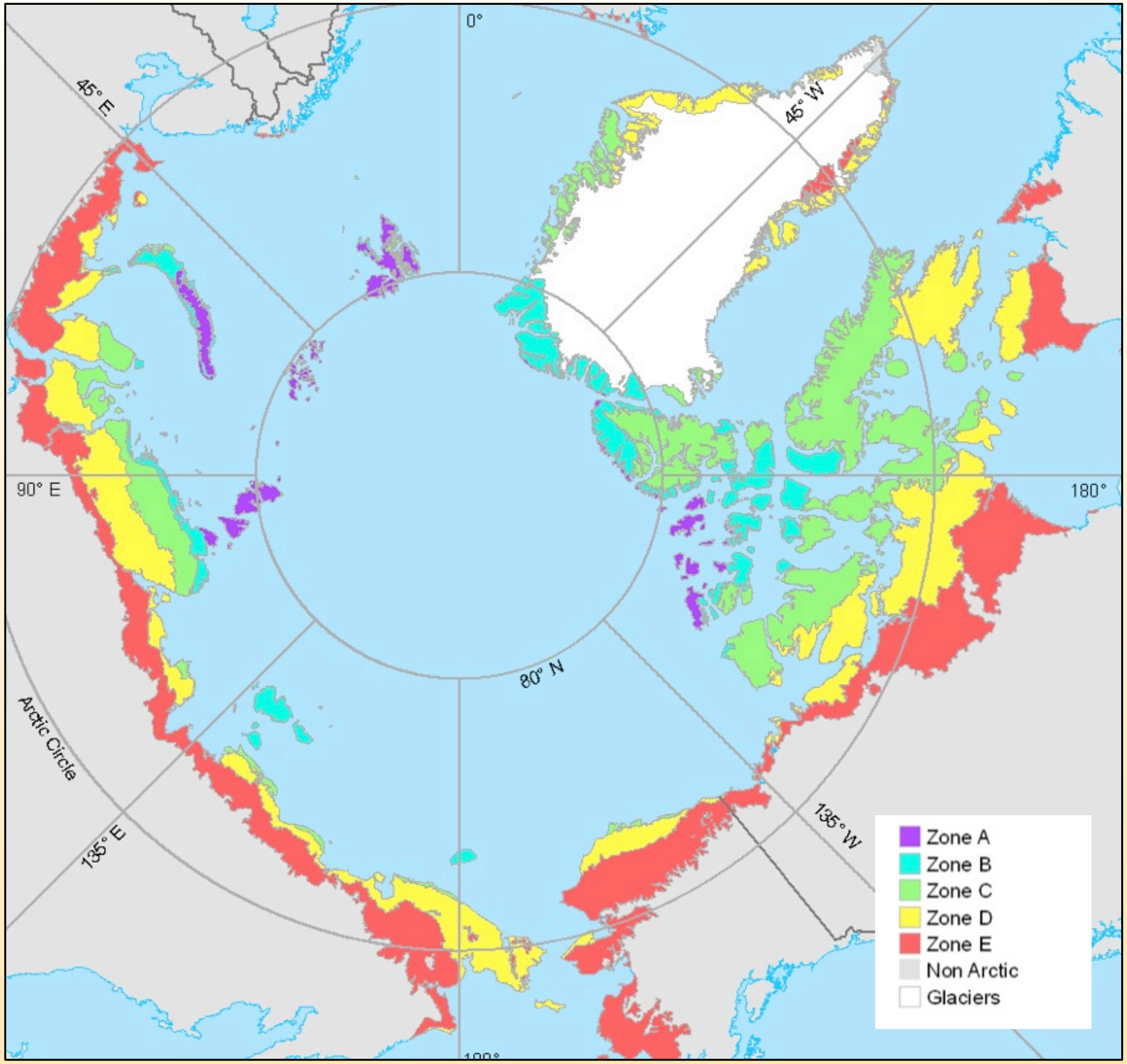
- PanArctic Flora (PAF) (Elven et al. 2011).
- The Circumpolar Arctic Vegetation Map (CAVM Team 2003).
- A CircumBoreal Vegetation Map (Talbot & Meades 2011).
- Three chapters for the Arctic Biodiversity Assessment (ABA Meltofte 2013).
- Arctic Vegetation Archive (Walker et al. 2014).

These products provide a consistent framework for studying circumpolar Arctic Vegetation.

CAVM version published in the Arctic Biodiversity Assessment, Terrestrial Ecology chapter, Ims et al. 2013.

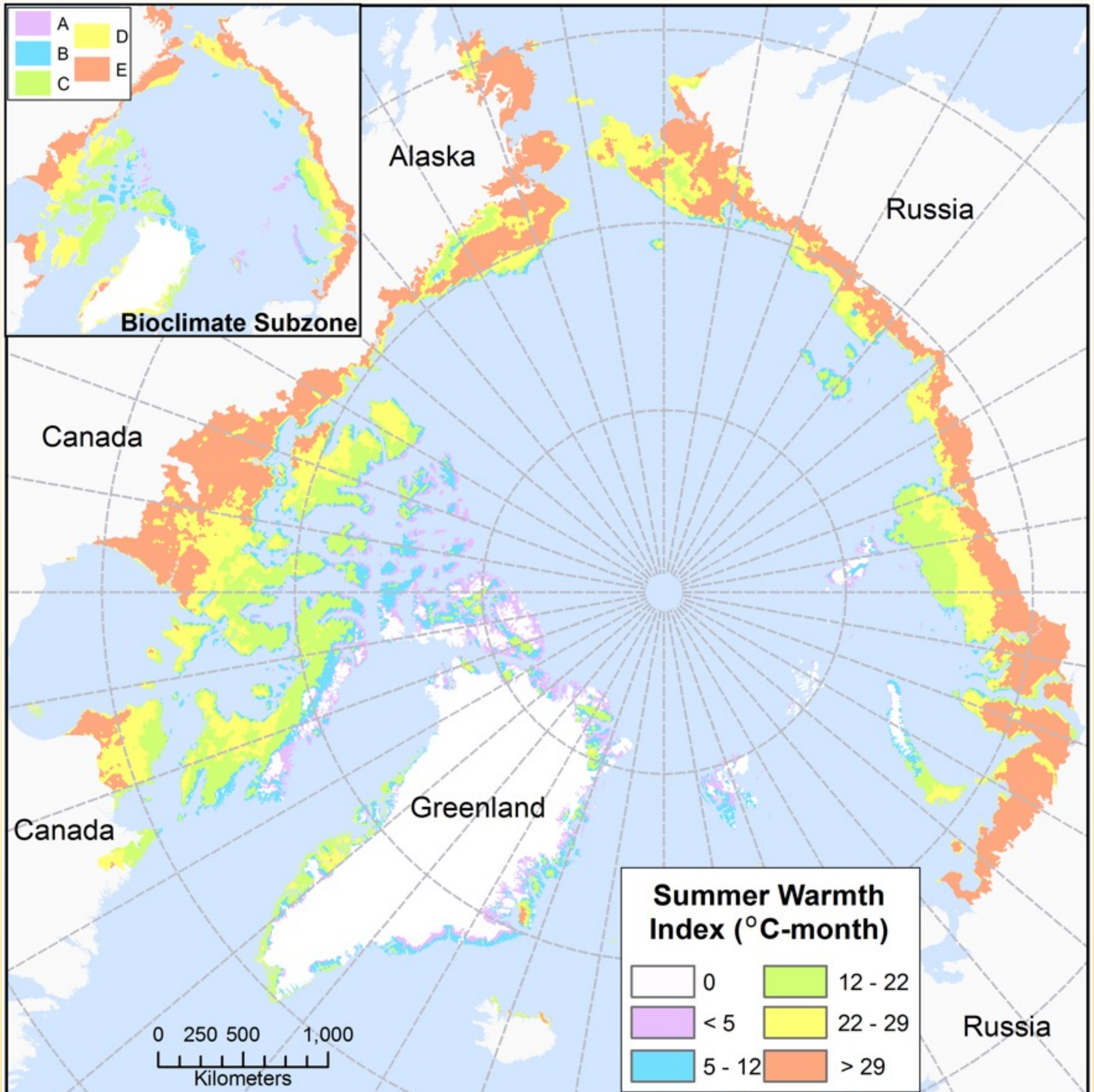
Arctic bioclimate subzones

- Russian zonal approach (Yurtsev 1994 and predecessors).
- Modified by Elvebakk (1999) for the Pan-Arctic Flora.
- Five subzones based on dominant plant growth forms and mean summer air temperatures.



Alaska Geobotany Center: http://www.arcticatlas.org/maps/themes/cp/cpbz

Correspondence between CAVM subzones and AVHRR- derived total summer warmth at the ground surface



Raynolds et al. 2008, *RSE.*

Inset map: CAVM bioclimate subzones.

Main map: Zonation derived from AVHRR-derived ground surface temperatures.

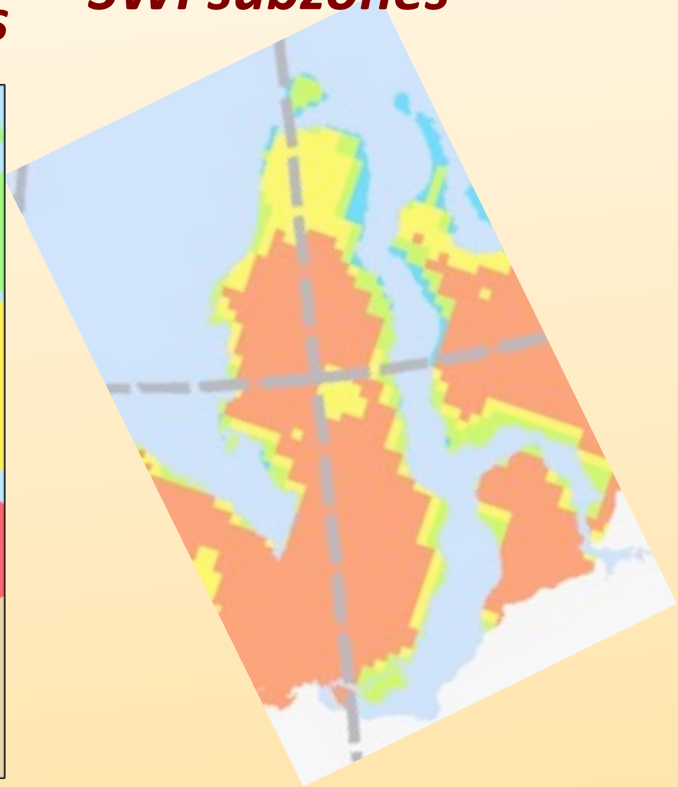
- Summer warmth index (SWI) is the sum of mean monthly temperatures above 0˚C (1982-2003) (Raynolds et al. 2008).
- **Strong general correspondence between the two maps.**

Discrepancies between the CAVM and SWI zonal maps

Yamal and Gydan peninsulas, Russia

CAVM subzones

SWI subzones



- All climate stations along the coast.
- Interior of the Yamal Peninsula is warmer than depicted on the CAVM.

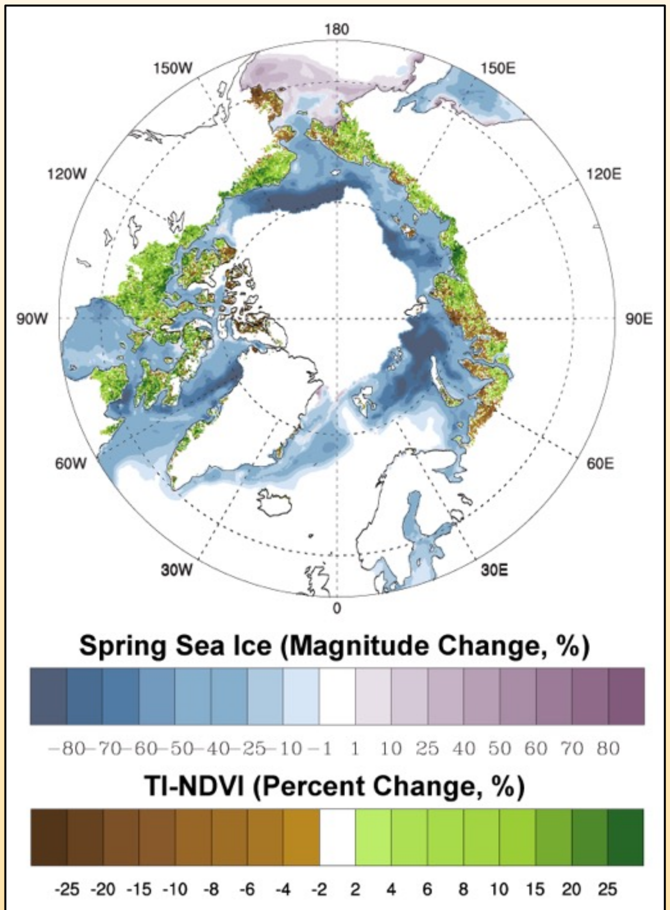
Overall, the SWI map provides more detail regarding steep temperature gradients in mountains, on islands and coasts.

IPY Greening of the Arctic Project

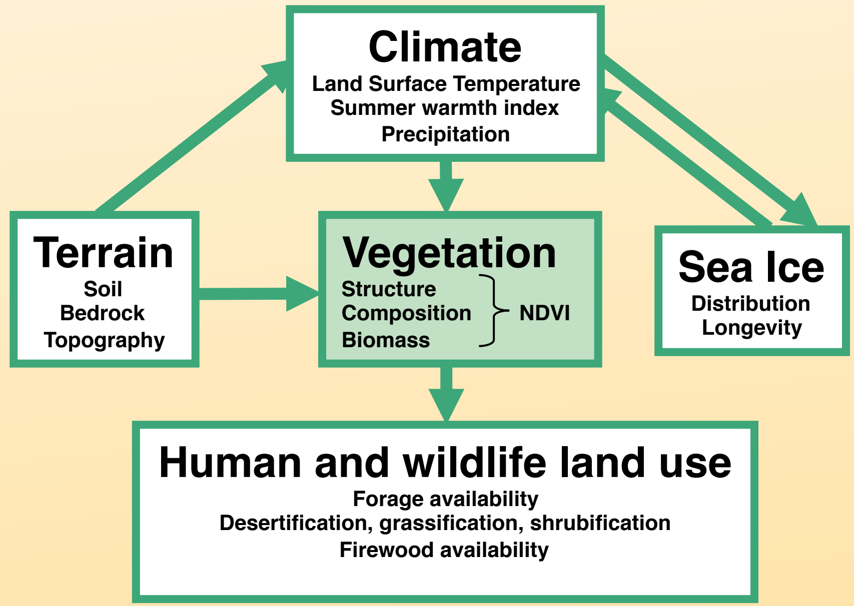
Examined the questions:

- How do circumpolar and regional NDVI trends relate to sea-ice and land-temperature trends?
- And to in situ measurement of vegetation composition & structure and the environment?

Sea-ice and Time-Integrated NDVI change



Significance of sea-ice, climate and vegetation change to Arctic Social Ecological Systems.



Bhatt et al. 2010, updated to 2014.

Are changes in sea-ice affecting regional land temperatures and greening patterns?

TI-NDVI increasing and sea ice decreasing:

- **Beaufort Sea (+,+)**
- **Baffin Bay (+.+)**

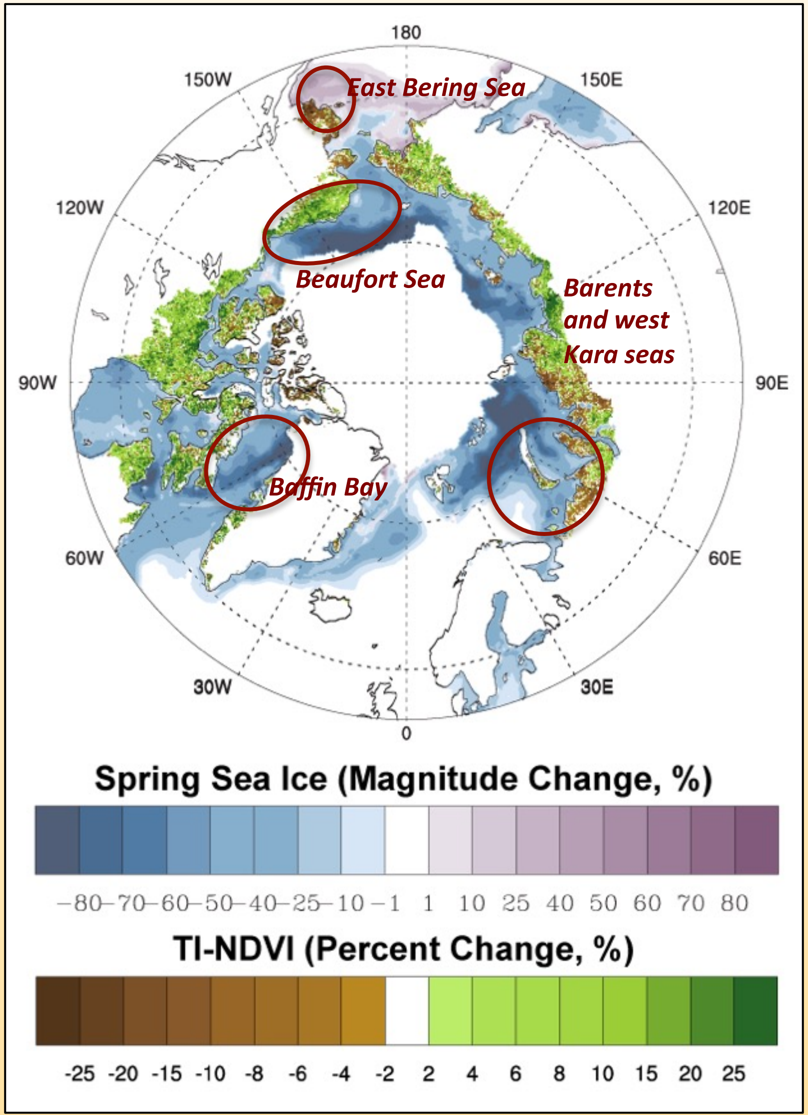
TI-NDVI decreasing and sea ice increasing:

- **East Bering (-,-)**

TI-NDVI is decreasing and sea ice decreasing.

- **Barents (-,+)**

Sea-ice and TI-NDVI change (1982-2014)

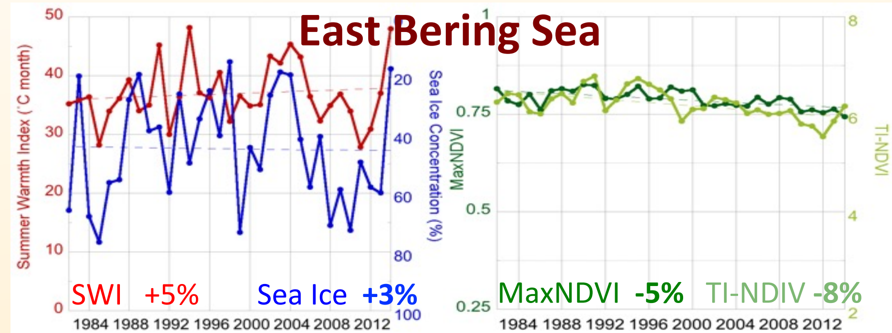


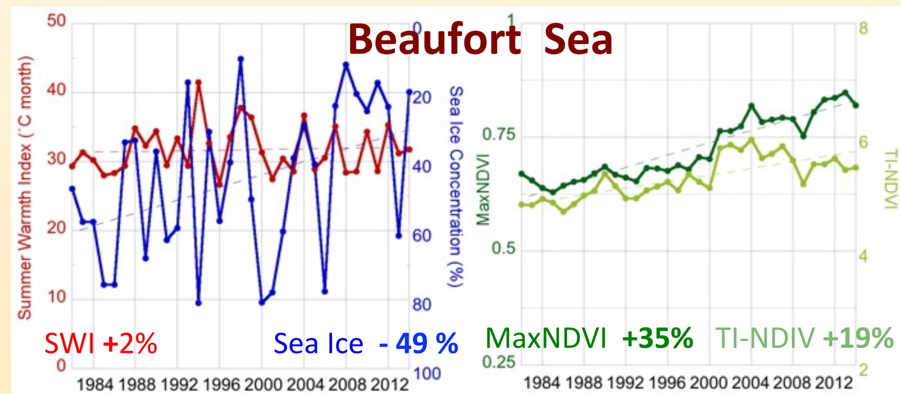
Bhatt et al. 2010, updated to 2014.

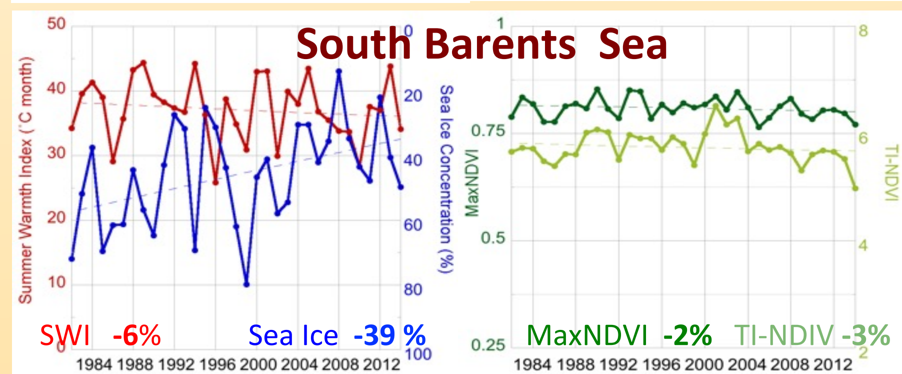
Examples of regional time-series trends in open water, summer land temperatures, MaxNDVI and TI-NDVI

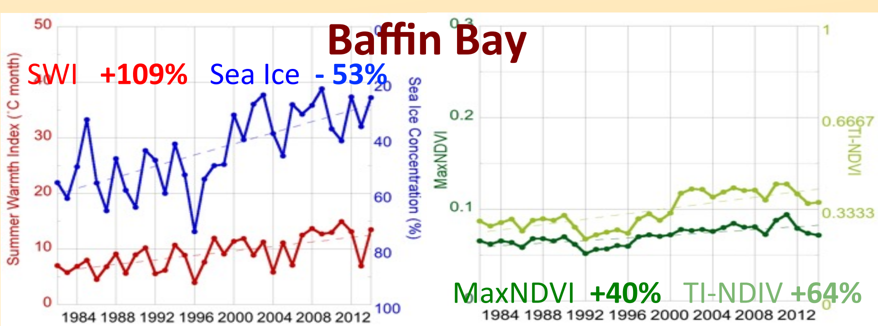
Regional divisions in marine environment with corresponding phytogeographic sectors on land

Treshnikov (1985 modified) & Yurtsev (1994)



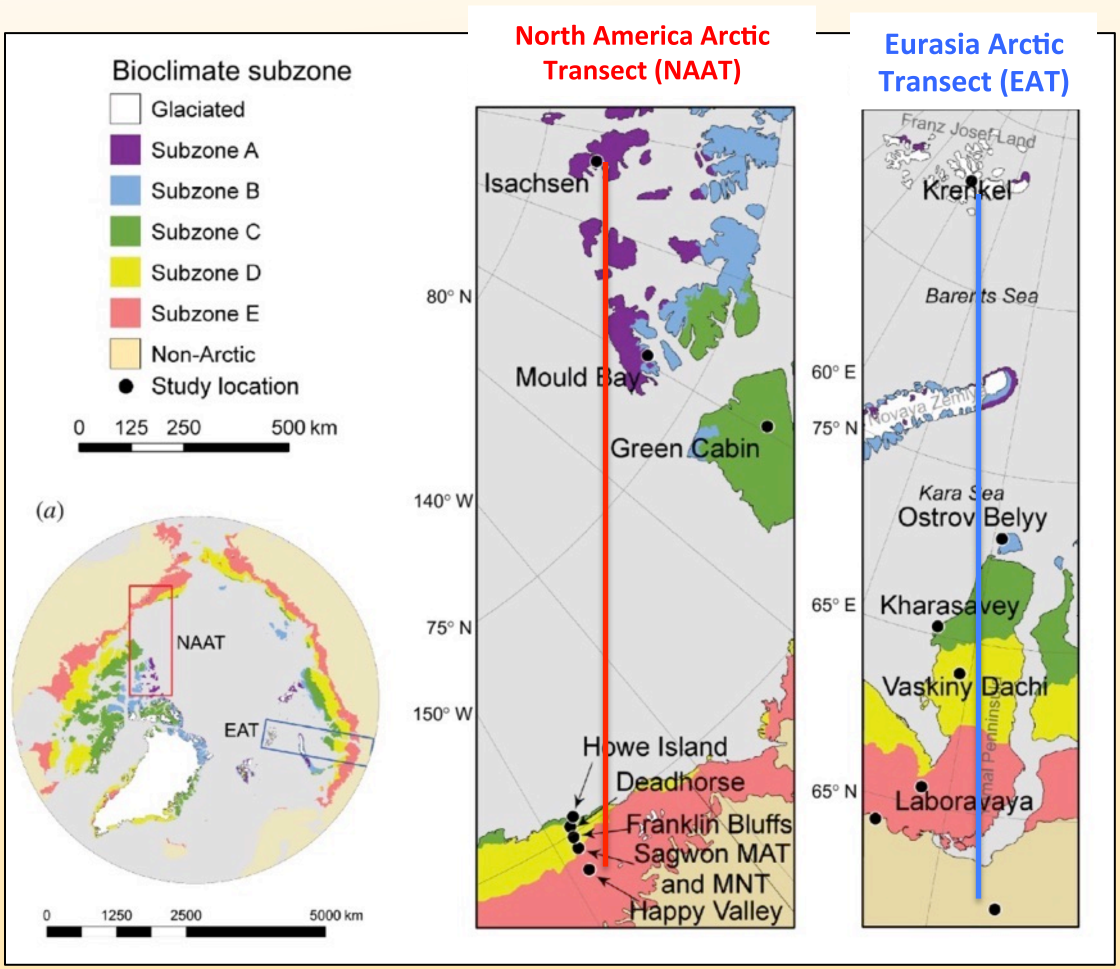






Bhatt et al. 2010, updated to 2014.

How does the in-situ vegetation relate to the patterns seen from space?



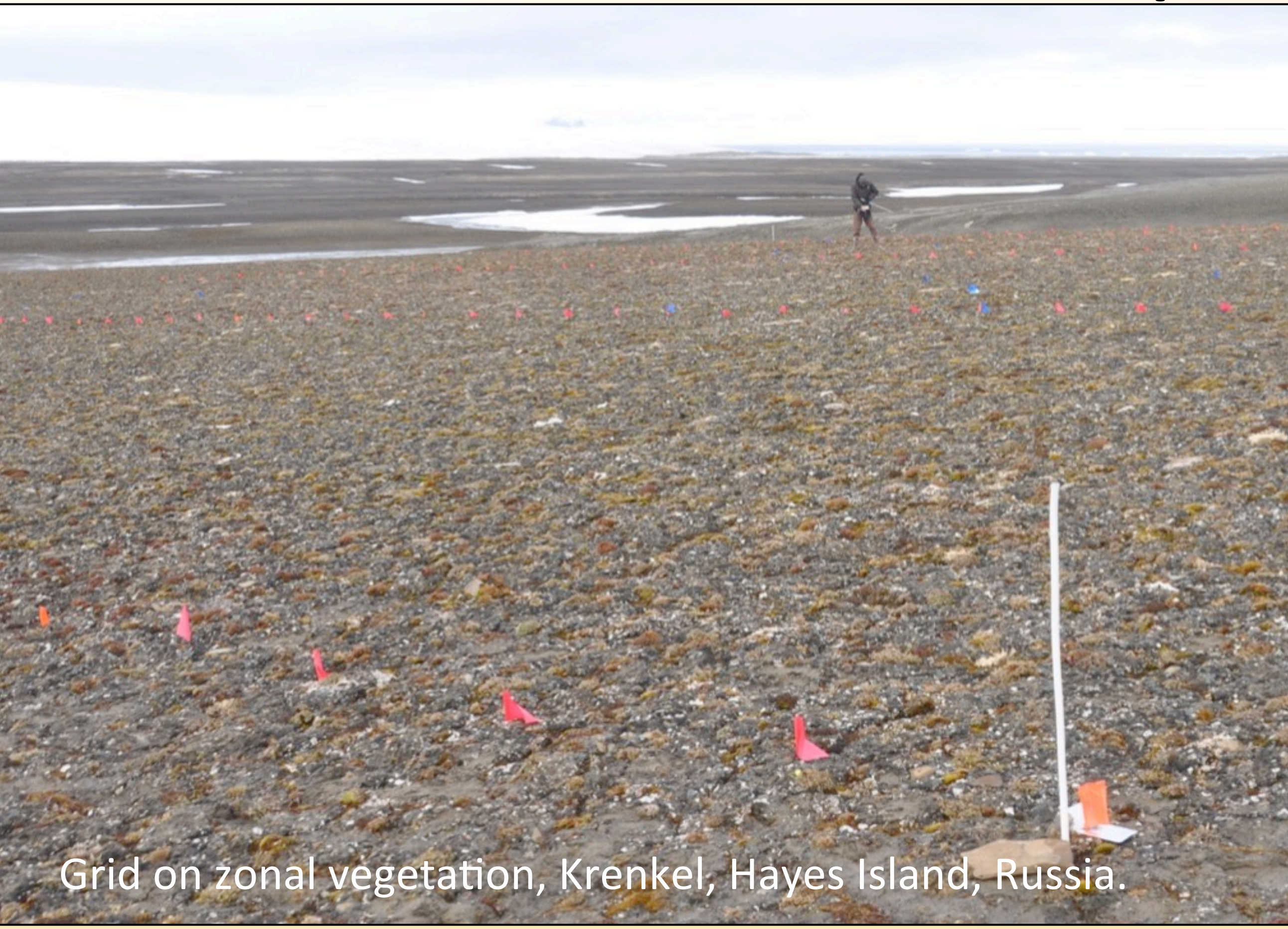
Examined regional differences in zonal NDVI-biomass relationships along two Arctic bioclimate transects.

NAAT: Continental Arctic climate, relatively low grazing intensity, mix of geologic substrates.

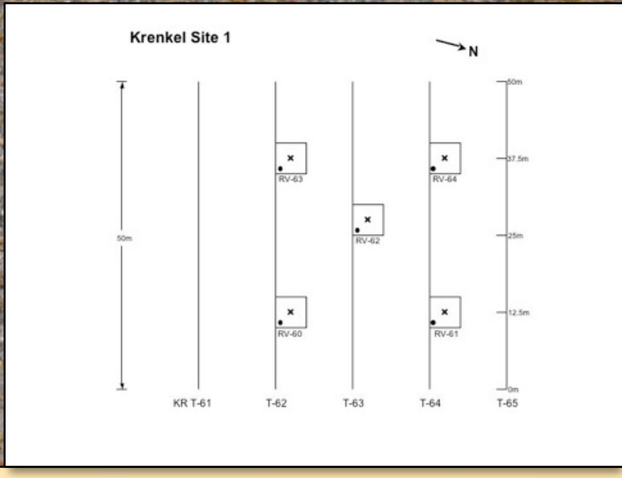
EAT: Maritime Arctic climate, high reindeer grazing, relatively consistent marine sediments (loams and sands) at most sites.

Raynolds et al. 2012. *Remote Sensing Letters.*

Sampling protocol along the Eurasia Arctic Transect (EAT)



Grid on zonal vegetation, Krenkel, Hayes Island, Russia.



- ✓ Five 50-m transects, 500 point measurements at 0.5-m intervals (species composition top and bottom of plant canopy, spectrometry, LAI, NDVI, thaw depth).
- ✓ Five 5-m relevés (species composition, site factors, soil properties, soil temperature (i-buttons).
- ✓ Five 20 x 50 cm biomass harvests (sorted according to plant growth forms, live-dead, woody-foliar).
- ✓ 1 soil pit with complete description and soil analysis.

Integrated field studies of permafrost, soils, vegetation and spectral properties

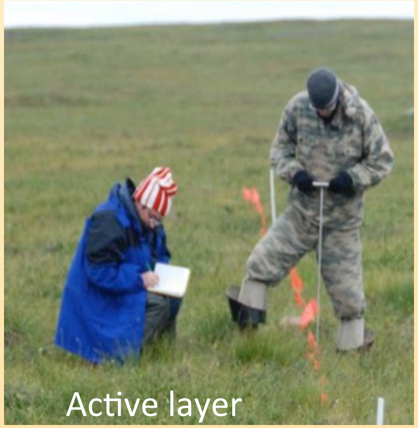
Field data collected:


Soils


Plant Cover and species composition


NDVI & LAI


Ground temperatures


Active layer

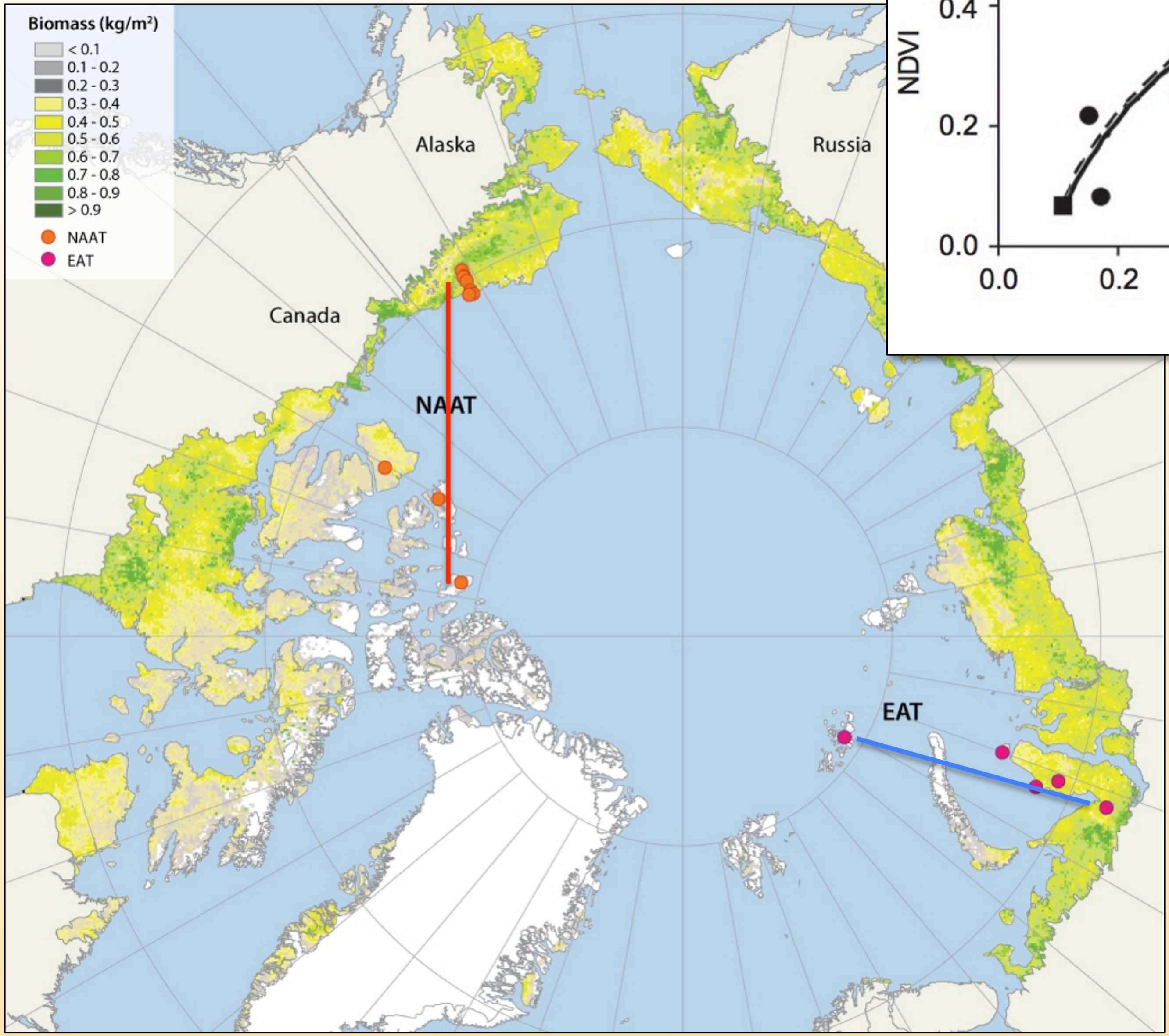

Plant Biomass

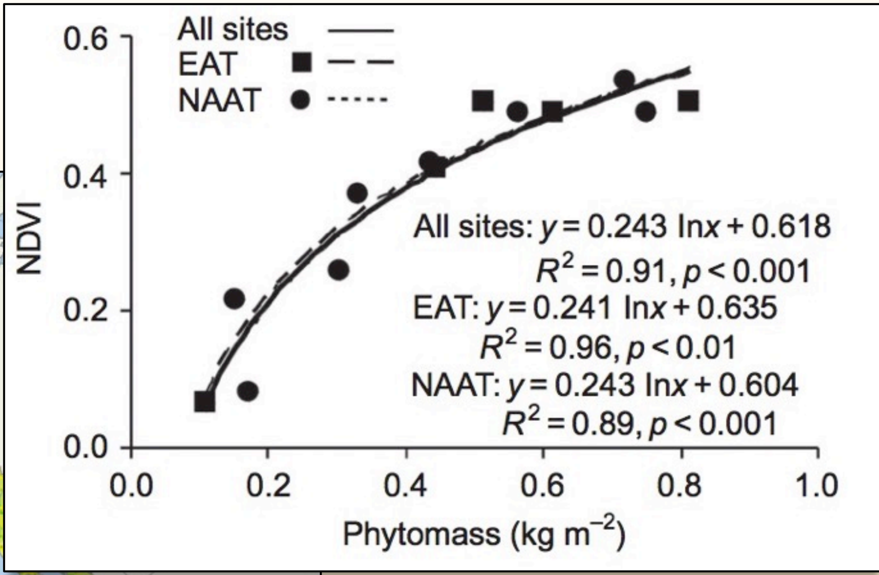
Biomass clip harvest

Biomass sorting according to plant functional types

20 x 50 cm clip harvest

- Forbs
  - Live
  - Dead
- Graminoids
  - Live
  - Dead
- Dwarf Shrubs
  - Evergreen
    - Woody
    - Foliar
      - Live
      - Dead
  - Deciduous
    - Woody
    - Foliar
      - Live
      - Dead
- Horsetails
  - Live
  - Dead
- Mosses
  - Live
  - Dead
- Lichens
  - Live
  - Dead



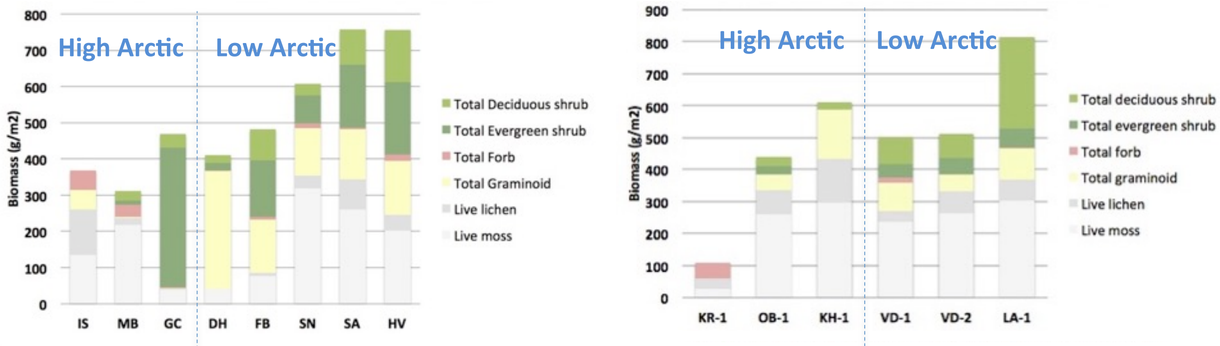


NDVI vs. total aboveground phytomass relationship is nearly the same along both transects.

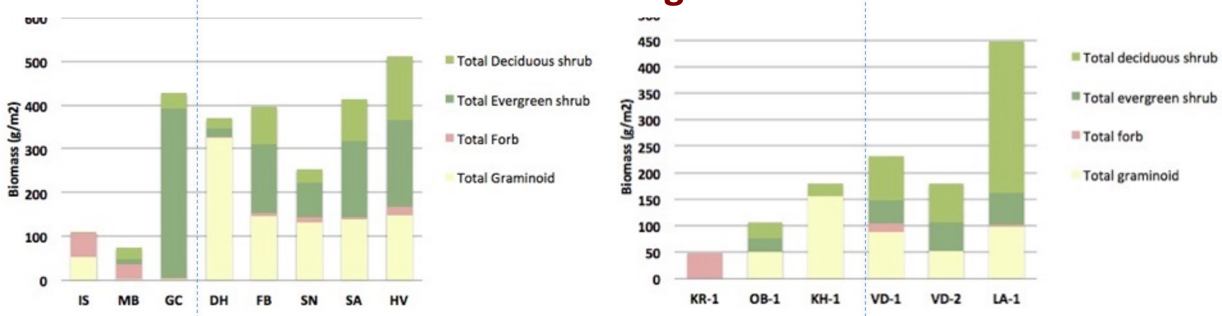
Raynolds et al. 2012, *RSL*.

NAAT EAT

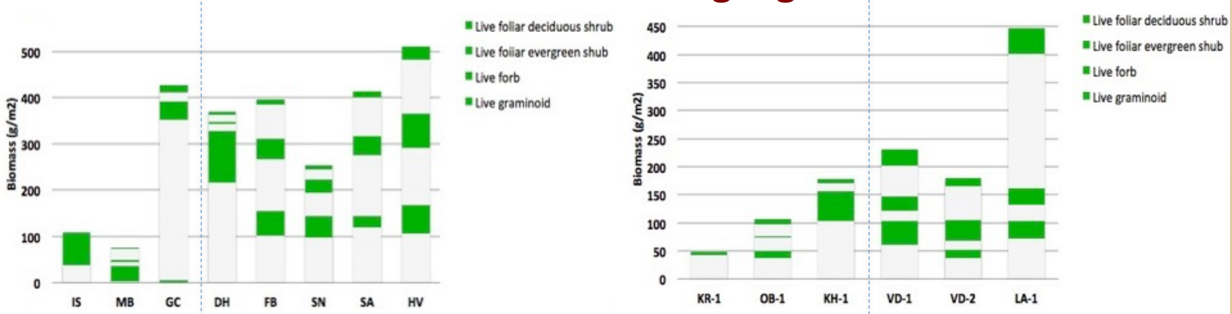
Total vascular and nonvascular aboveground biomass



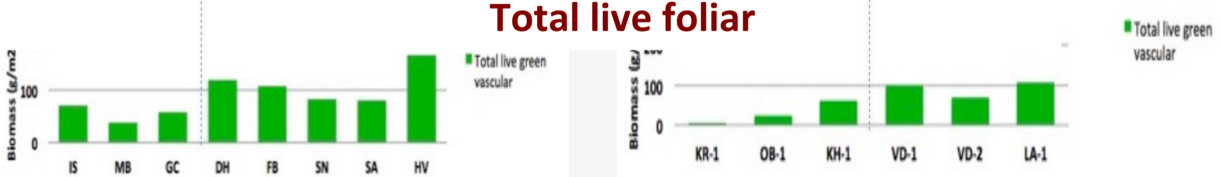
Total vascular aboveground biomass



Live foliar fraction highlighted



Total live foliar



Differences in biomass and canopy structure along the two transects.

Generally more cryptogam biomass along the EAT. (More maritime climate?)

More evergreen shrubs, graminoids and total vascular plant biomass along the NAAT. (Less grazing?)

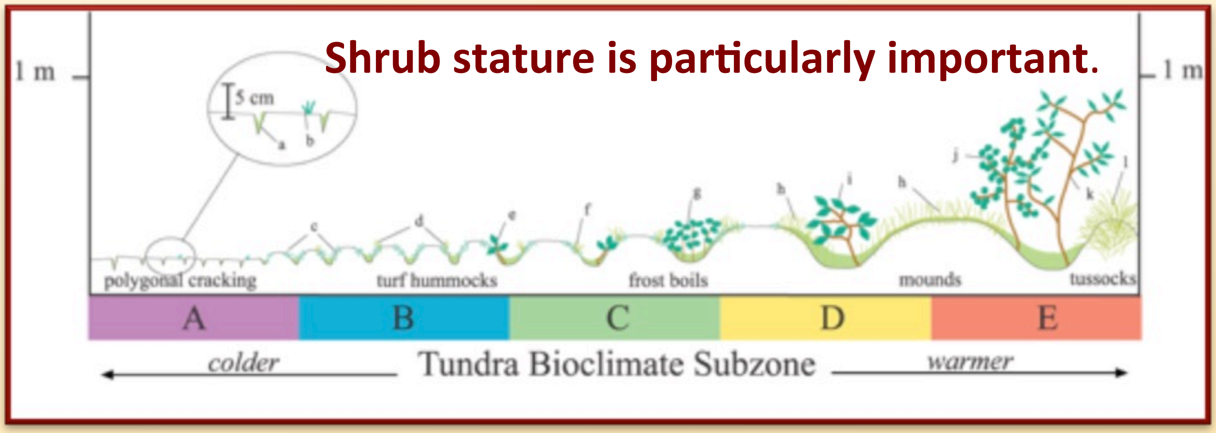
Green vascular-plant biomass generally lower in the High Arctic of the EAT (colder, snowier conditions?).

Understanding the variation in horizontal and vertical structure of vegetation with respect to summer temperature is the key to understand zonal variation of spectral properties.

Factors affecting the NDVI/Biomass relationship:

- **Horizontal structure (cover of plants vs. bare soil),**
- **Vertical structure (number of layers, height of the vegetation),**
- **Amount of dead or woody vs. green foliar biomass,**
- **Dominant plant functional types.**

Shrub stature is particularly important.



A: No shrubs.

B: Prostrate dwarf shrubs (<10 cm tall).

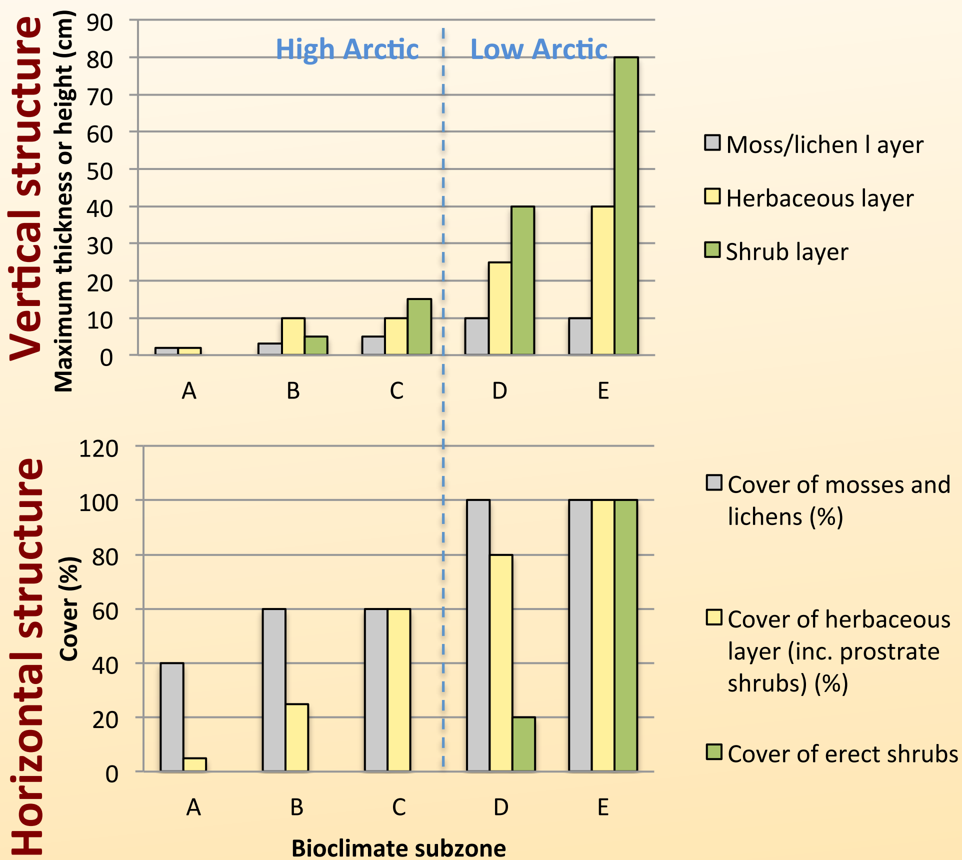
C: Hemi-prostrate dwarf shrubs (<25 cm tall) and prostrate dwarf shrubs.

D: Erect dwarf shrubs (<50 cm tall).

E: Erect dwarf shrubs and low shrubs (>50 cm tall).

Theoretical vertical and horizontal structure of zonal Arctic vegetation

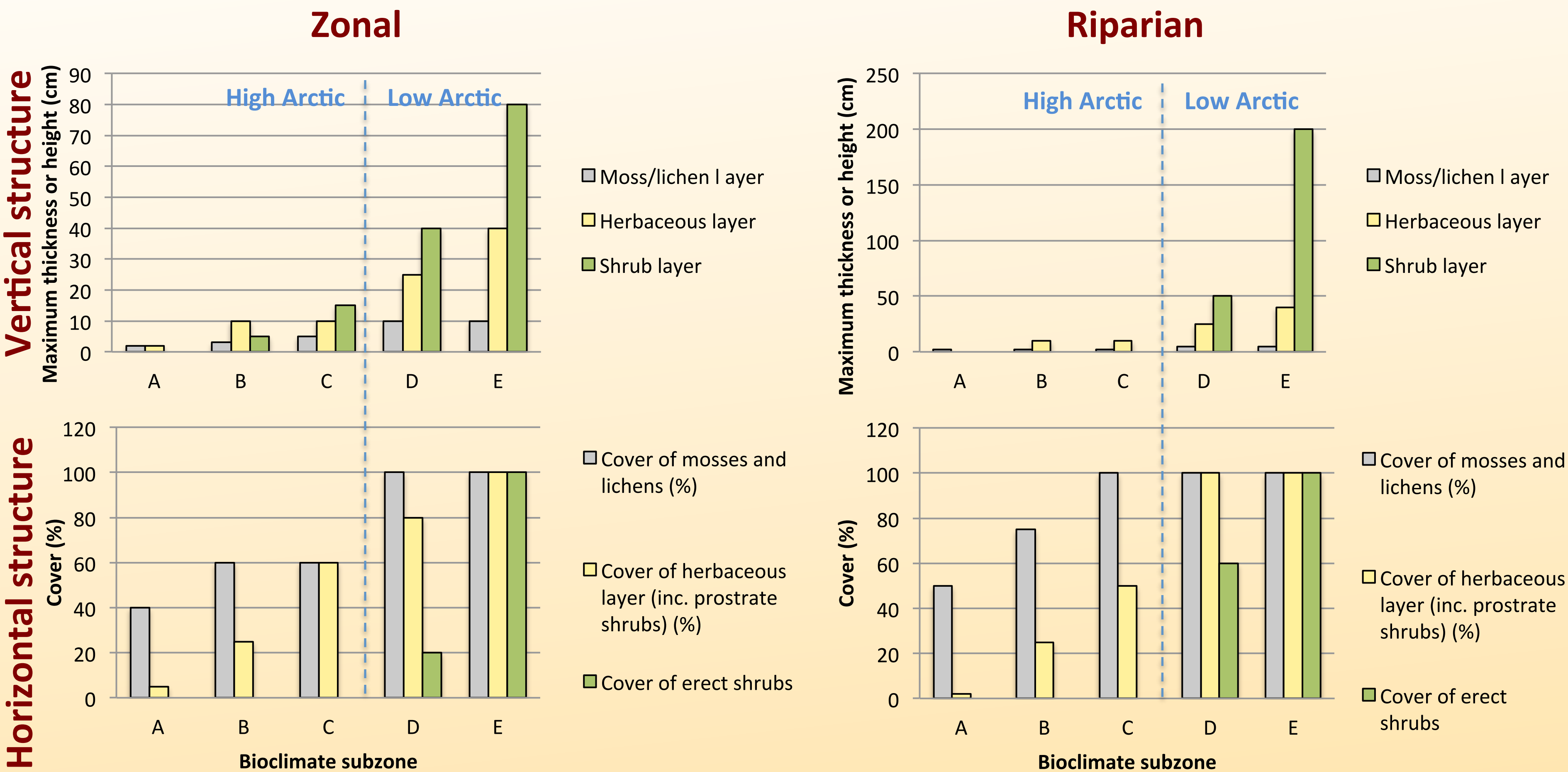
Zonal



- **Erect shrubs (>20 cm high) are generally absent in the High Arctic, but increase exponentially in height and cover in the Low Arctic.**
- **Horizontal covers of mosses lichens and graminoids increase most strongly with temperature (and soil moisture) in the High Arctic.**

(Based on Walker et al. 2005, Table 1, and information from Matveyeva and Chernov 1998).

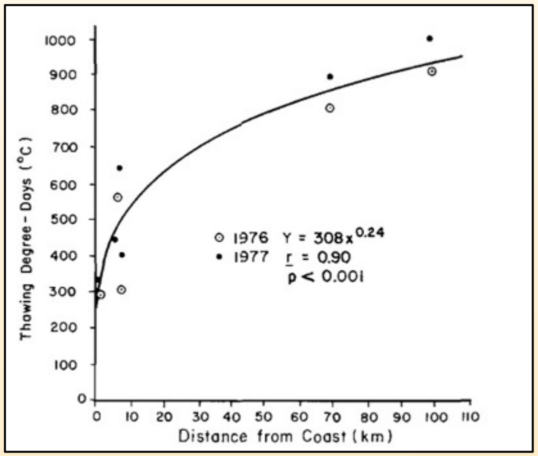
But to fully understand the NDVI information, we also need to examine other parts of the landscape, particularly what is happening in riparian habitats.



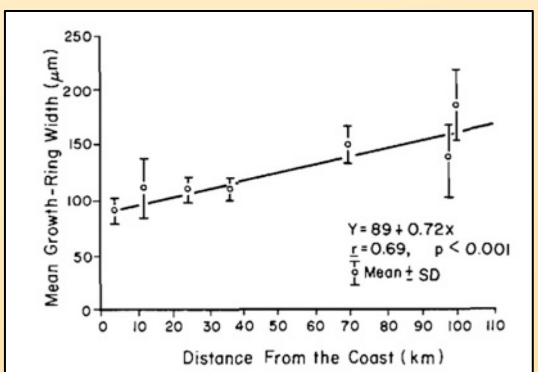
- **Vertical and horizontal structure of <u>erect</u> shrubs increases dramatically with temperature <u>in Low Arctic riparian areas compared to zonal sites</u> (note change of vertical scale for riparian vertical structure).**

Height and growth rings of *Salix lanata* along the Arctic Alaska coastal temperature gradient

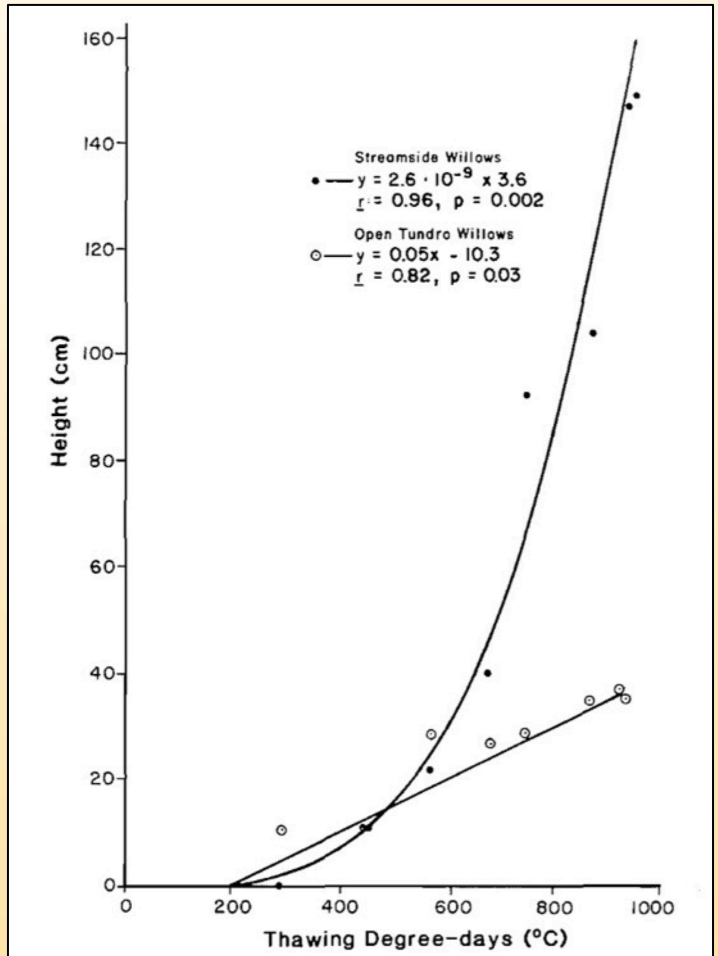
Coastal temperature gradient along the Dalton Highway



Growth-ring widths of *Salix lanata* in open tundra environments.

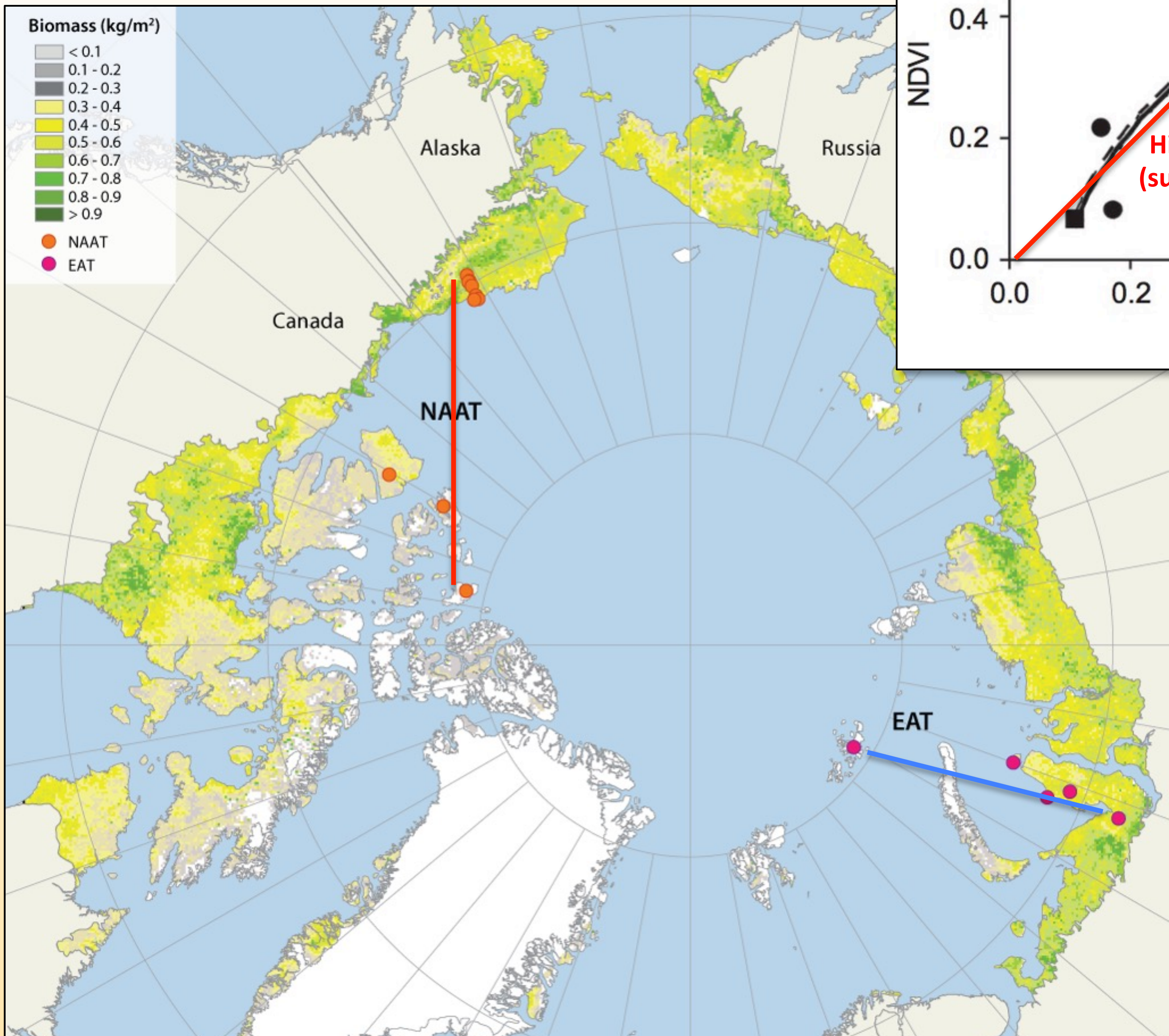


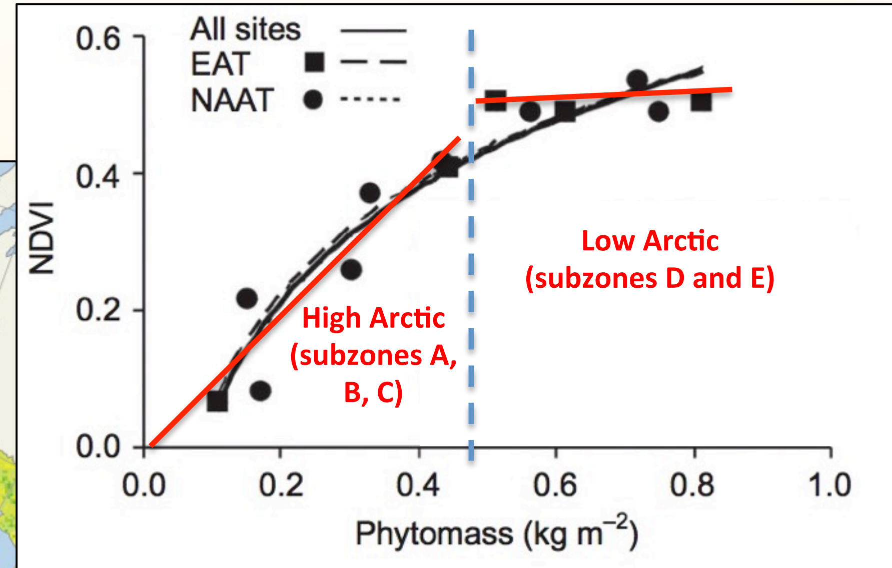
Maximum height of willows in open tundra vs. riparian habitats



- **Riparian willows show strong growth response to increased temperature south of Prudhoe Bay.**
- **Open tundra willow response is relatively subdued.**
- **Likely due to relatively warm soils and high nutrient fluxes along streams compared to cold nutrient-poor soils of open tundra sites.**

Walker. 1987, *Can. J. Bot*.





- The zonal-biomass — NDVI relationship may better be described by two equations:
- High Arctic (strong linear relationship below about 500 g/ m²),
- Low Arctic (nearly flat above about 500 g/ m²).

Raynolds et al. 2012, *RSL*.

Conclusions from EAT and NAAT biomass effort

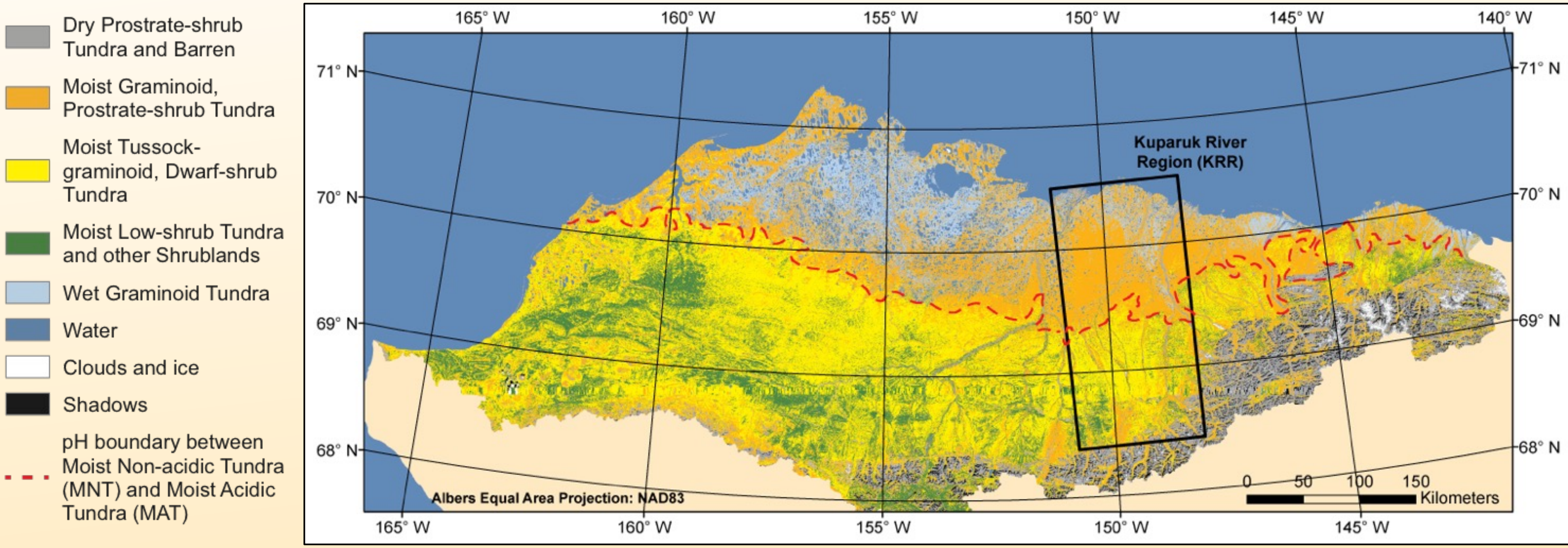
Biomass trends:

- Interpreting the NDVI-biomass relationships requires a better understanding of the ground conditions.
- The previous interpretation of the biomass NDVI relationship as a continuous curve may be better interpreted as two curves that represent a state transition from dominance of prostrate shrubs to erect shrubs at the High/Low Arctic boundaries.

Methods:

- More transects and sampling are needed to confirm these trends.
- With some modification, this relatively simple sampling method used along the EAT could be used by other researchers to monitor Arctic phytomass consistently across the Arctic.
- A network of sampling locations could be set up at many locations including most of the Arctic Observatories.
- More effort is needed to sample riparian and other habitat types along the climate gradients.

A closer look at the prostrate-shrub/erect shrub transition at the regional scale, North Slope, Alaska



Landsat-derived classification by Muller et al. 1999. *IJRS.*

- Boundary between graminoid, prostrate-dwarf-shrub tundra and graminoid erect-dwarf-shrub tundra is striking.
- Corresponds to a climatic boundary (subzone D and E) and pH boundary (nonacidic and acidic).

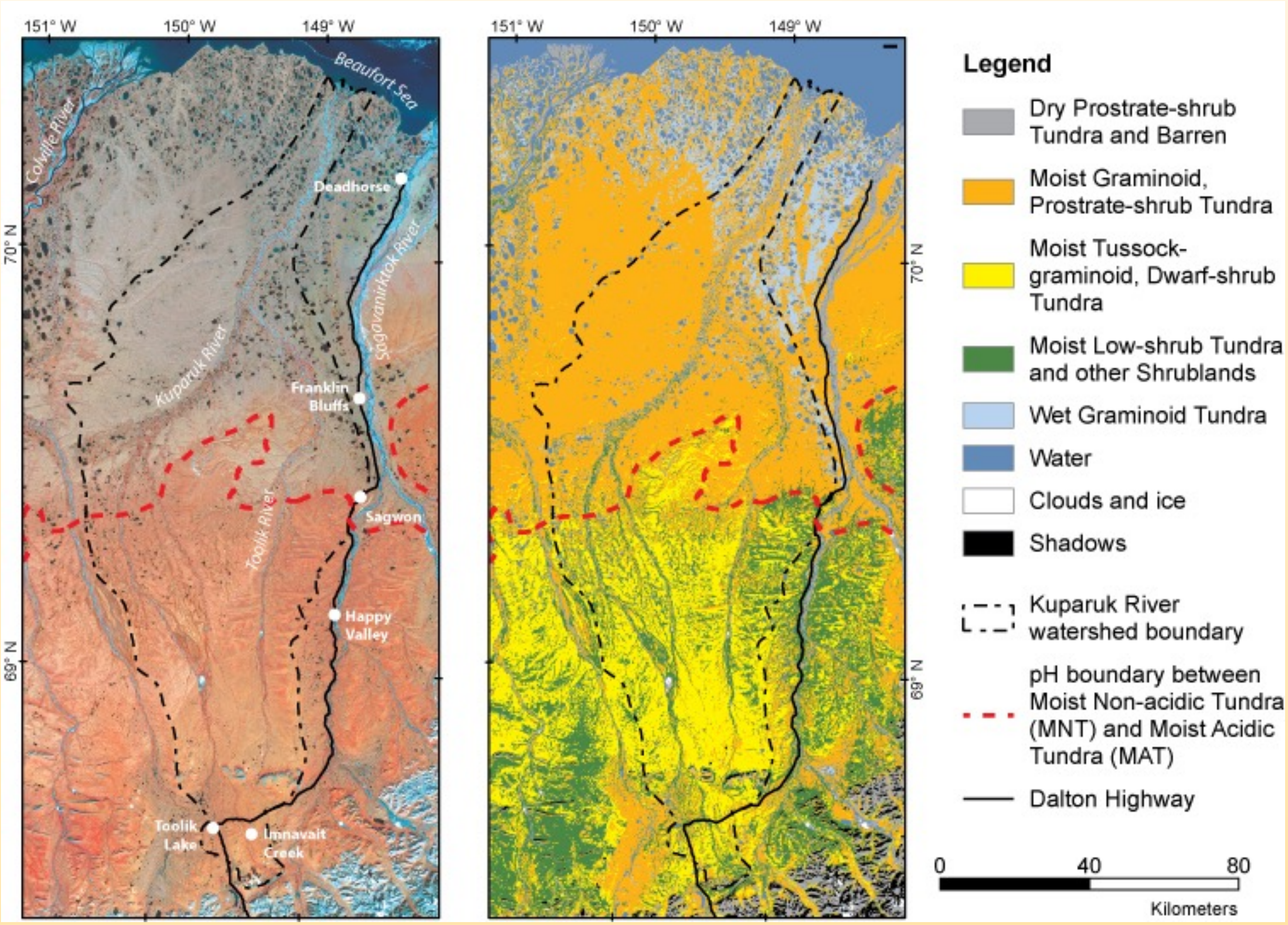
Kuparuk River region (southern part of the NAAT)

North of the pH boundary: Abundant bare soil (frost boils) and dead sedge vegetation, few erect shrubs, <u>low NIR reflectance</u>.

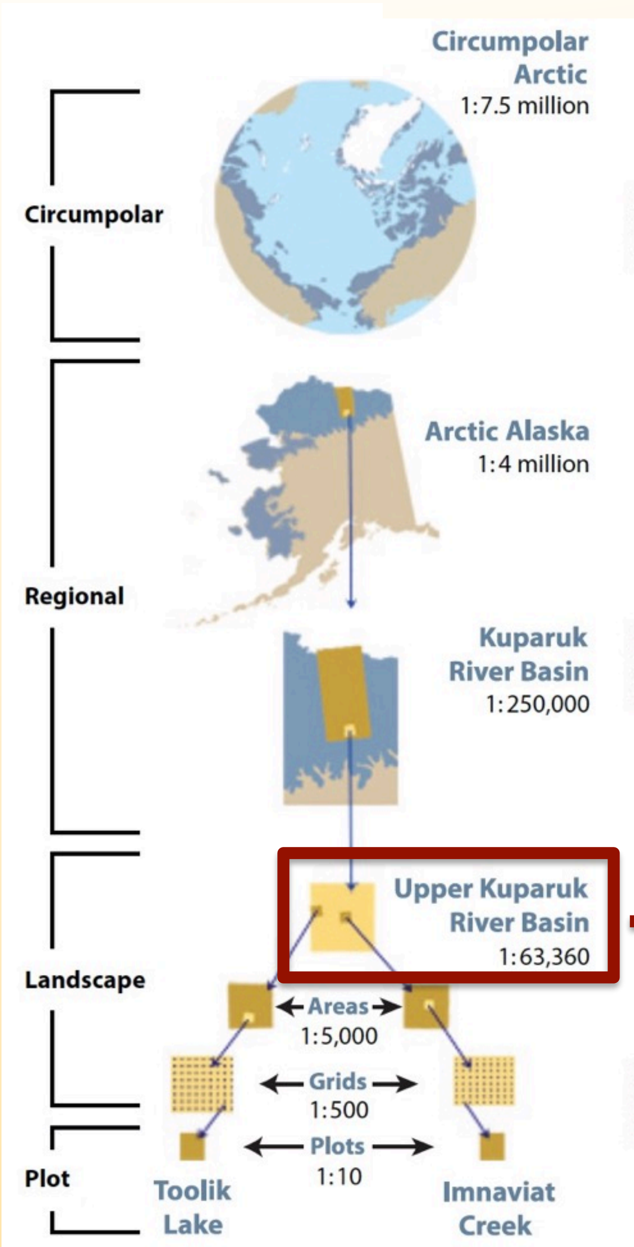
South of the pH boundary: Abundant erect shrubs, <u>high NIR reflectance</u>.

LANDSAT
False-color infrared

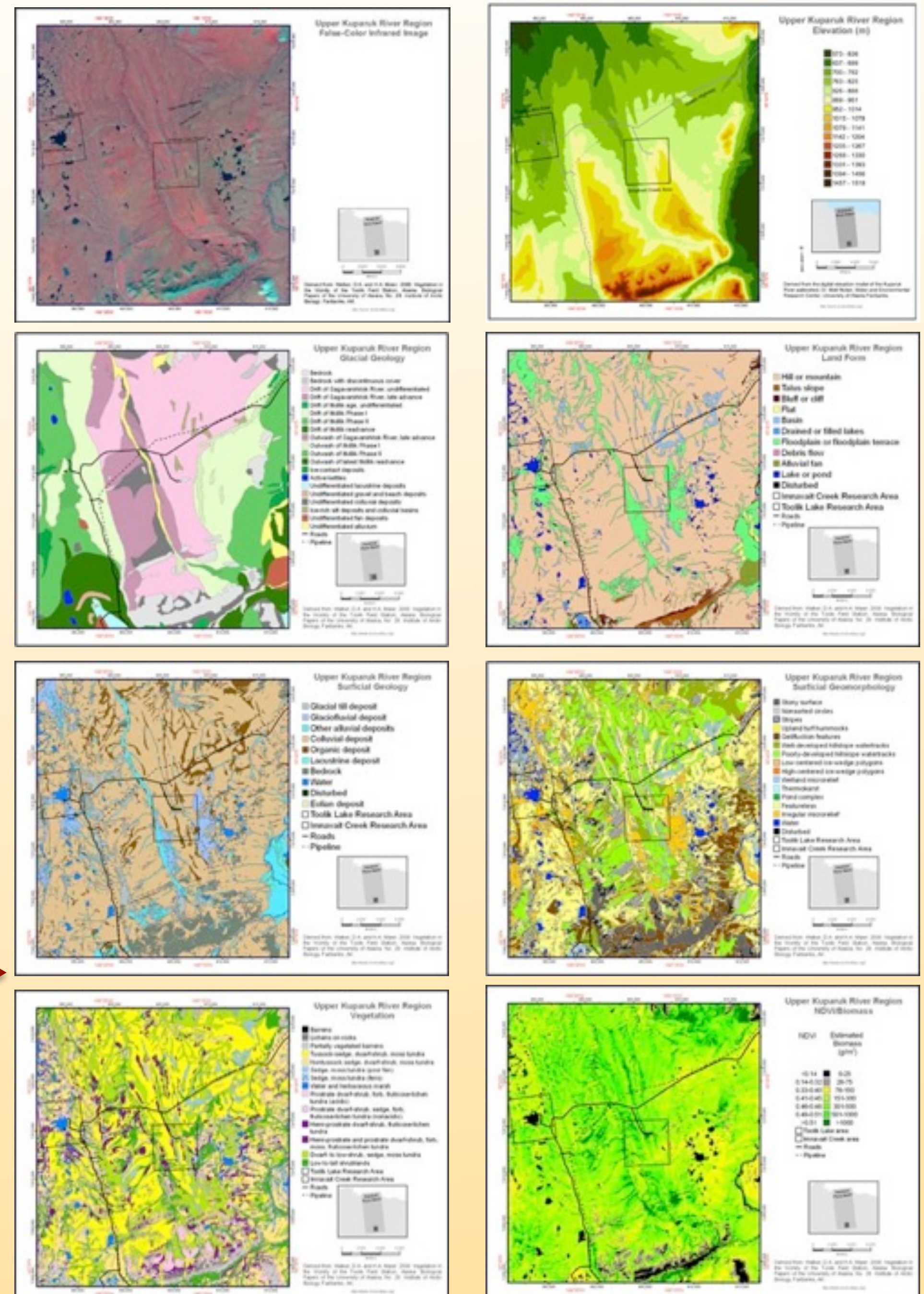
Vegetation



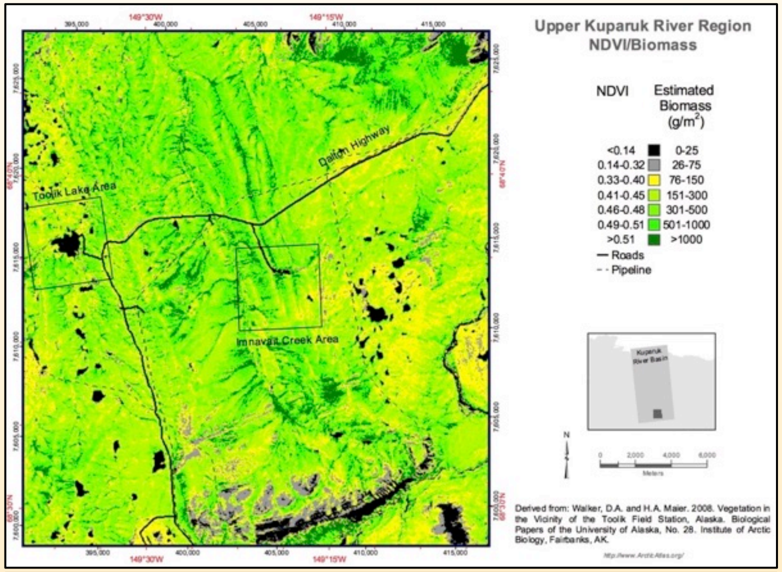
Landscape-level relationships

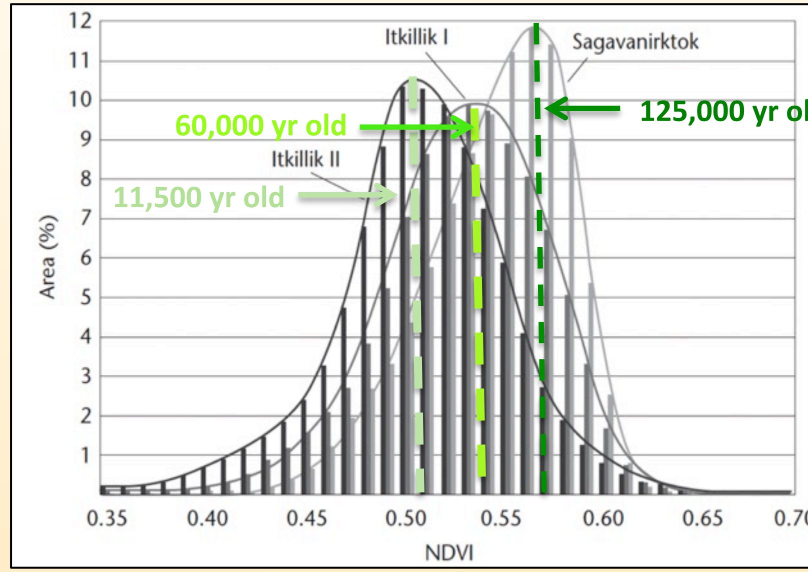


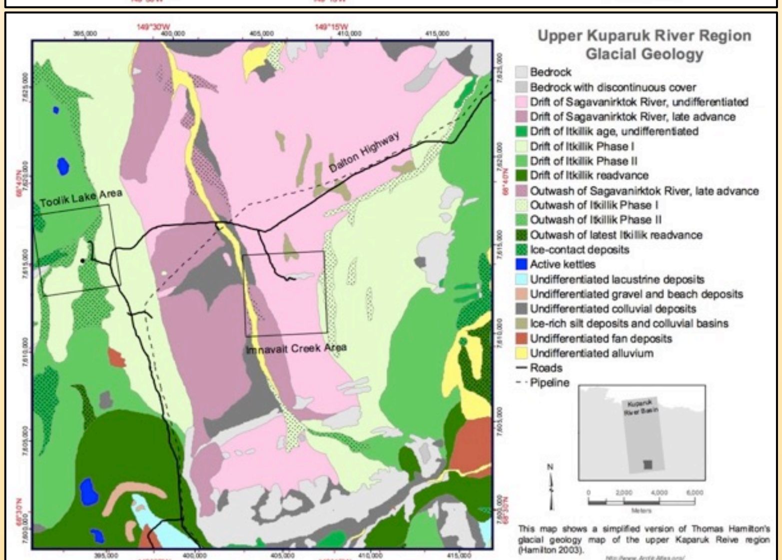
Map themes for the Upper Kuparuk River



Landscape-level analysis
Glacial geology & SPOT-derived NDVI relationships in the Upper Kuparuk River region







- Younger to older surfaces spanning about 125,000 years
- General increase in NDVI and total landscape biomass/unit area with landscape age.
- Note: The structure of the landscape changes with age, with a lot more water tracks (drainages) with large amounts of shrubby biomass.

Walker et al. 1995, Polar Record

Linkage of Upper Kuparuk River glaciation study to plot NDVI and biomass data

Polar Record 31 (177): 147–154 (1995). Printed in Great Britain.

Biomass and leaf-area index maps derived from SPOT images for Toolik Lake and Imnavait Creek areas, Alaska

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ABSTRACT. A new emphasis on understanding natural systems at large spatial scales has led to an interest in deriving ecological variables from satellite reflectance images. The normalized difference vegetation index (NDVI) is a measure of canopy greenness that can be derived from reflectances at near-infrared and red wavelengths. For this study we investigated the relationships between NDVI and leaf-area index (LAI), intercepted photosynthetically active radiation (IPAR), and biomass in an Arctic tundra ecosystem. Reflectance spectra from a portable field spectrometer, LAI, IPAR, and biomass data were collected for 180 vegetation samples near Toolik Lake and Imnavait Creek, Alaska, during July and August 1993. NDVI values were calculated from red and near-infrared reflectances of the field spectrometer spectra. Strong linear relationships are seen between mean NDVI for major vegetation categories and mean LAI and biomass. The relationship between mean NDVI and mean IPAR for these categories is not significant. Average NDVI values for major vegetation categories calculated from a SPOT image of the study area were found to be highly linearly correlated to average field NDVI measurements for the same categories. This indicates that in this case it is appropriate to apply equations derived for field-based NDVI measurements to NDVI images. Using the regression equations for those relationships, biomass and LAI images were calculated from the SPOT NDVI image. The resulting images show expected trends in LAI and biomass across the landscape.

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Introduction

Advantages of remotely sensed observations of ecological variables

The new emphasis in the natural sciences on the understanding of global scale phenomena has prompted ecologists to seek methods by which ecological data can be collected at large spatial scales. For example, calculating fluxes of trace gases from a region would require estimates of the spatial extent and variability across the region of ecological variables that control these fluxes. Collecting collected at large spatial scales. For example, calculating fluxes of trace gases from a region would require estimates of the spatial extent and variability across the region of ecological variables that control these fluxes. Collection of such data through field surveys is usually not feasible because of financial and time limitations. Remotely sensed reflectance data provide an alternative means for making these estimates.

Additional advantages of remotely sensed reflectance data include the non-destructive nature of reflectance measurements. Moreover, they record the actual rather than the potential state of ecological variables, because they include any local perturbations. For example, effects of variation in soils, topography, vegetation history, disturbance regimes, or anthropogenic perturbations (such as agriculture and development) are inherent in remotely sensed data (Box and others 1989; Prince 1991; Walker and Walker 1991). Commonly used bioclimatic estimates of ecological variables, on the other hand, can only describe the vegetation that is expected on the basis of average climatic conditions.

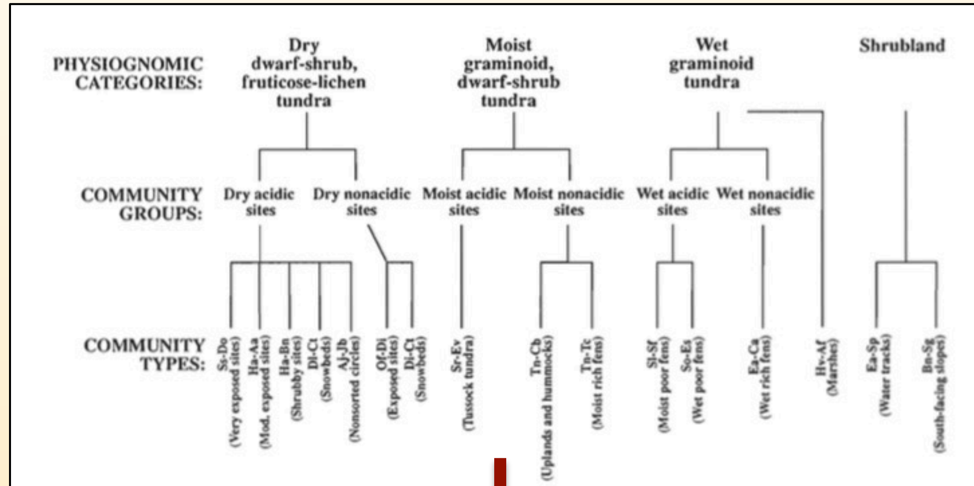
Objective of this study

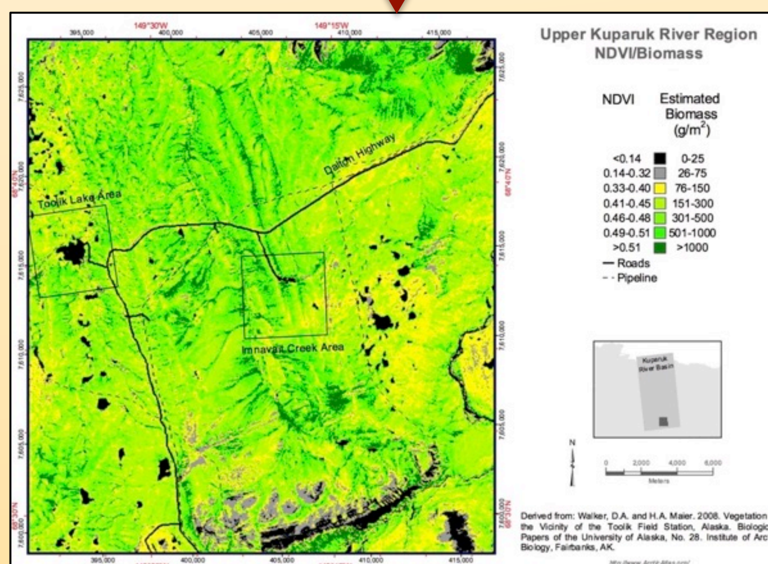
The objective of this study was to investigate the feasibility of deriving variables of ecological interest from satellite multispectral reflectance images of Arctic tundra. A particular interest in studying aspects of the carbon cycle led to examining the relationships between reflectance and biomass, leaf-area index (LAI), and intercepted photosynthetically active radiation (IPAR), because these ecological variables are relevant to this cycle. LAI is a measure of the density of foliage. IPAR is an indication of the photosynthetic rate of the canopy. Biomass is a measure of the amount of carbon stored in the canopy. Many previous studies have examined relationships between reflectance and biomass, LAI, and IPAR in temperate ecosystems and crops (for example, Biscoe and others 1975; Hodges and Kanemasu 1977; Asrar and others 1985). LAI and IPAR have been used in crop yield and evapotranspiration models and vegetation monitoring ef-1975; Hodges and Kanemasu 1977; Asrar and others 1985). LAI and IPAR have been used in crop yield and evapotranspiration models and vegetation monitoring efforts (for example, Wiegand and others 1979; Steven and others 1983; Hatfield and others 1984).

Vegetation indices

When sunlight falls on green vegetation, red wavelengths (near 0.6 μm) are absorbed by chloroplasts, while near-infrared wavelengths (0.7–0.9 μm) are reflected. Because this spectrum is unique to vegetation, one way to infer the amount of vegetation existing in a pixel of a multispectral reflectance image is to compare the reflectance for that pixel at red wavelengths to the reflectance at near-infrared wavelengths. If the near-infrared reflectance is much larger than the red reflectance, then presumably there is a considerable amount of green vegetation present. The use of a ratio of near-infrared to red light for estimating vegetation amount was first reported by Jordan (1969). He used a ratio of light transmitted to the forest floor at 0.800 and 0.675 μm to derive the leaf-area index for forest

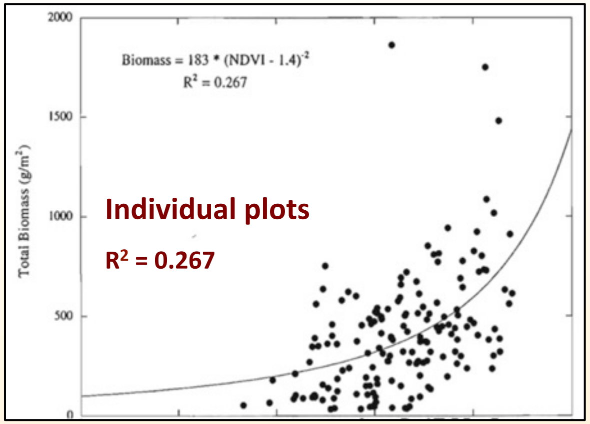
60 plots: Biomass & NDVI (PS-2, SPOT) (Walker et al. 1995)

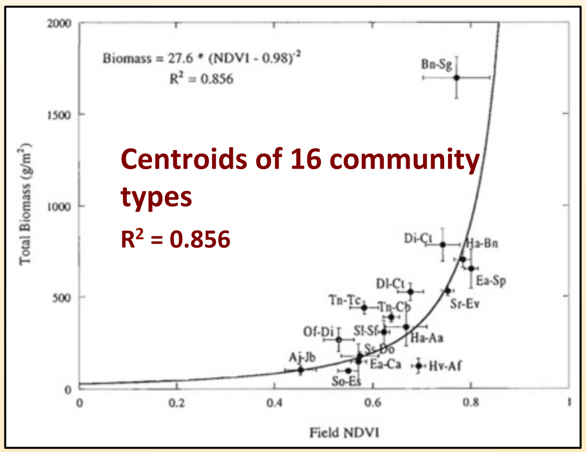


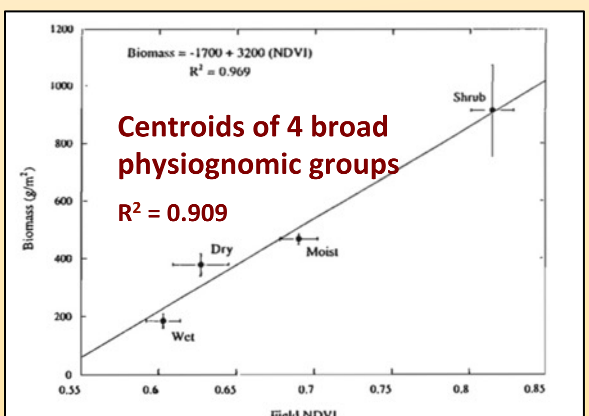


Analysis of Toolik NDVI-biomass relationship by different groupings of the plot data

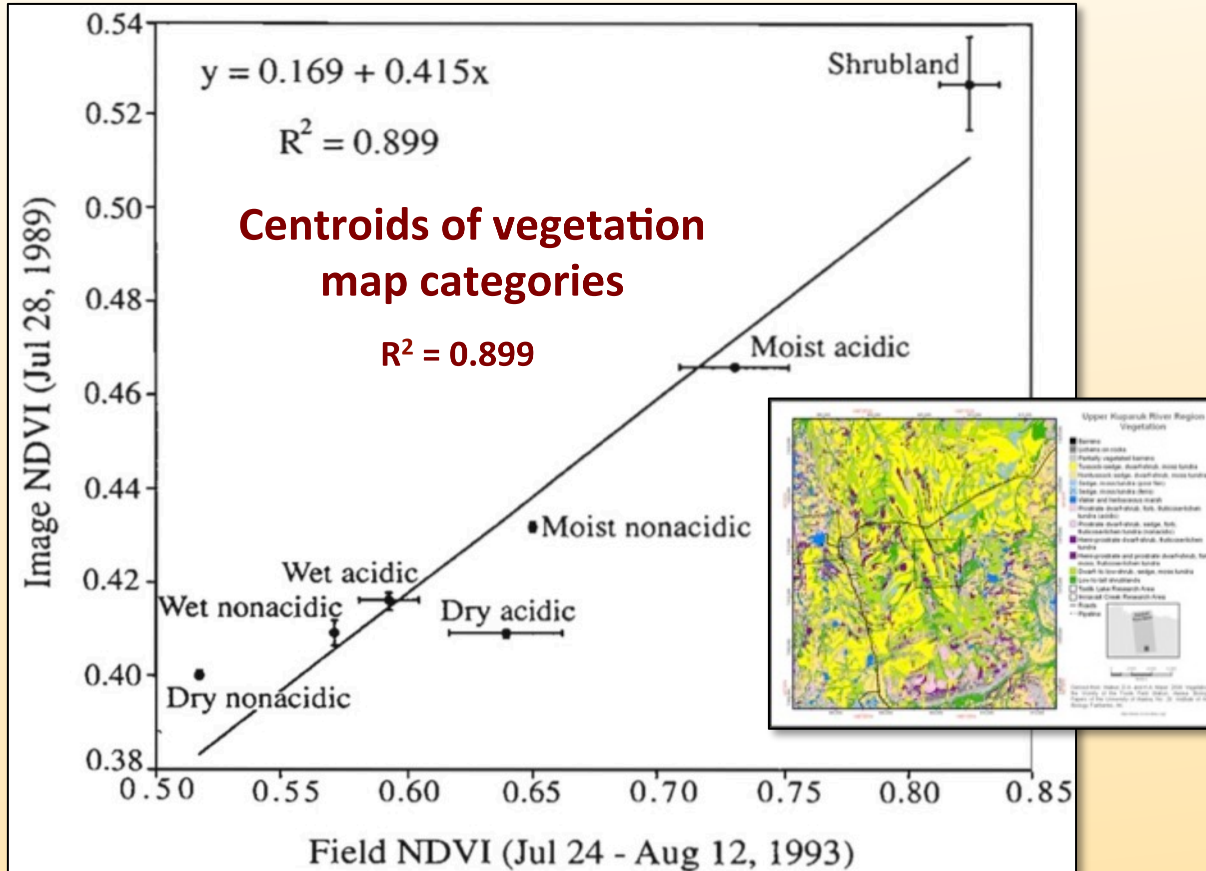
Biomass vs. Field NDVI







Comparison of SPOT NDVI vs. Field NDVI



Range of mean NDVI values:

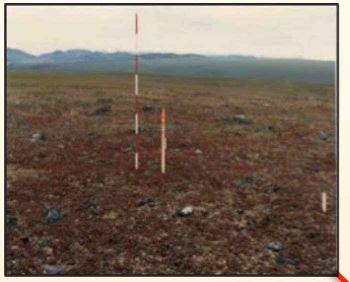
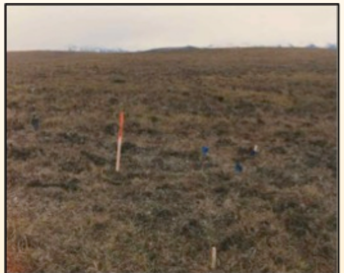
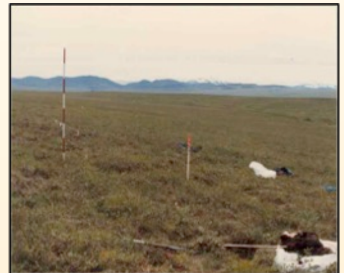
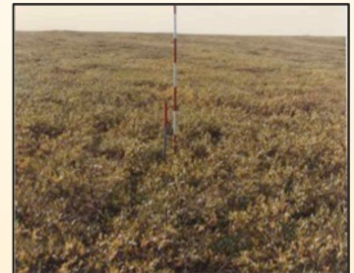
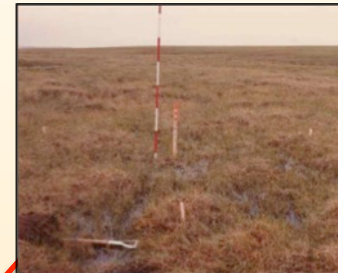
Field: 0.52 (dry nonacidic)-0.83 (shrublands)

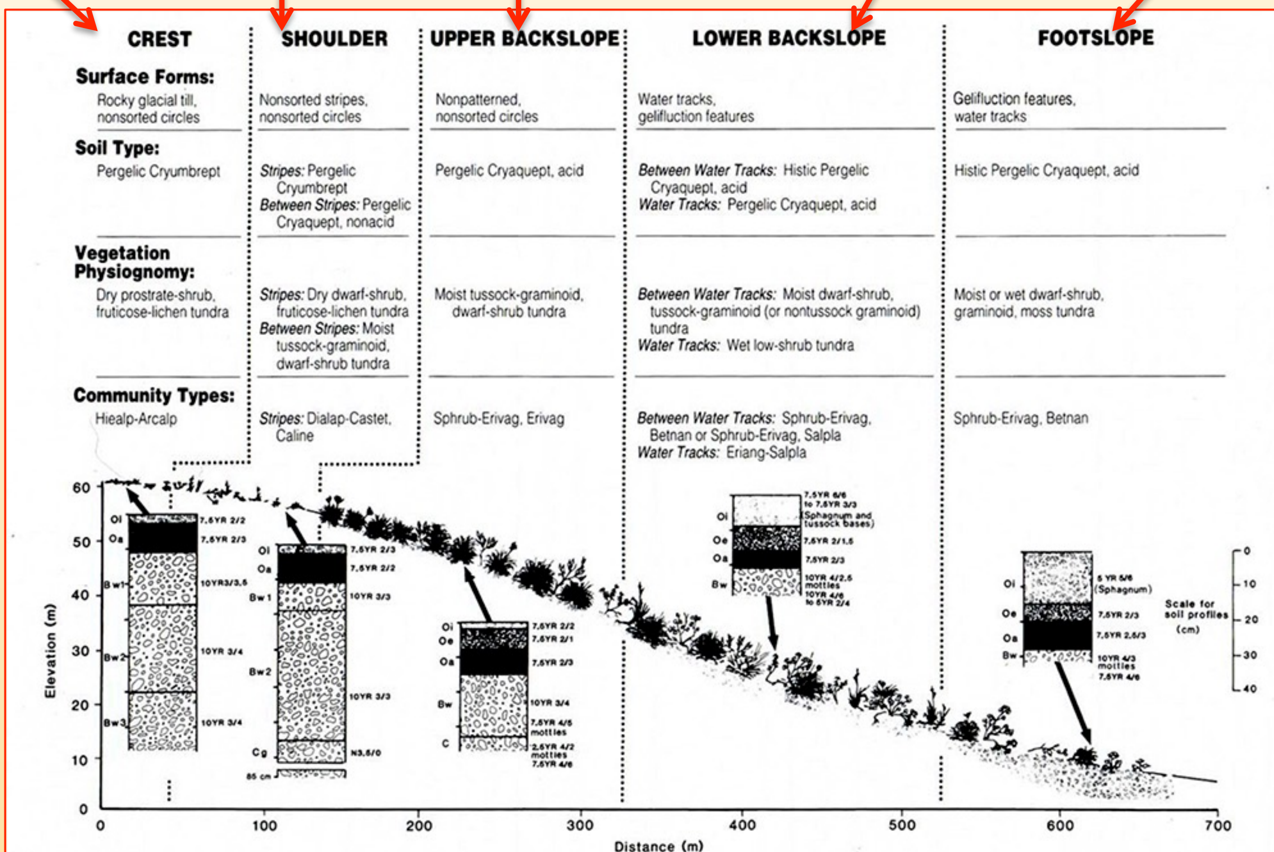
SPOT: 0.40 – 0.53

Shippert et al. 1995, Polar Record

Interpretation of vegetation at all scales is based on plot-level surveys of vegetation, soils and site factors

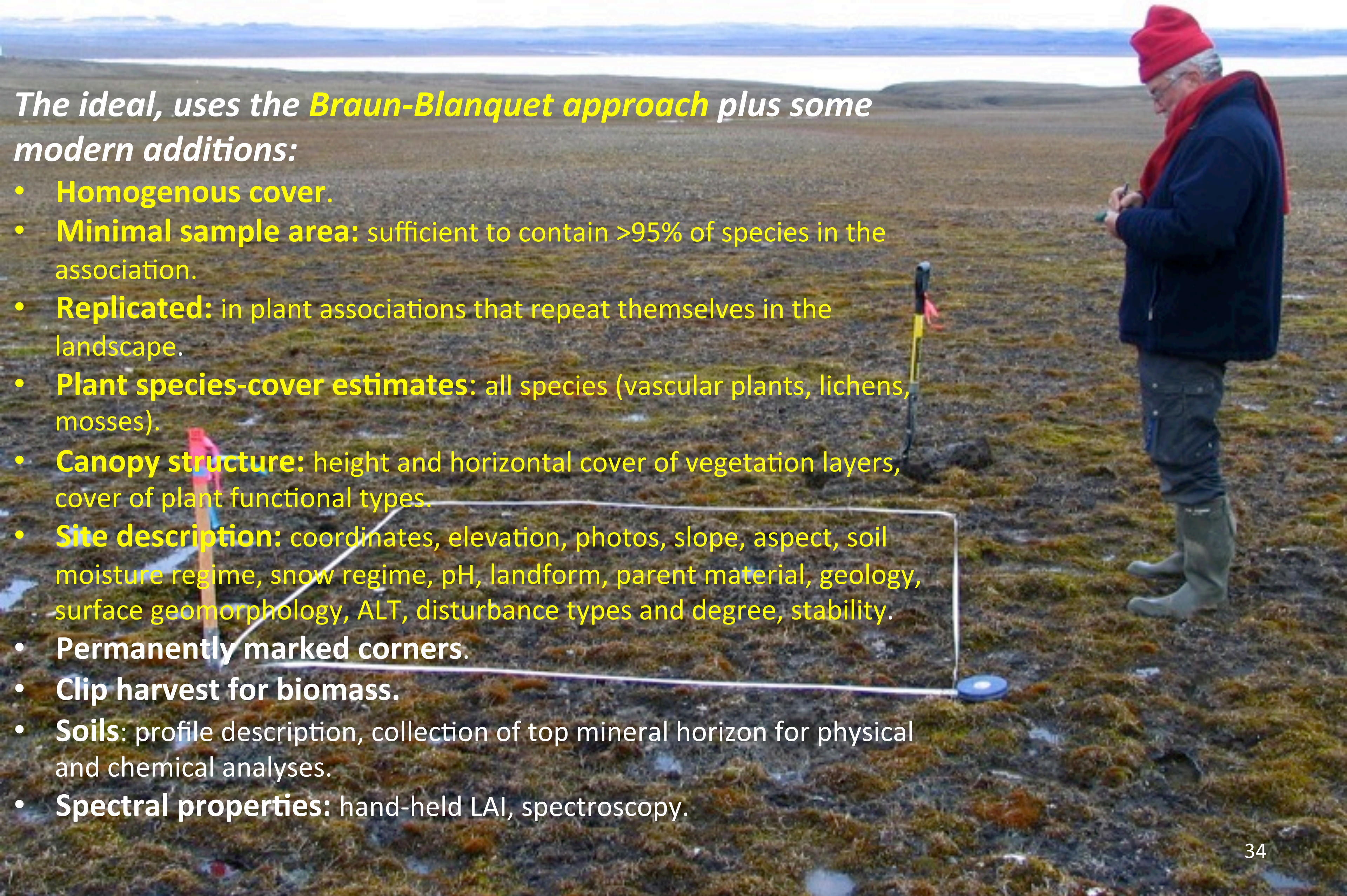
Toposequence at Imnavait Creek (Sagavanirktok glacial surface, 125,000 yr old)



Walker et al. in Reynolds and Tenhunen (1996).

Plot-level observations



The ideal, uses the Braun-Blanquet approach plus some modern additions:

- **Homogenous cover**.
- **Minimal sample area:** sufficient to contain >95% of species in the association.
- **Replicated:** in plant associations that repeat themselves in the landscape.
- **Plant species-cover estimates**: all species (vascular plants, lichens, mosses).
- **Canopy structure:** height and horizontal cover of vegetation layers, cover of plant functional types.
- **Site description:** coordinates, elevation, photos, slope, aspect, soil moisture regime, snow regime, pH, landform, parent material, geology, surface geomorphology, ALT, disturbance types and degree, stability.
- **Permanently marked corners**.
- **Clip harvest for biomass.**
- **Soils**: profile description, collection of top mineral horizon for physical and chemical analyses.
- **Spectral properties:** hand-held LAI, spectroscopy.

Alaska Arctic Vegetation Plot Archive

si

Authors: D.A. Walker, U.S. Bhatt, A.L. Breen, M. Buchhorn, L.A. Druckenmiller, H.E. Epstein, W. Fisher, S. Hennekens, M.K. Raynolds, J. Sibik, M.D. Walker, L.M. Wirth

Collaborators: K. Boggs, T. Boucher, H. Bültmann, D.J. Cooper, F.J.A Daniëls, J.J. Ebersole, S.C. Elmendorf, W.A. Gould, B.D. Hollister, C. Iverson, A. Kade, M.T. Jorgenson, M.T. Lee, M.H. MacKenzie, R.K. Peet, U. Schickhoff, V. Sloan, S.S. Talbot, C.E. Tweedie, S. Villarreal, P.J. Webber

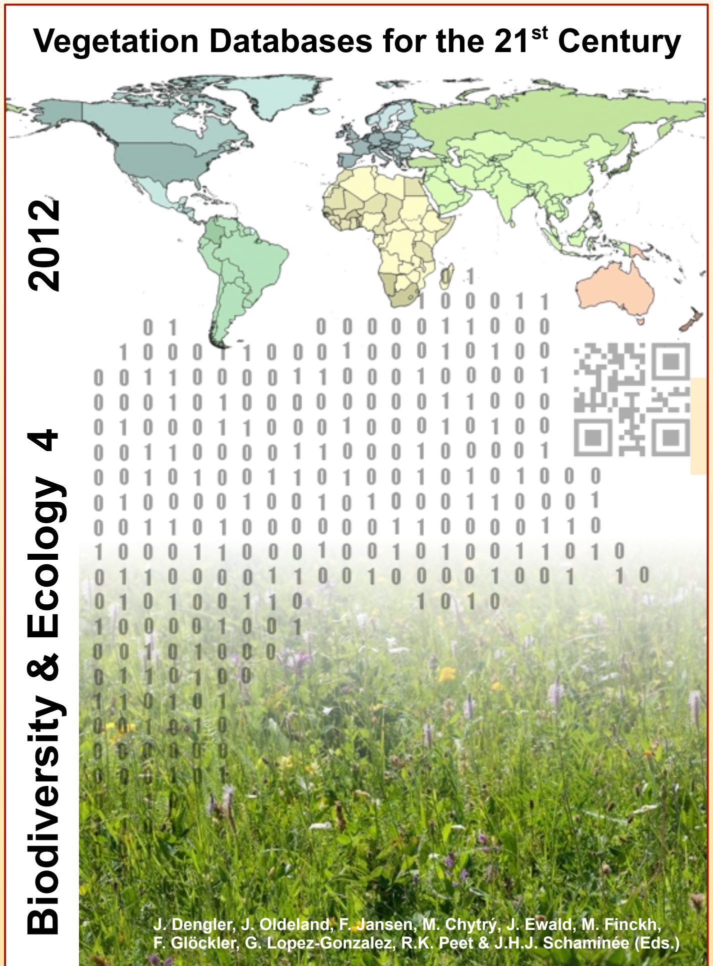
Alaska Geobotany Center

NASA

ABoVE
ARCTIC BOREAL VULNERABILITY EXPERIMENT

The Arctic vegetation archive is modeled after the European Vegetation Archive (EVA).

The European Vegetation Archive: A methodology for handling massive vegetation databases.



Applied Vegetation Science (2015)

REPORT

European Vegetation Archive (EVA): an integrated database of European vegetation plots

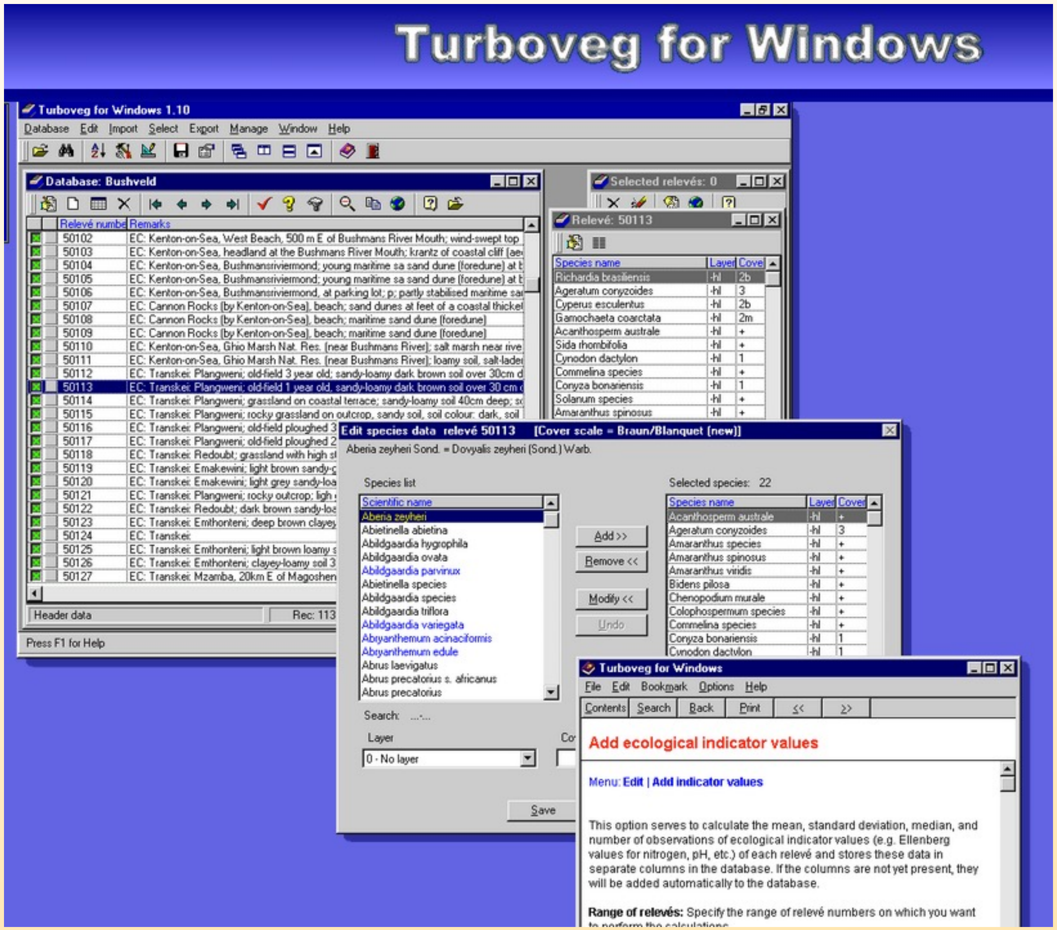
Milan Chytrý, Stephan M. Hennekens, Borja Jiménez-Alfaro, Ilona Knollová, Jürgen Dengler, Florian Jansen, Flavia Landucci, Joop H.J. Schaminée, Svetlana Aćić, Emiliano Agrillo, Didem Ambarlı, Pierangela Angelini, Iva Apostolova, Fabio Attorre, Christian Berg, Erwin Bergmeier, Idoia Biurrun, Zoltán Botta-Dukát, Henry Brisse, Juan Antonio Campos, Luis Carlón, Andraž Čarni, Laura Casella, János Csiky, Renata Ćušterevska, Zora Dajić Stevanović, Jiří Danihelka, Els De Bie, Patrice de Ruffray, Michele De Sanctis, W. Bernhard Dickoré, Panayotis Dimopoulos, Dmytro Dubyna, Tetiana Dziuba, Rasmus Ejrnæs, Nikolai Ermakov, Jörg Ewald, Giuliano Fanelli, Federico Fernández-González, Úna FitzPatrick, Xavier Font, Itziar García-Mijangos, Rosario G. Gavilán, Valentin Golub, Riccardo Guarino, Rense Haveman, Adrian Indreica, Deniz Işık Gürsoy, Ute Jandt, John A.M. Janssen, Martin Jiroušek, Zygmunt Kącki, Ali Kavgacı, Martin Kleikamp, Vitaliy Kolomiychuk, Mirjana Krstivojević Ćuk, Daniel Krstonošić, Anna Kuzemko, Jonathan Lenoir, Tatiana Lysenko, Corrado Marcenò, Vassiliy Martynenko, Dana Michalcová, Jesper Erenskjold Moeslund, Viktor Onyshchenko, Hristo Pedashenko, Aaron Pérez-Haase, Tomáš Peterka, Vadim Prokhorov, Valerijus Rašomavičius, Maria Pilar Rodríguez-Rojo, John S. Rodwell, Tatiana Rogova, Eszter Ruprecht, Solvita Rūsiņa, Gunnar Seidler, Jozef Šibík, Urban Šilc, Željko Škvorc, Desislava Sopotlieva, Zvjezdana Stančić, Jens-Christian Svenning, Grzegorz Swacha, Ioannis Tsiripidis, Pavel Dan Turtureanu, Emin Uğurlu, Domas Uogintas, Milan Valachovič, Yulia Vashenyak, Kiril Vassilev, Roberto Venanzoni, Risto Virtanen, Lynda Weekes, Wolfgang Willner, Thomas Wohlgemuth & Sergey Yamalov

Abstract

The European Vegetation Archive (EVA) is a centralized database of European vegetation plots developed by the IAVS Working Group European Vegetation Survey. It has been in development since 2012 and first made available for use in research projects in 2014. It stores copies of national and regional vegetation-plot databases on a single software platform. Data storage in EVA does not affect on-going independent development of the contributing databases, which remain the property of the data contributors. EVA uses a prototype of the database management software TURBOVEG 3 developed for joint management of multiple databases that use different species lists. This is facilitated by the SynBioSys Taxon Database, a system of taxon names and concepts used in the individual European databases and their corresponding names on a unified list of European flora. TURBOVEG 3 also includes procedures for handling data requests, selections and provisions according to the approved EVA Data Property and Governance Rules. By 30 June 2015, 61 databases from all European regions have joined EVA, contributing in total 1 027 376 vegetation plots, 82% of them with geographic coordinates, from 57 countries. EVA provides a unique data source for large-scale analyses of European vegetation diversity both for fundamental research and nature conservation applications. Updated information on EVA is available online at http://euroveg.org/eva-database.

61 databases, 1,027,376 plots

Species data and a select set of environmental header data are in a single Turboveg database <u>and</u> separate .csv files for each dataset



http://www.synbiosys.alterra.nl/turboveg/

Turboveg

Database management system for the storage, selection, and export of vegetation data (relevés).

- ✓ **Free for:**
  - **private use**
  - **students**
  - **institutes or universities which don't have sufficient resources to buy the software.**
- ✓ **Easy import into vegetation analysis programs (e.g., JUICE, Twinspan, Canoco, Excel, Mulva).**

Hennekens, S. M., & Schaminée, J. H. J. (2001). TURBOVEG, a comprehensive data base management system for vegetation data. *Journal of Vegetation Science*, *12*, 589–591.

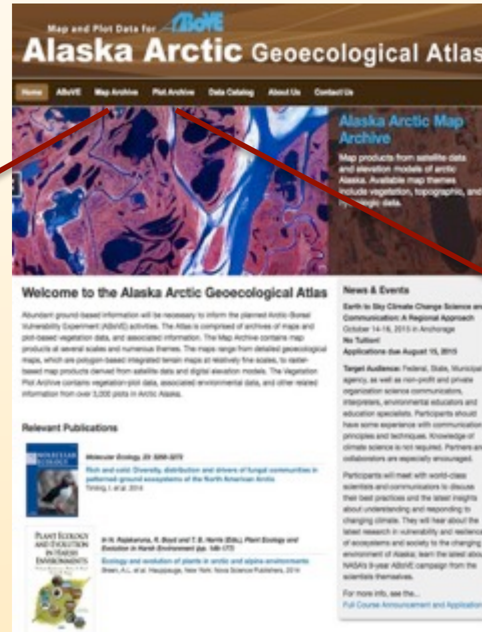
Data portal

2013. Alaska Arctic Geoecological Atlas data portal

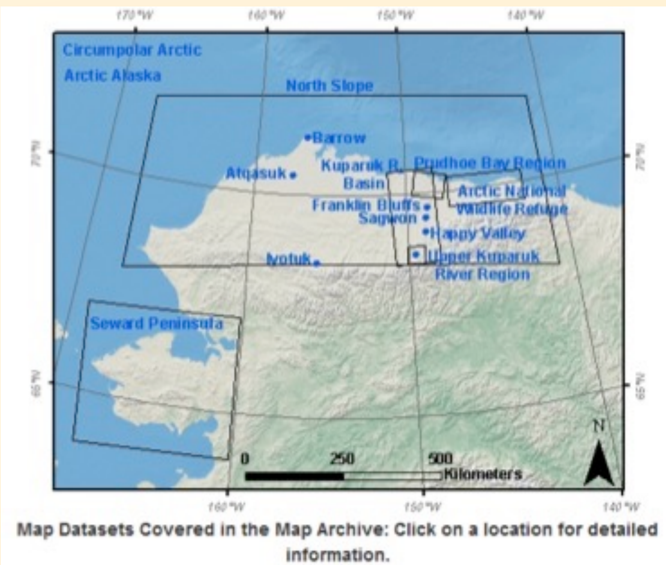
- **Housed at the Geographic Information Network of Alaska (GINA), UAF.**
- **Includes the AK-AVA (plot archive) and AK-AMA (map archive).**
- **Web Link: http://alaskaaga.gina.alaska.edu/**

Three major components of the geoecological atlas

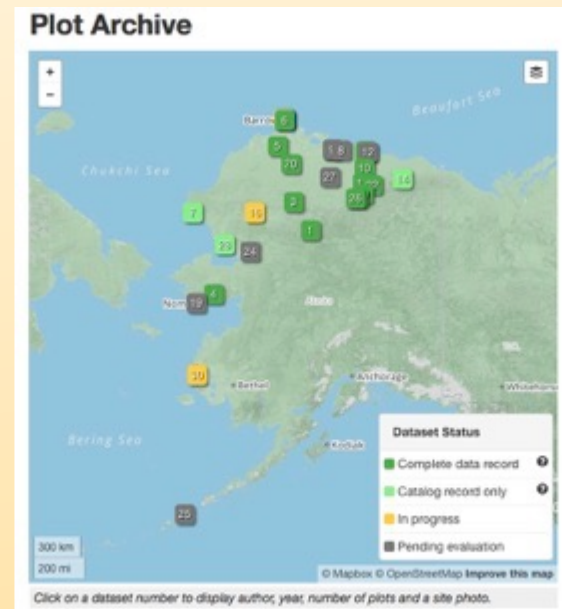
Data Portal



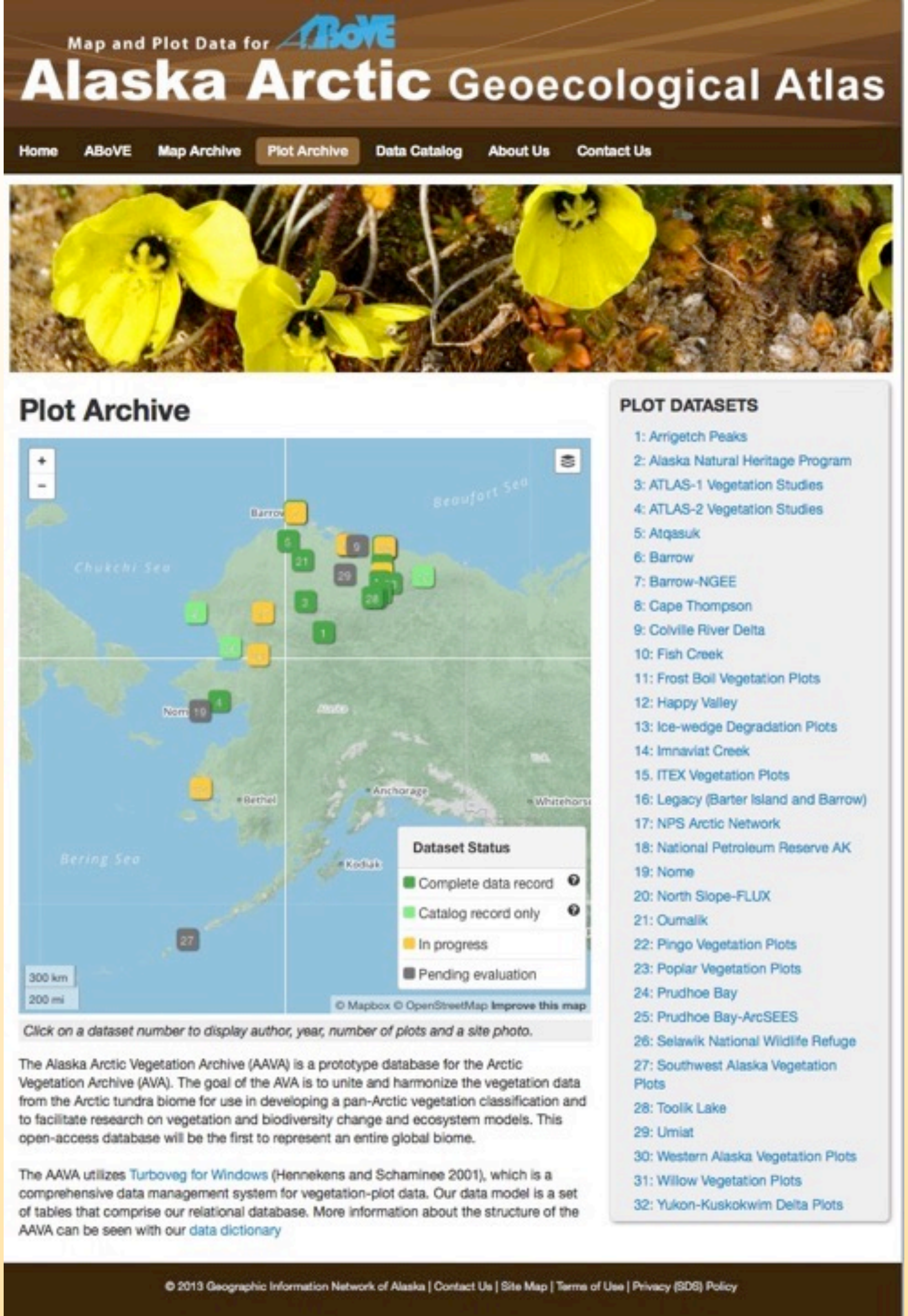
Map Archive



Plot Archive

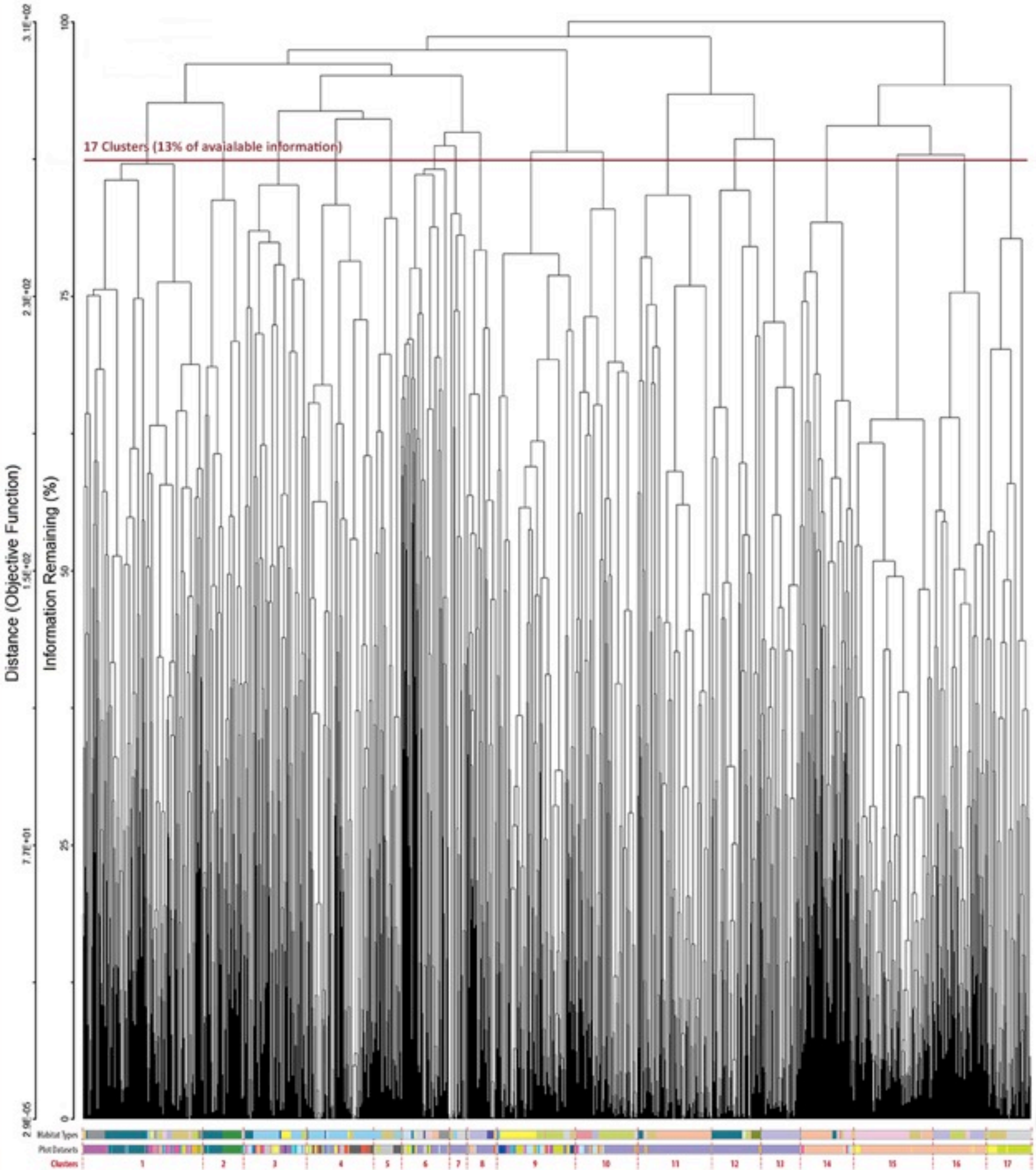


A synthesis of data from Arctic Alaska vegetation plot studies + remote sensing and map products derived from these studies.



Data currently in the AK-AVA Plot Archive

- **16 completed datasets.**
- **1603 plots.**



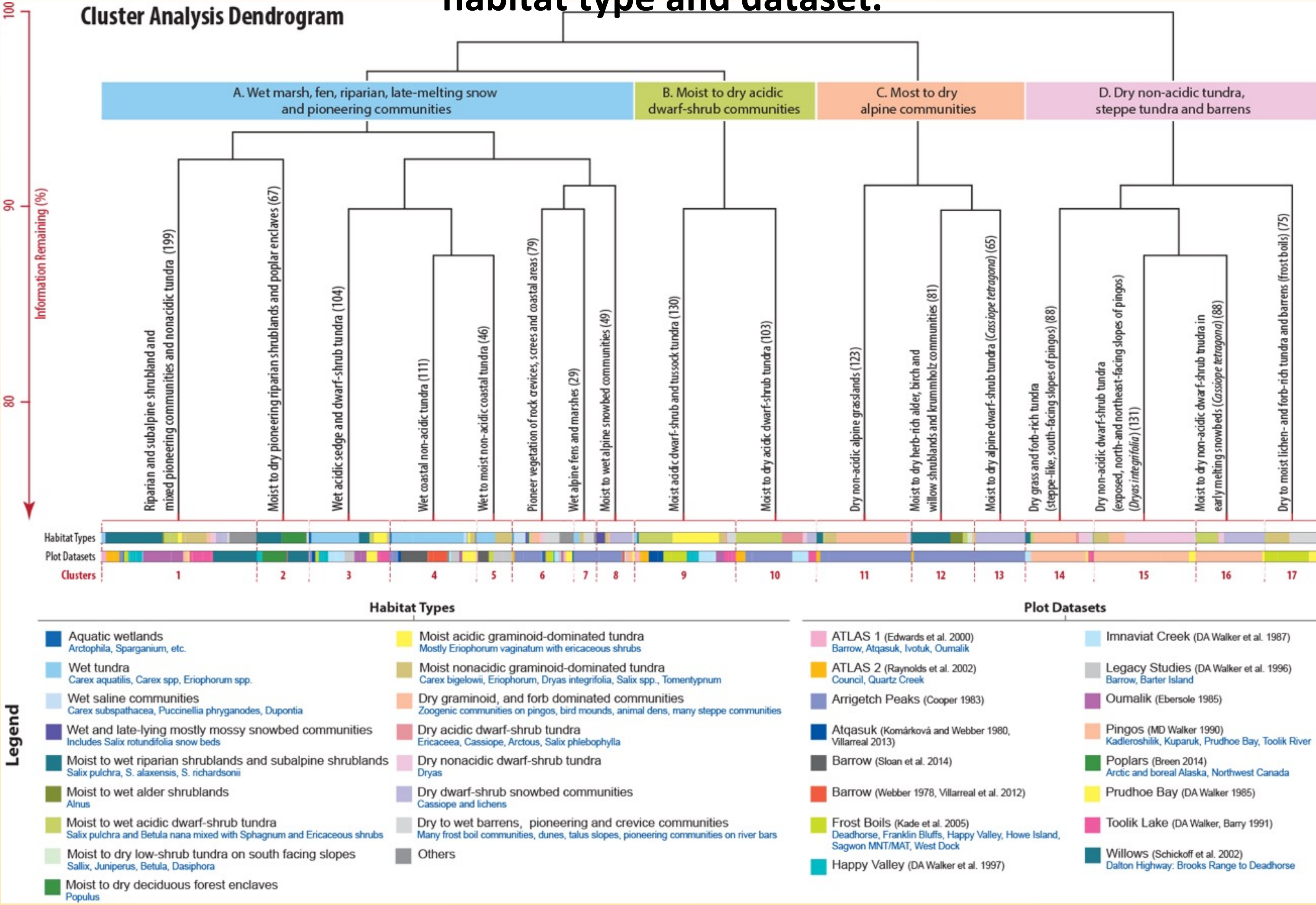
Preliminary cluster analysis of AK-AVA data

Full dendrogram showing all relevés

- 1603 plots analyzed according to floristic similarity.
- 17 high-level clusters (above the red line) show the highest “separation power” (next slide).
- The two bottom color bars show the habitat type and datasets of the plots.

Sibik et al. 2015 in prep.

Preliminary cluster analysis of AK-AVA data: Top 4 and top 17 subclusters: sorted by habitat type and dataset.



Cluster A: Wet tundra, wet snowbeds, riparian shrublands, poplar groves, azonal and pioneering communities: 684 plots.
Cluster B: Acidic tundra types including tussock tundra, dry dwarf-shrub heaths: 233 plots.
Cluster C: Most alpine plant communities with high cover of forbs and grasses: 269 plots.
Cluster D: Dry non-acidic tundra and steppe tundra vegetation: 382 plots.

Sibik et al. 2015 in prep.

Recommendations for monitoring future biomass and productivity changes

1. **Arctic Observatories:** Fulll vegetation surveys at all locations, with permanently marked and replicated vegetation monitoring plots established in the full range of habitat types.
2. **Consistent criteria**, including:
   - Methods for marking plots.
   - Methods for surveying plants and the environment.
   - Full species lists for the vascular plants, bryophytes, and lichens.
   - Methods for collecting and analyzing phytomass and ground-based spectral data.
3. **Periodic resurveys** (perhaps every 5-10 years) including ground-based measurements of biomass, leaf-area index, and NDVI.
4. **Link information to maps** using International standards for vegetation classification and mapping.
5. **Coordinated observations by other specialists** on the same plots (e.g., soil scientists, permafrost scientists, remote-sensing specialists, and animal ecologists).
6. **Areas of special concern and "hotspots" of productivity or biodiveersity**: Need to also survey critical areas not represented at the observatories.

Conclusion

- Although space-based methods of monitoring are the only means to detect circumpolar-scale patterns of productivity and biomass changes, the satellite data cannot detect changes to diversity of Arctic species or many of the subtle structural changes or changes to ecosystem processes that can only be observed with coordinated ground-based monitoring.
- Moving forward with our exploration, description, and analysis of the vegetation in the Arctic tundra biome will require greater attention to unified collaborative approaches to improve sampling and sharing of plot information.
- High priority should be given to developing plot-based survey methods and datasets that lend themselves to hierarchical studies at landscape, regional and panarctic scales using remote sensing.