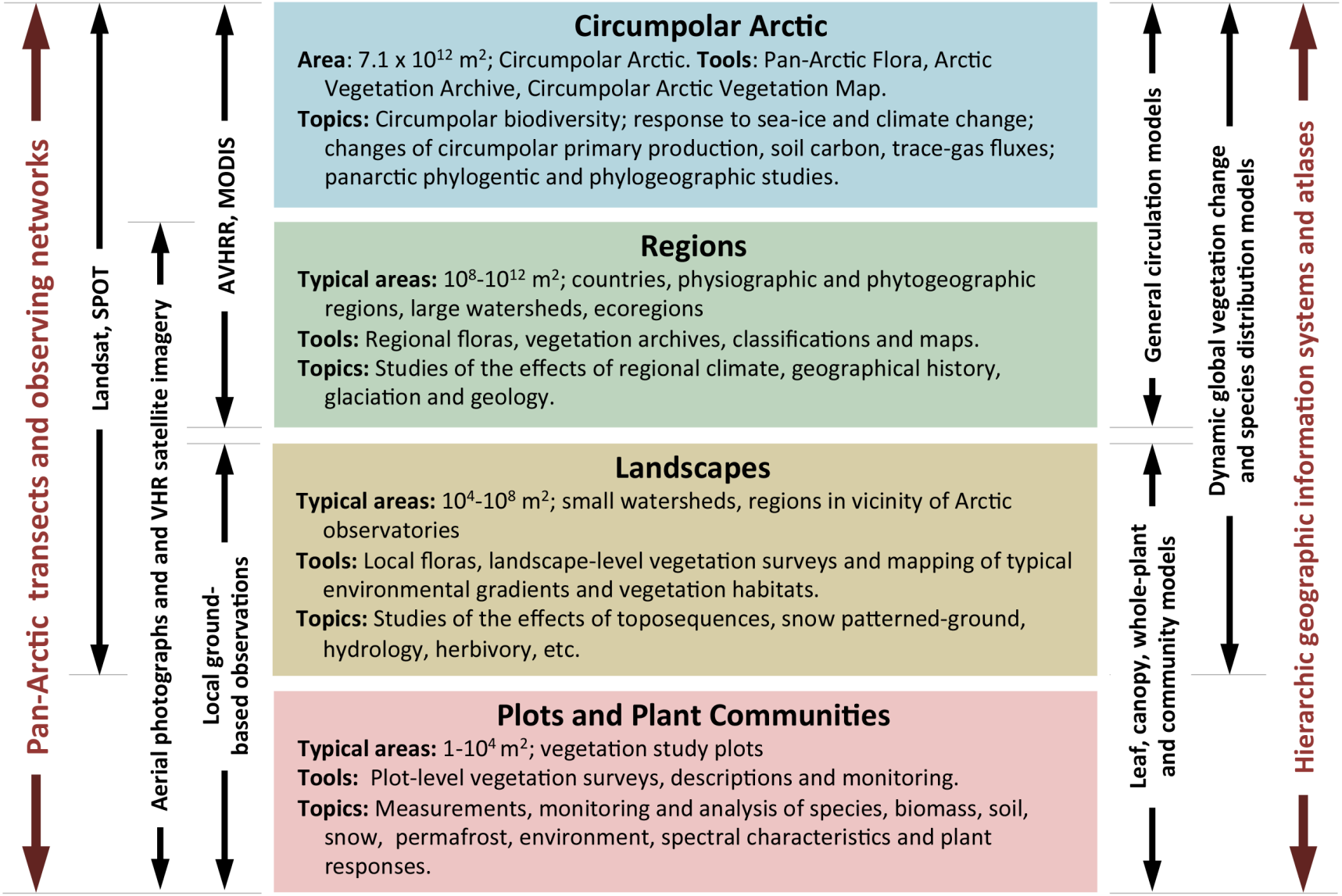
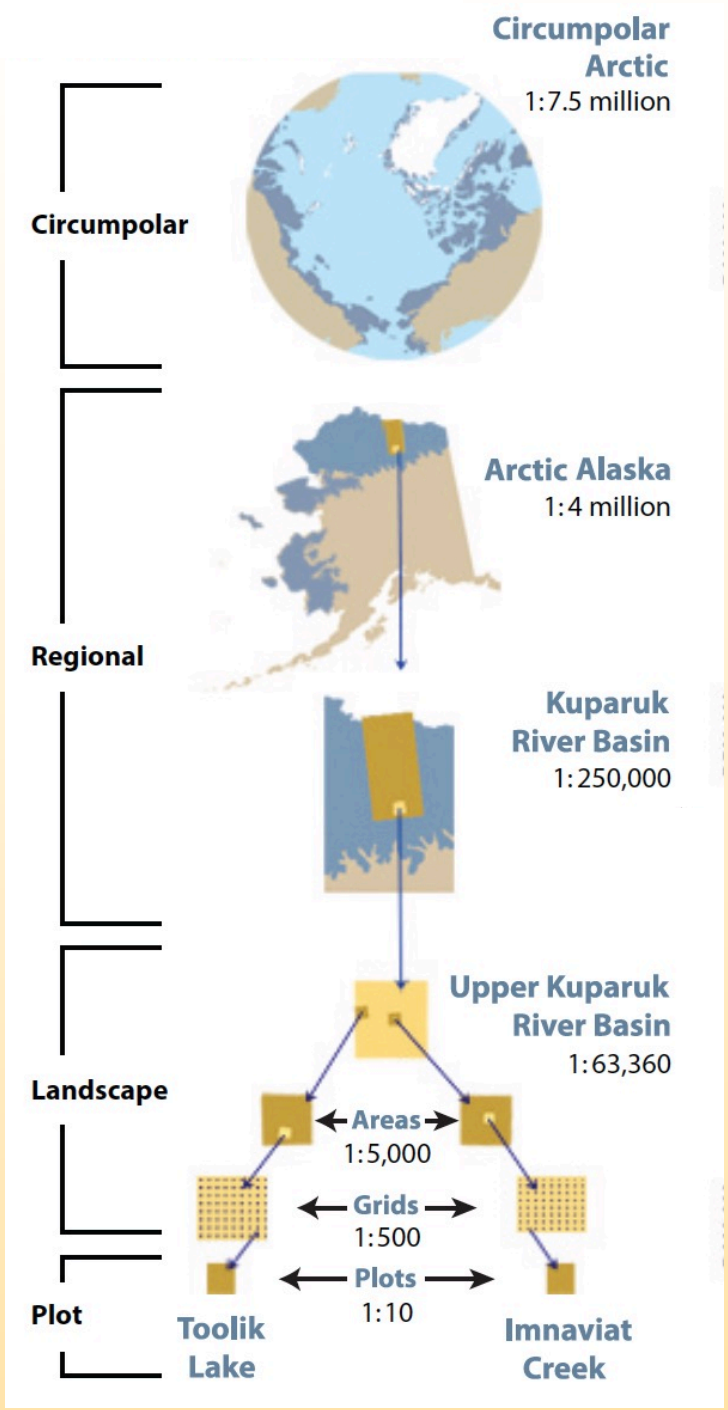
A hierarchic framework for studying Arctic vegetation

Remote sensing and ground-based monitoring tools

Scales, size of areas, typical topics, other resources

Integration and modeling tools





Hierarchy of mapping scales and relevant vegetation and productivity topics for northern Alaska

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:

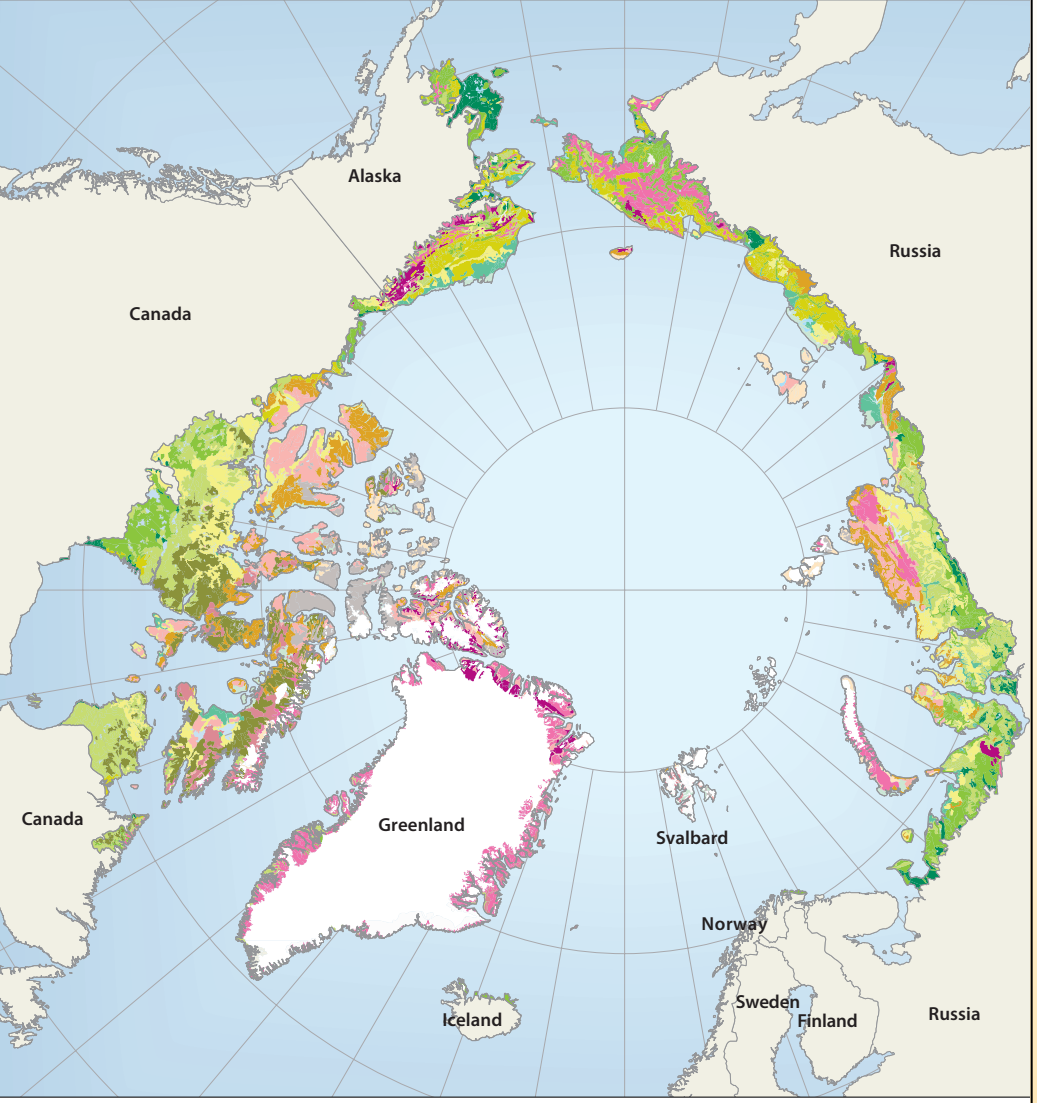
- Variation due meso-topography, landscape water and snow distribution.

Plot:

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

The Circumpolar Arctic Vegetation Map

- Provides a consistent pan-Arctic framework for studying and monitoring change of Arctic Vegetation.



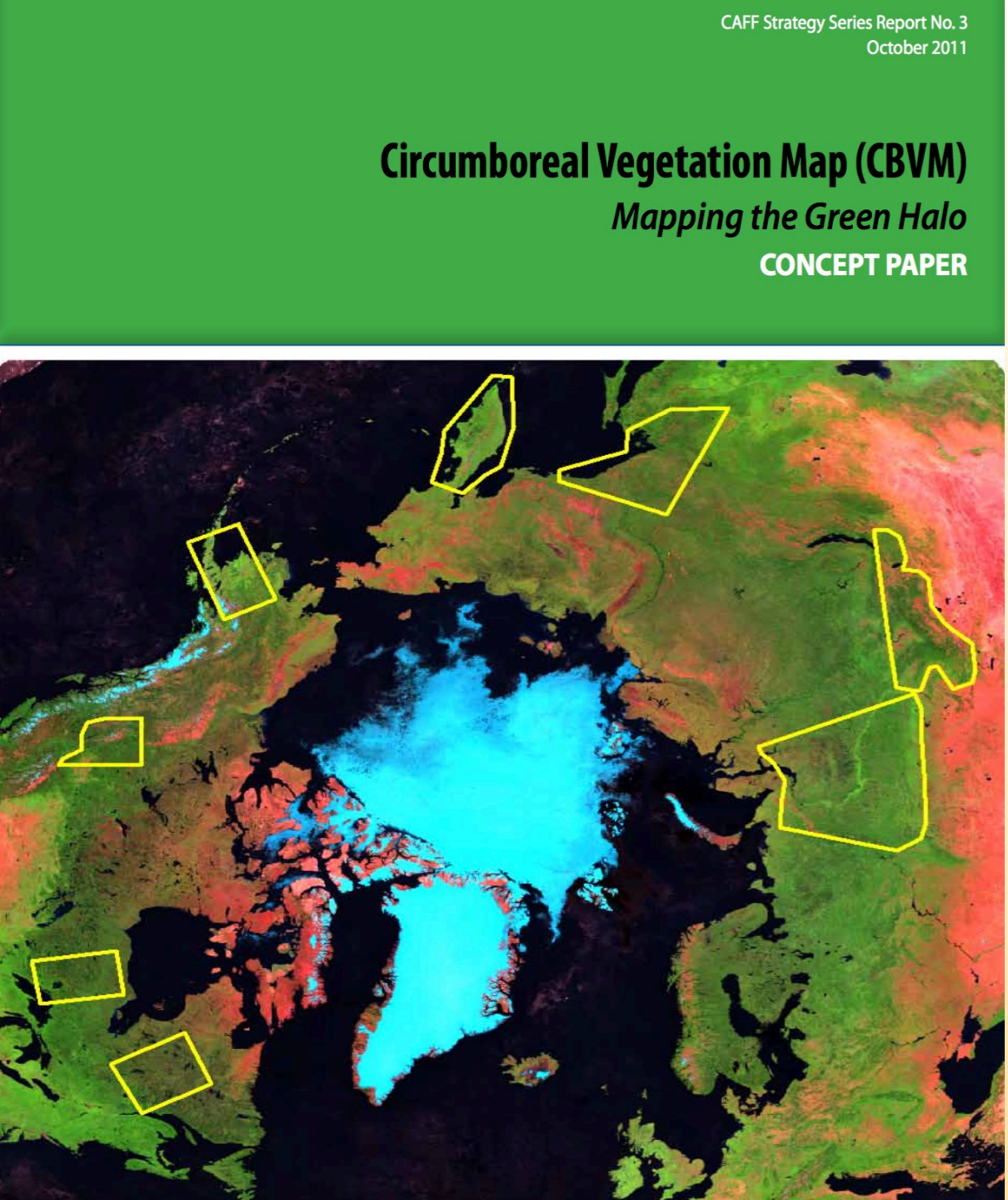
Barrens
- B1 - Cryptogam-herb barren
- B2 - Cryptogam-barren complex (bedrock)
- B3 - Non-carbonate mountain complex
- B4 - Carbonate mountain complex

Graminoid tundras
- G1 - Rush/grass, forb, cryptogam tundra
- G2 - Graminoid, prostrate dwarf-shrub, forb tundra
- G3 - Non-tussock sedge, dwarf-shrub, moss tundra
- G4 - Tussock sedge, dwarf-shrub, moss tundra

Prostrate dwarf shrubs
- P1 - Prostrate dwarf-shrub, herb tundra
- P2 - Prostrate/hemi-prostrate dwarf-shrub tundra

Erect swarf shrubs
- S1 - Erect dwarf-shrub tundra
- S2 - Low-shrub tundra

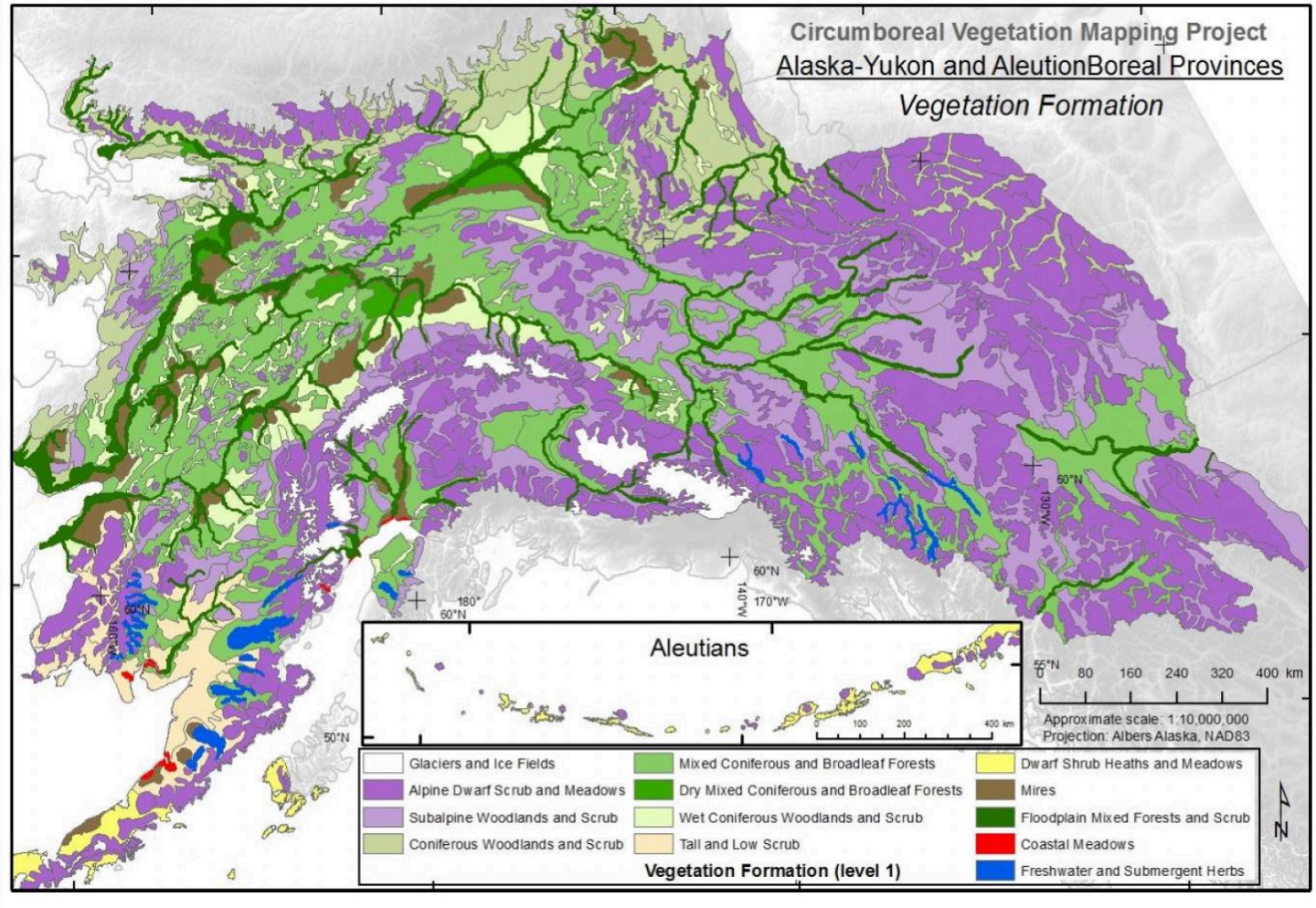
Wetlands
- W1 - Sedge/grass, moss wetland
- W2 - Sedge, moss, dwarf-shrub wetland
- W3 - Sedge, moss, low-shrub wetland



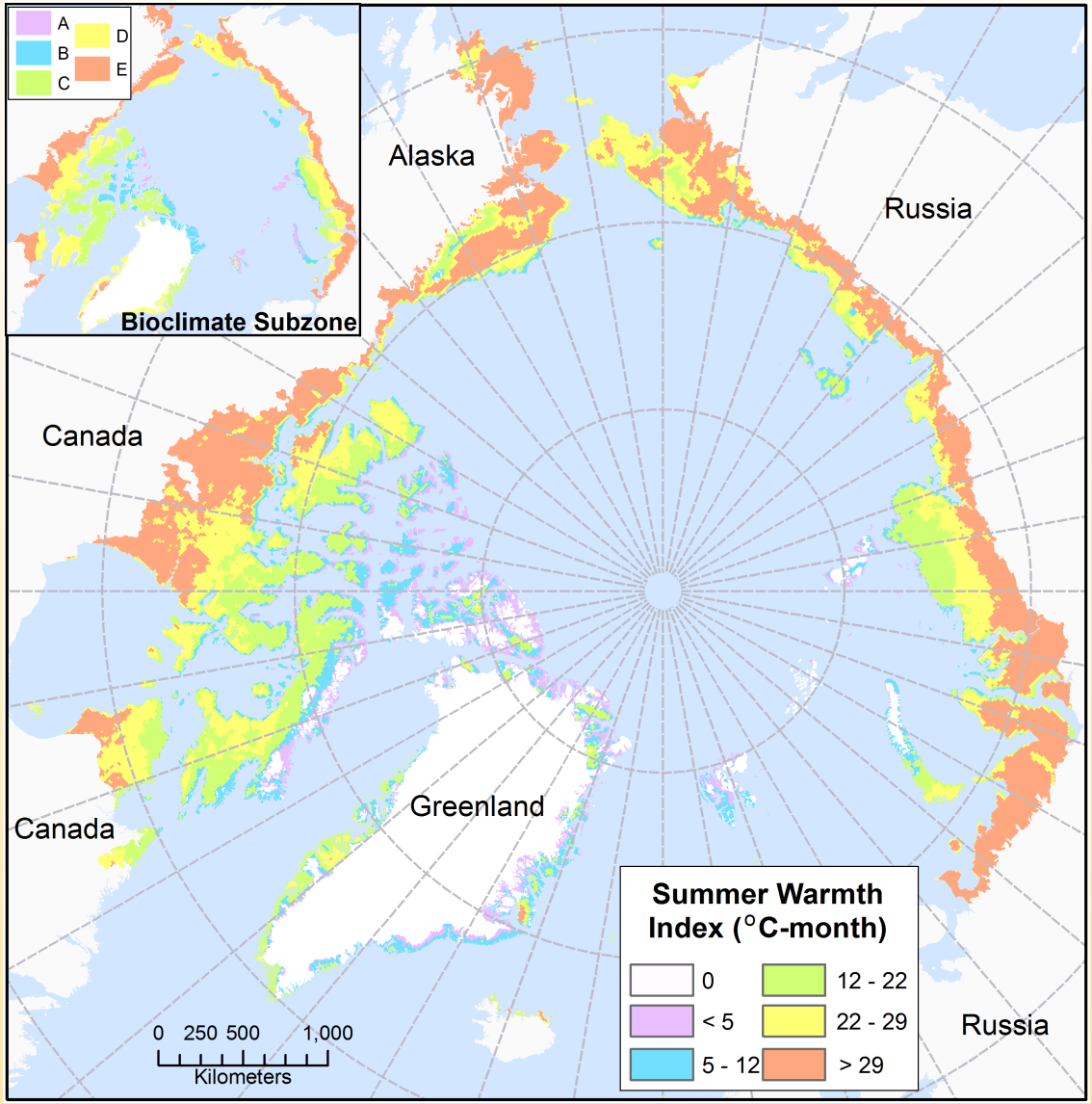
CircumBoreal Vegetation Map (CBVM)

- MODIS base
- Becci Anderson: USGS
- Plan to link map and legends with CAVM.

Jorgenson Boreal Alaska-Yukon-Aleutian Map



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

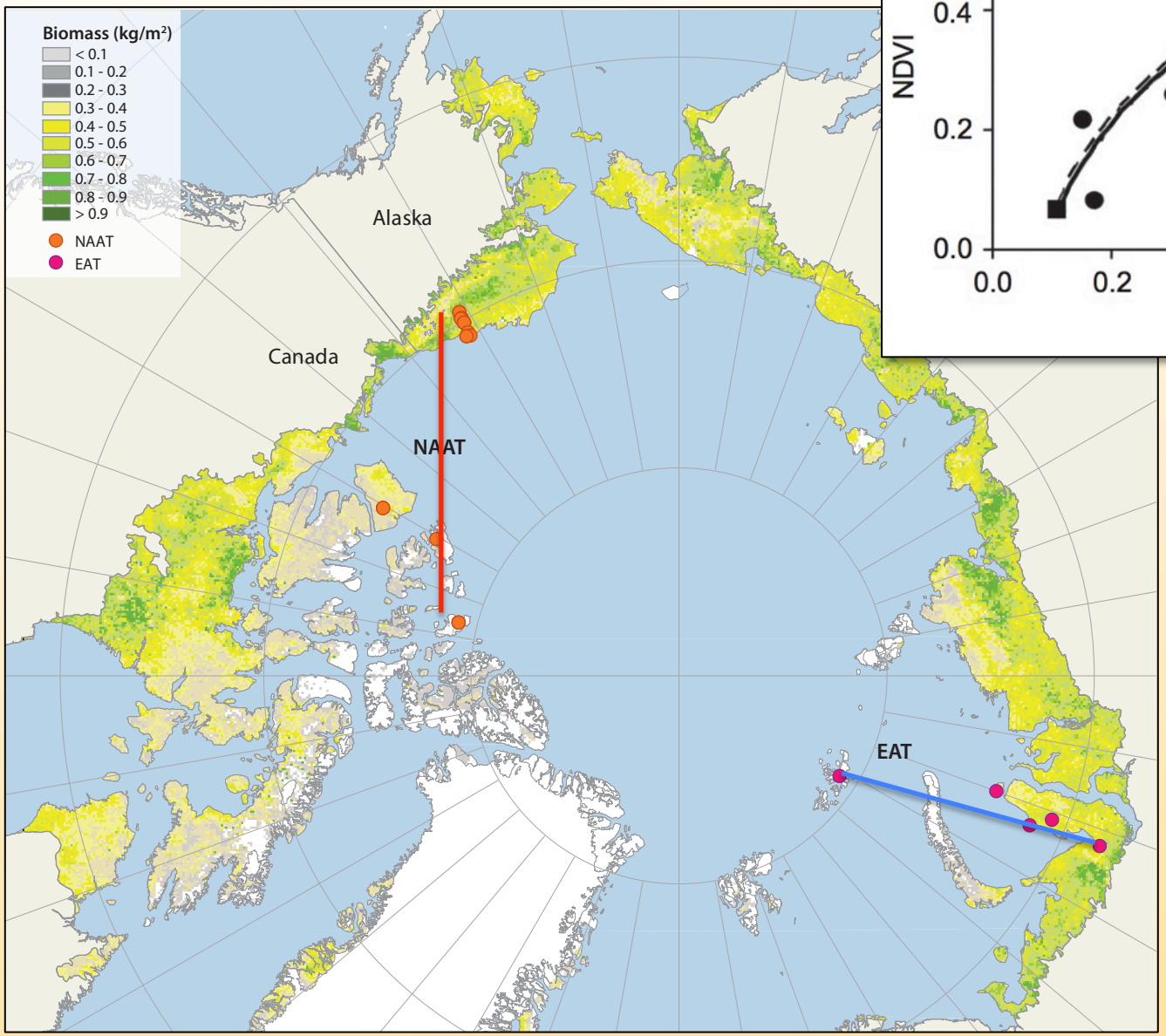


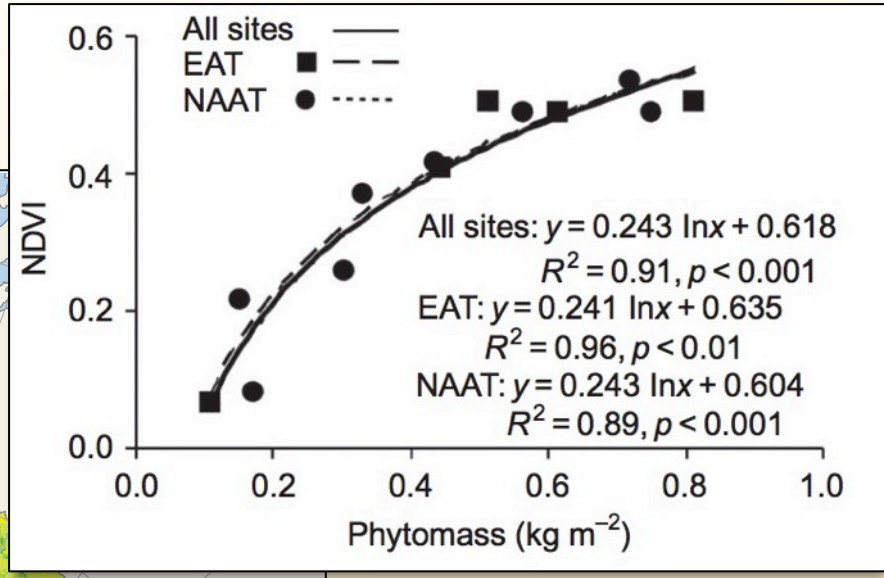
Raynolds et al. 2008, *RSE.*

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.**

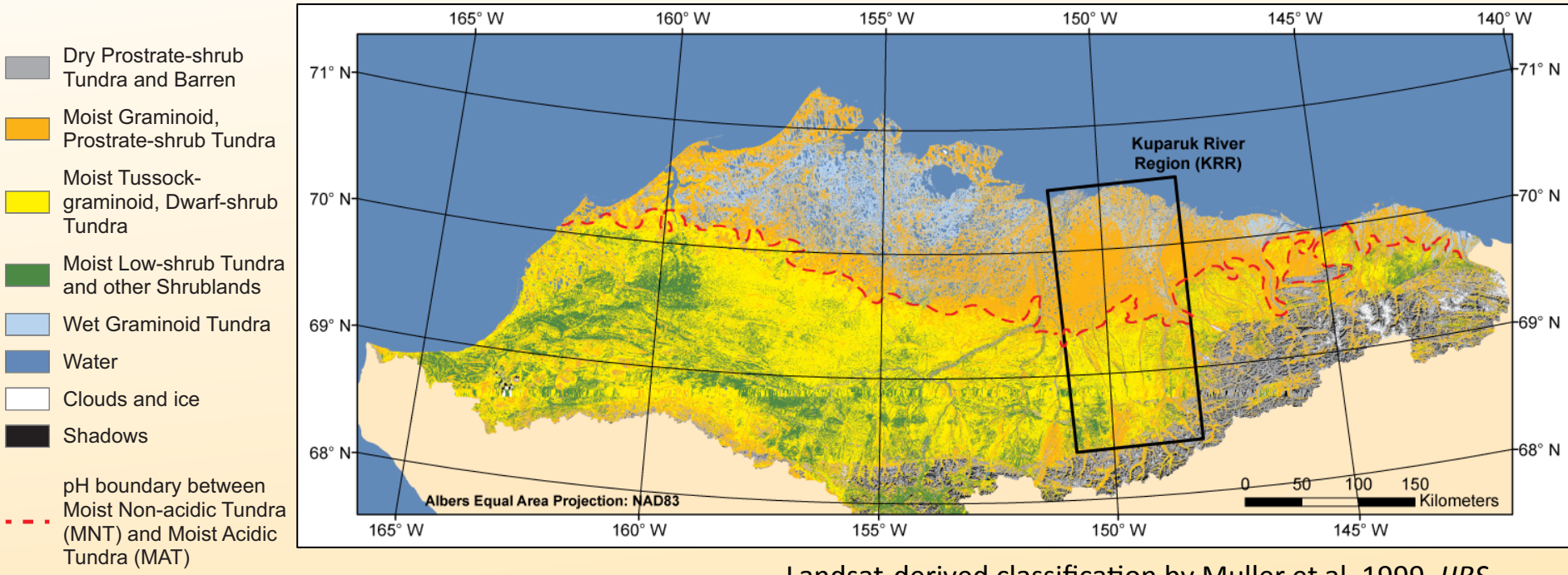




NDVI vs. total aboveground phytomass relationship is nearly the same along both transects.

Raynolds et al. 2012, *RSL*.

Regional scale, North Slope, Alaska



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

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

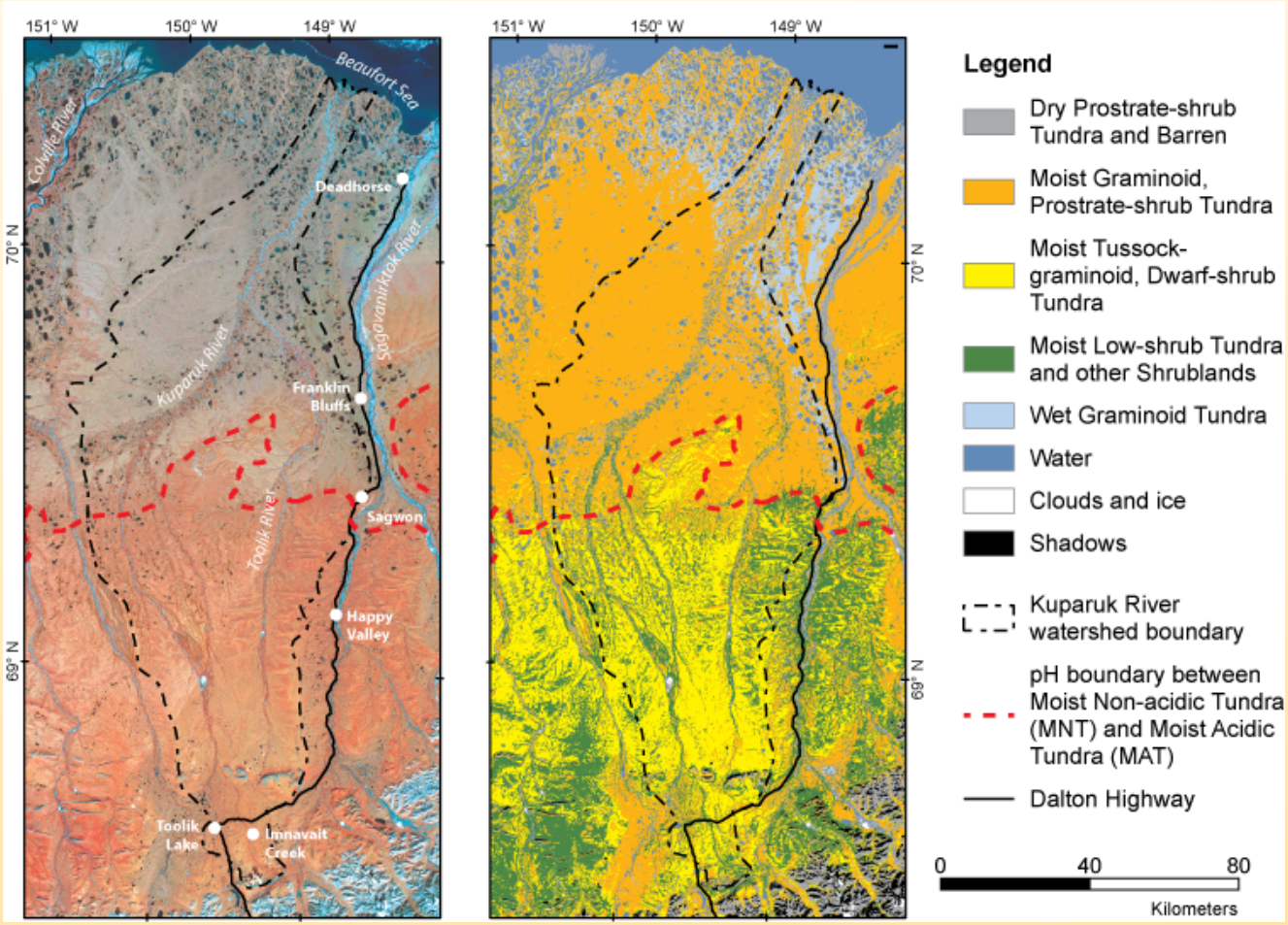
Kuparuk River region and Dalton Hiway Transect

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

South of the pH boundary: Abundant erect shrubs, high NIR reflectance.

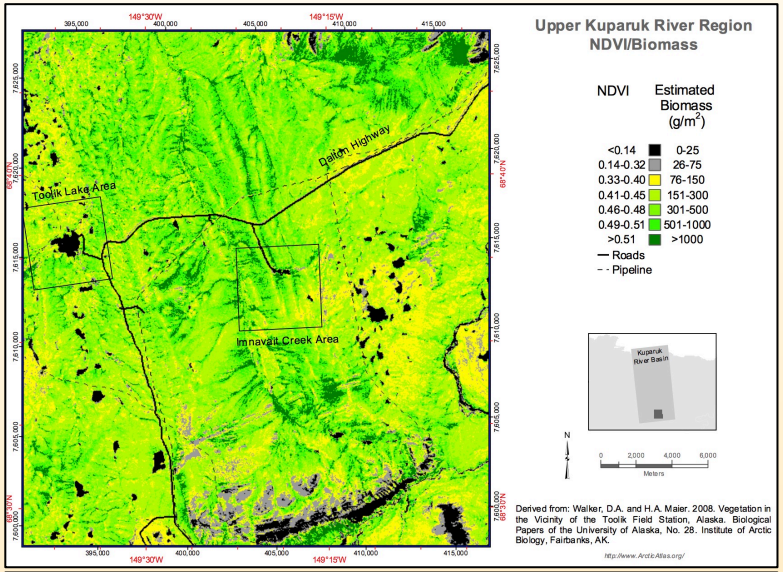
LANDSAT
False-color infrared

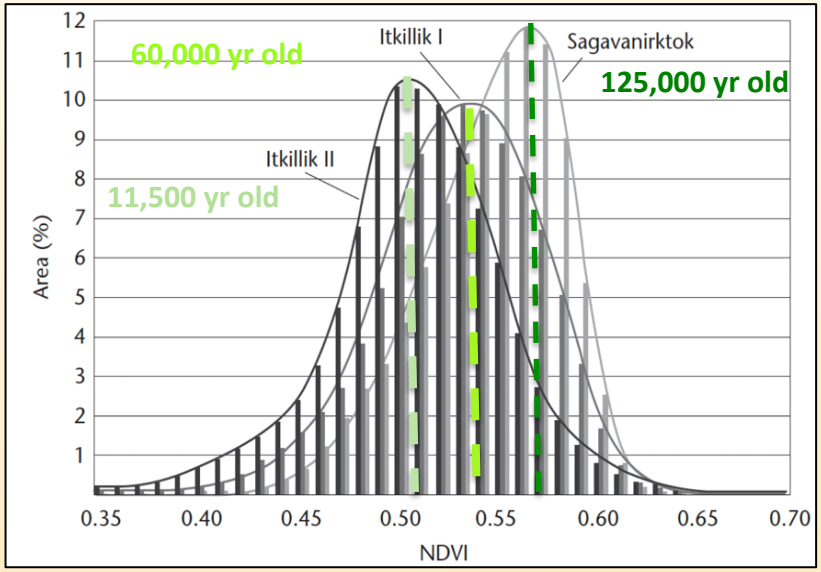
Vegetation

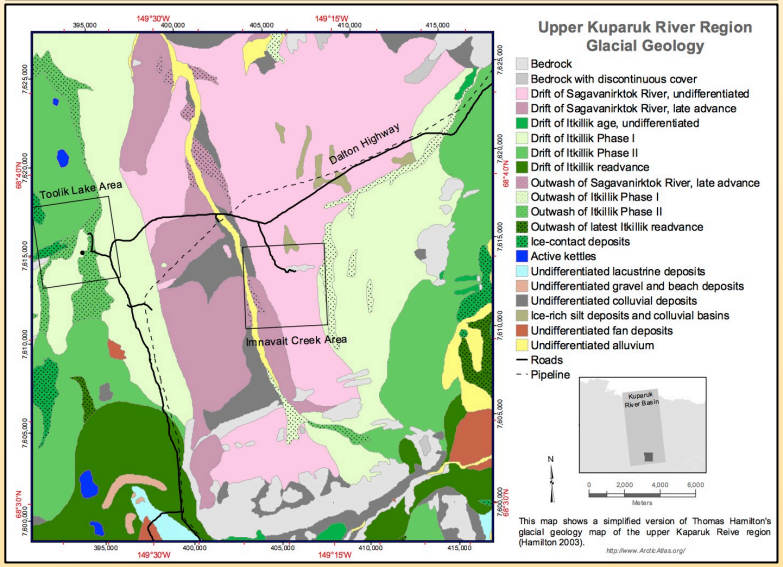


Landscape-level

Glacial chronosequence & SPOT-derived NDVI relationships in the Upper Kuparuk River region





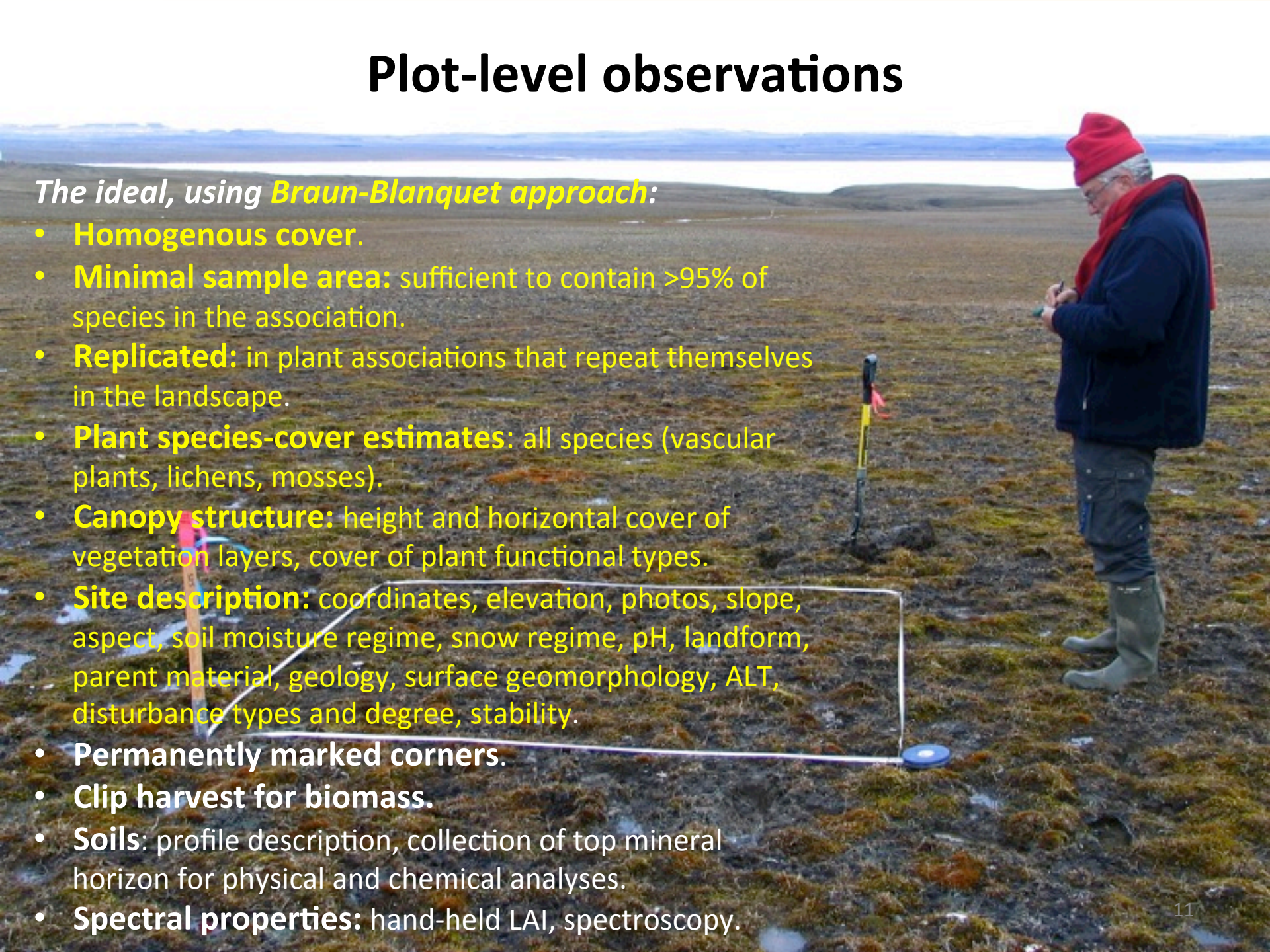


Younger to older surfaces spanning about 125,000 years

General increase in NDVI and total landscape biomass/unit area with landscape age.

Walker et al. 1995, Polar Record

Plot-level observations



*The ideal, using **Braun-Blanquet approach**:*

- **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.

Plot and Map Data portal

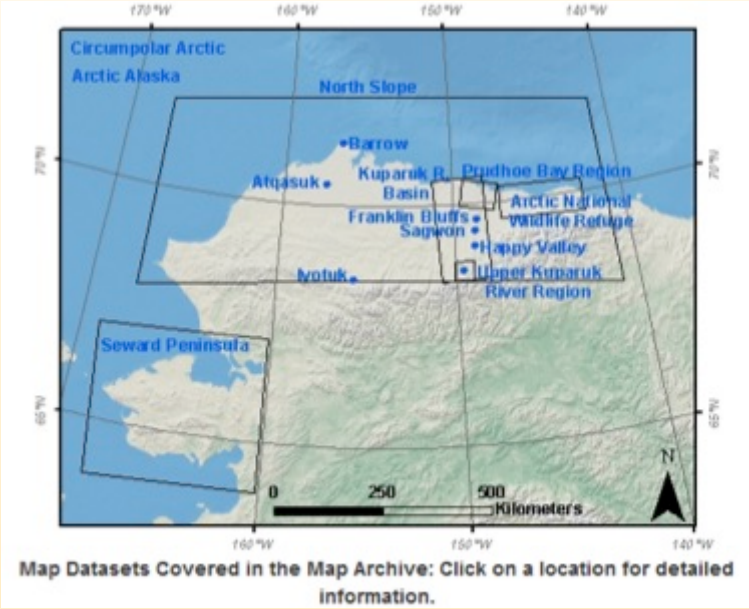
Alaska Arctic Geoecological Atlas data portal

- 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

Plot Archive

Map Archive

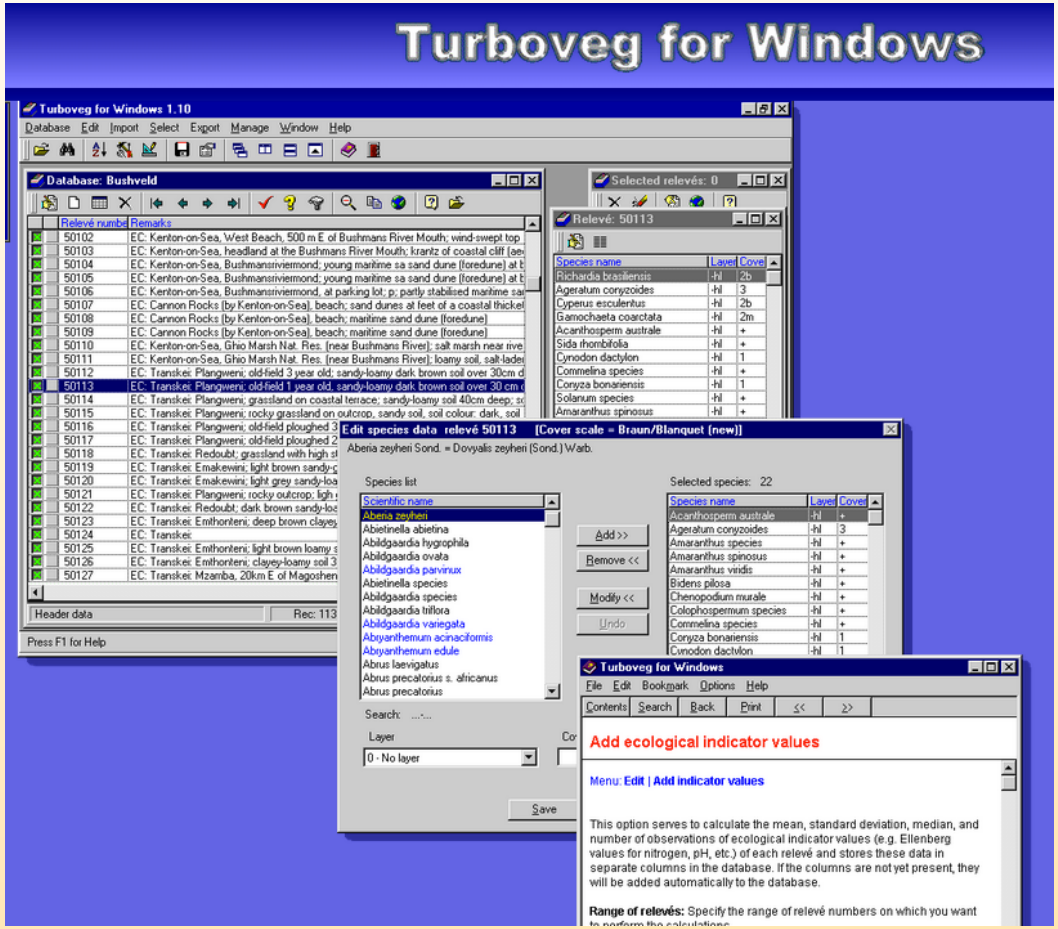


Data Portal

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

Plot archive currently has over 3000 plots from 25 datasets.

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



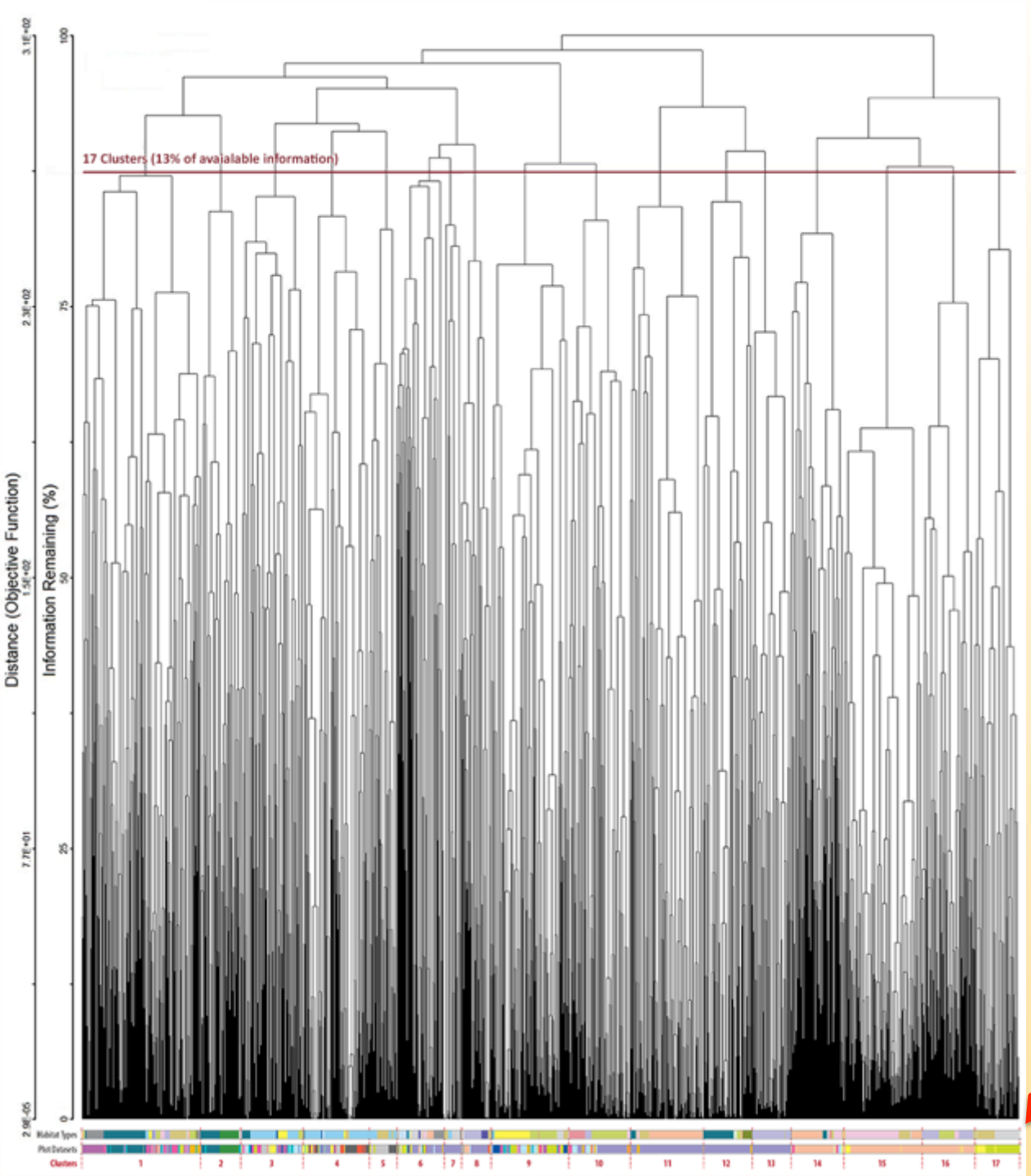
Turboveg

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).**

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

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.



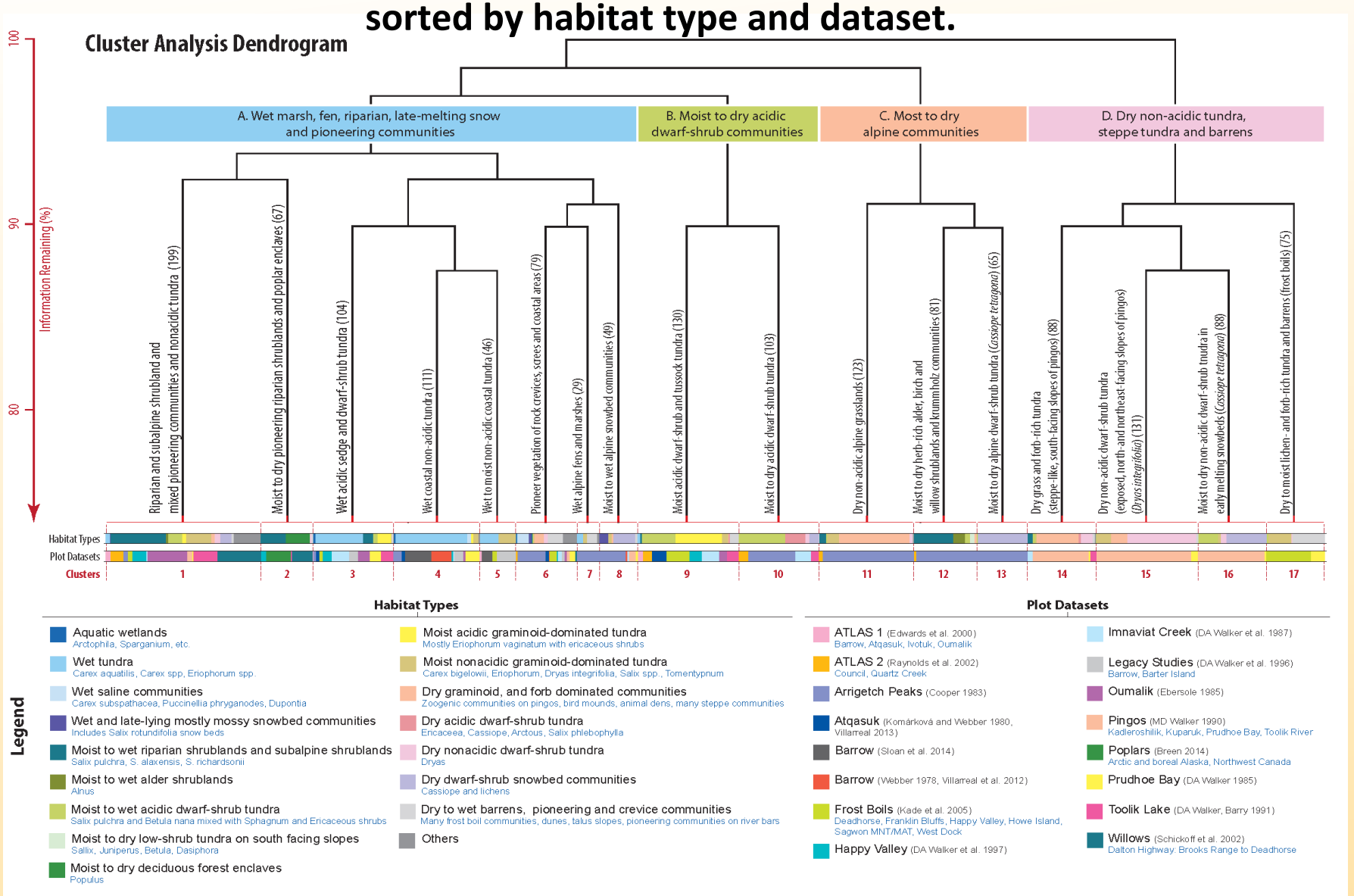
Preliminary cluster analysis of AK-AVA data

Full dendrogram showing all relevés

- 1603 plots analyzed according 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 clusters and 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.

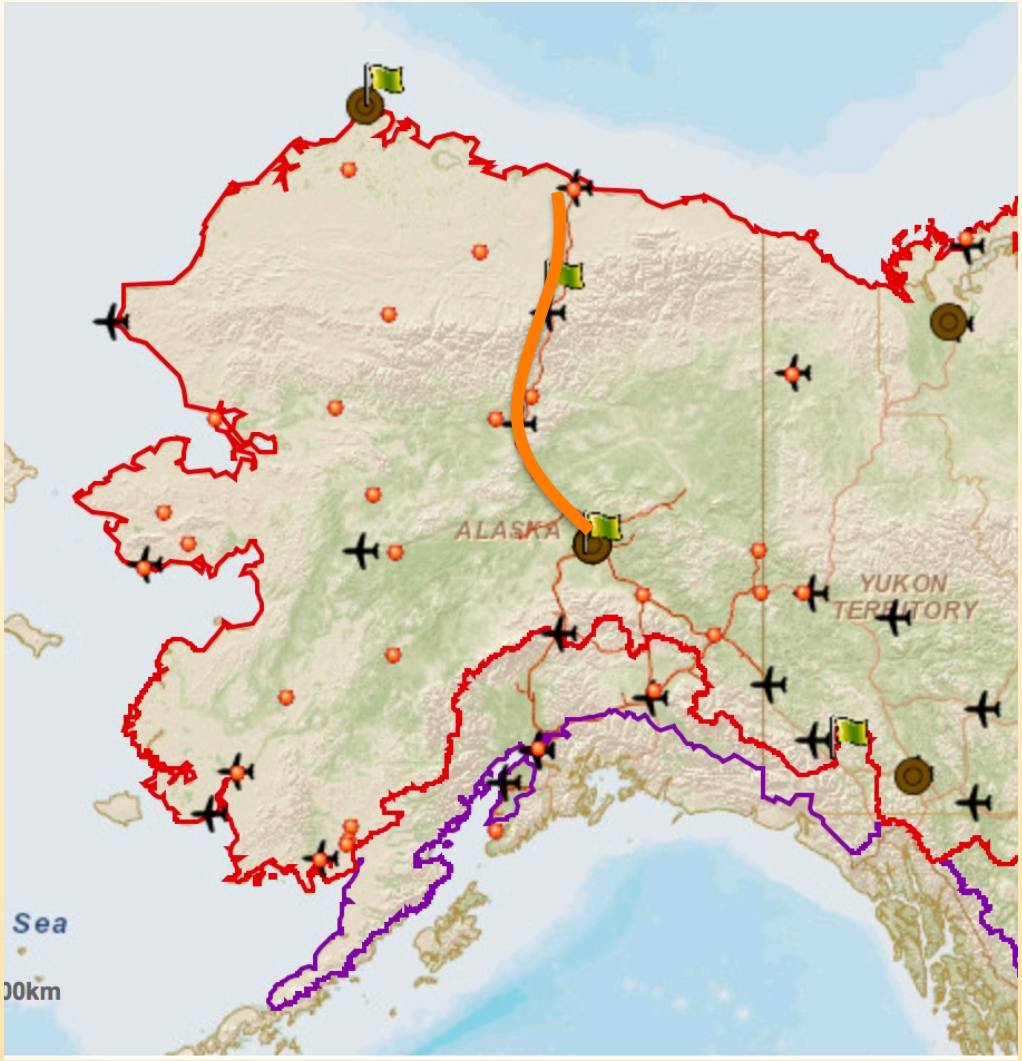
Cluster D: Dry non-acidic tundra and steppe tundra vegetation: 382 plots.

Sibik et al. 2015 in prep.

Three suggested airborne transects to capture the major bioclimatic and regional environmental gradients

1. Elliott-Dalton-Hiway Transect

- Major N-S Bioclimate gradient
- Boreal Forest-Treeline-Tundra
- Acidic-Nonacidic transition
- Logistically easy to study
- Rich historical well-studied datasets along the entire route:
  - Burn studies
  - 21 mapped sites
  - Atigun Pass alpine
  - Toolik-Lake
  - Imnavait Creek
  - Happy Valley
  - Sagwon
  - Franklin Bluffs
  - Deadhorse
- Captures many disturbance gradients, including fire, infrastructure, thermokarst Prudhoe Bay.
- Two LTER sites.



Suggested airborne transects to capture the major bioclimatic and regional environmental gradients

2. Western-Alaska Transect

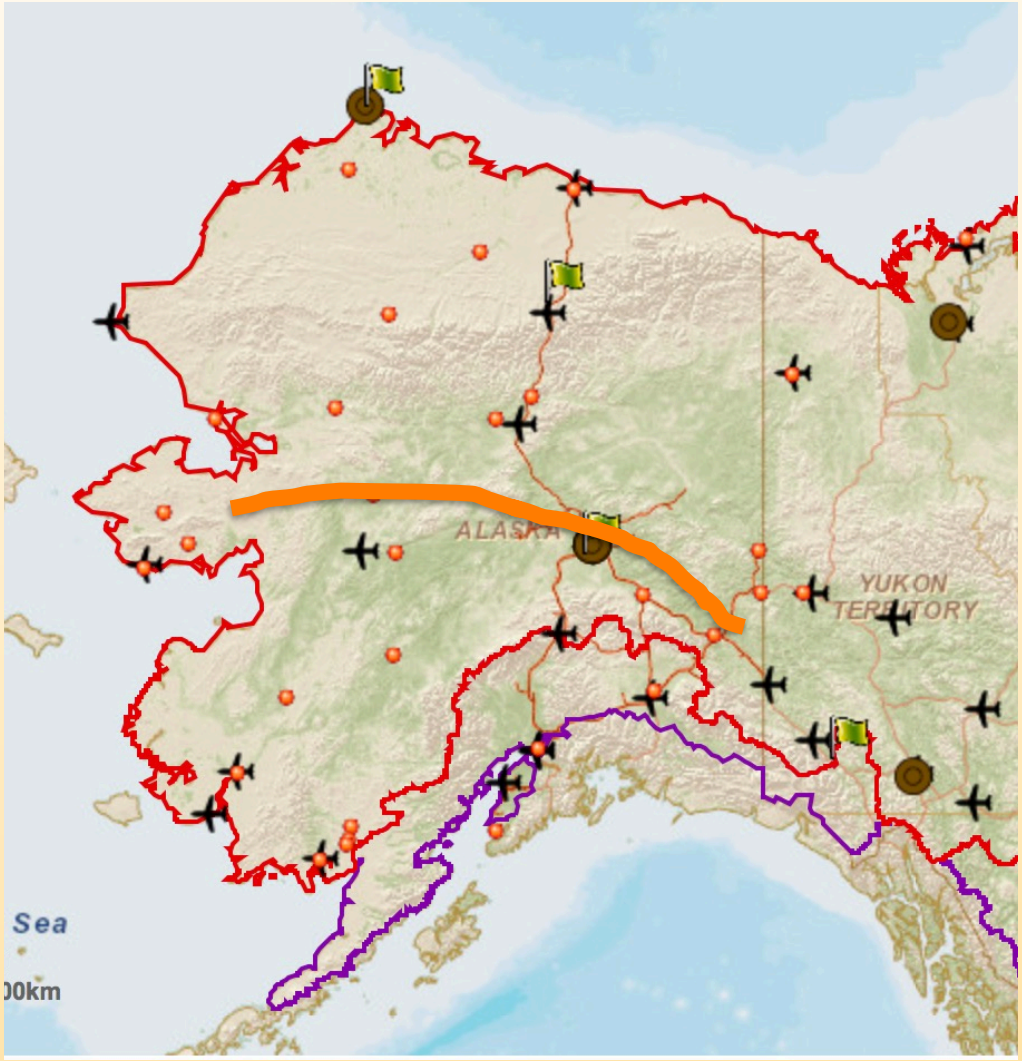
- Maritime-continental contrast with Dalton transect
- Captures the preexisting DOE ATLAS transect + Y-K Delta
  - Barrow
  - Atqasuk
  - Oumalik
  - Ivotuk
  - Council, Quartz Creek (Seward Peninsula)
  - Frost Y-K site
- Western treeline transitions (Noatak R., Seward Peninsula)
- Important sand region in NPR-A
- Strong shrub gradient in foothills
- DOE-NGEE, NOAA collaborations

Three suggested airborne transects to capture the major AK bioclimatic and regional environmental gradients

3. Central Boreal Transect:

- Focus on fire, interior thermokarst
  - Bonanza Creek
  - Caribou-Poker Creek
  - Many fire sites and forest study sites

- East west interior bioclimate gradient



Recommendations for future plot-based studies

1. **Use the Arctic Observatories:** Take advantage of established plots in full range of habitat types and landscape-level maps based on the plot information.
1. **Link information to maps** using International standards for vegetation classification and mapping.
2. **Coordinated observations by other specialists** on the same plots (e.g., soil scientists, permafrost scientists, remote-sensing specialists, and animal ecologists).
3. **Special attention needs to be devoted to protecting the plots from trampling and changes in site factors**. Use adjacent homogeneous areas for sampling.
4. **New permanent plots should use consistent criteria**, including:

   Methods for choosing and marking plots.

   Methods for surveying species composition, structure, soils, and the environment, phytomass, and ground-based spectral data.