The Circumpolar Arctic Vegetation Science Initiative (CAVSI):

Skip Walker, University of Alaska Fairbanks

Oral presentation at Arctic Science Summit Week, Boulder, CO, 21-28 March 2025,
Science Session 2.8. Building a time machine out of a Delorean: Observing, reconstructing, and predicting vegetation change in the Arctic

Circumpolar Arctic Vegetation Science Initiative Workshop,
March 21-23, during Arctic Science Summit Week 2025, Boulder, CO

CAVSI
Circumpolar Arctic Vegetation Science Initiative

3-day CAVSI Workshop, 21-23 Mar

Contribution to ICARP IV Research Priority Team 2: Observing, reconstructing, and predicting future climate dynamics and ecosystem responses

The need for CAVSI

A well-distributed Arctic vegetation observatory network and a set of internationally accepted protocols for sampling, describing, classifying, and mapping vegetation are needed to aid in developing circumpolar resource assessments, models, and forecasts of change.

- Priority terrestrial science topics for ICARP IV will include:
  - Monitoring, modeling, and predicting the consequences of climate change and other disturbances to:
    - Plant and animal biodiversity
    - Shrub distribution, biomass, and greening patterns
    - Soil carbon stocks and emissions
    - Snow, water, and permafrost changes
    - Paleo-history of the Arctic
    - Cumulative impacts of infrastructure and climate change
    - Changes to indigenous people's lands and livelihoods
- All these efforts require improved knowledge of patterns of vegetation and environmental controls across a hierarchy of spatial scales.

Draft CAVSI White Paper

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The Circumpolar Arctic Vegetation Science Initiative (CAVSI)

Draft white paper for consideration as part of ICARP IV Research Priority Theme 2: Observing, reconstructing, and predicting future climate dynamics and ecosystem responses

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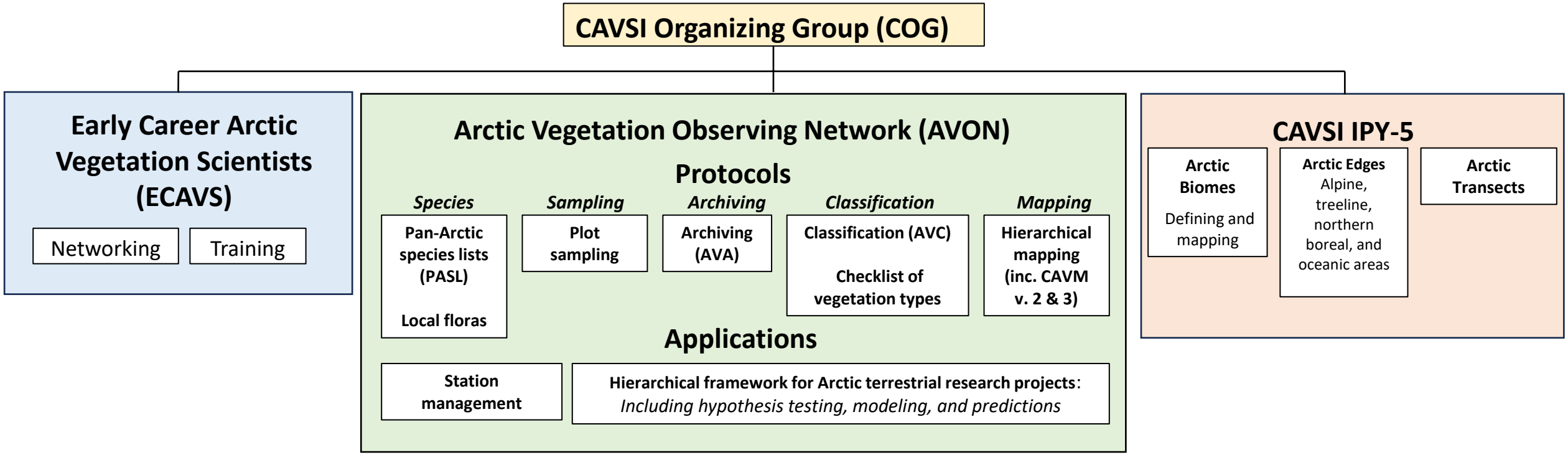
Jana Peirce, University of Alaska Fairbanks
Others to be added after the workshop

CAVSI Circumpolar Arctic Vegetation Science Initiative NSF IASC CAFF Conservation of Arctic Flora and Fauna

CAVSI Organization



There is a critical shortage of new researchers trained in Arctic plant taxonomy and traditional and evolving new methods of sampling, archiving, classifying, and mapping Arctic vegetation.

Early Career Arctic Vegetation Scientists (ECAVS)

This is the most important element of CAVSI for the long-term success of the initiative.

Goals of ECAVS:

1. Foster networking to navigate the multitude of organizations and institutions involved in the Arctic vegetation science research
2. Foster cooperative cross-disciplinary and cross cultural connections with other Arctic related early-career groups (e.g, PYRN), and indigenous Arctic research organization, (e.g, ANSEP).
3. Promote Arctic-science training through field courses, online courses, in traditional and new methods of vegetation science.

Arctic Vegetation Observing Network (AVON)

Goals:

- Identify existing stations where plot data are collected within the existing Arctic Observing Networks.
- Identify commonalities, gaps, and inconsistencies in the plot data collected in the current set of Arctic vegetation observation stations across the full range Arctic climates, phytogeographic regions, and local vegetation habitats.
- Develop a plan to create an Arctic Vegetation Observing Network (AVON) within established observation networks
- Encourage new satellite observatories in understudied vegetation-habitat types, including climatic regions, geological regimes, and substrates of the Arctic.

Protocols and methods manuals

A. Species
    1. Checklists of Arctic vascular plants, bryophytes, lichens
    2. Local floras
B. Surveying and inventory of plant communities
    1. Methods for collecting plot data
    2. Rescuing legacy plot data
    3. Archiving plot data
    4. Classification of Arctic plant communities
    5. Checklist of Arctic plant communities
C. Mapping Arctic vegetation in a hierarchy of scales

A common taxonomical framework for vascular plants, bryophytes, and lichens is essential for comparing and analyzing local and regional floras as well as classifying Arctic plant communities.

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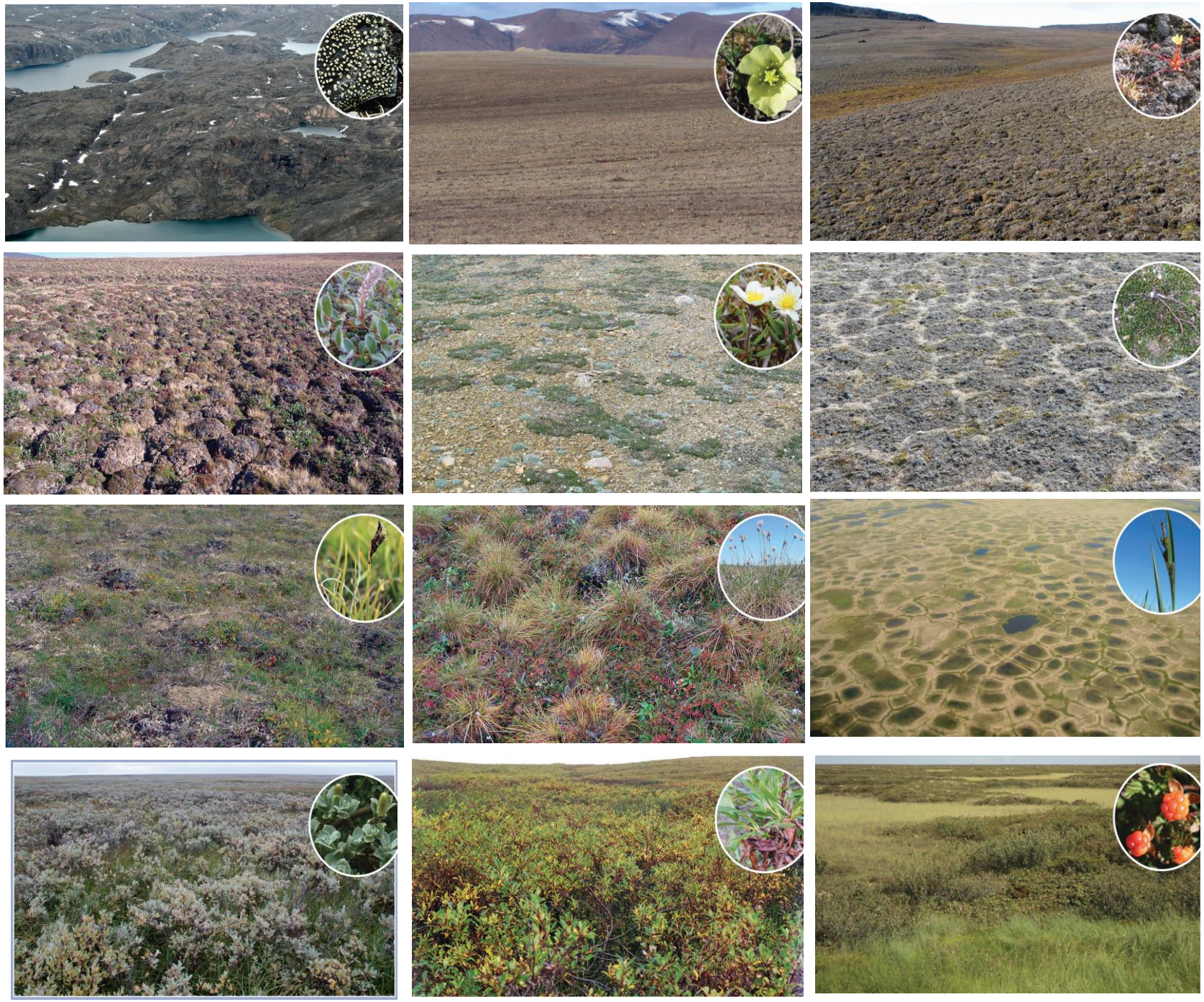
Species checklists and local floras

- **Pan-Arctic species lists.** Plan to provide consistent regularly updated Pan-Arctic species list (PASL) that includes vascular plants bryophytes and lichens.
- **Local floras**. A standard protocol for the creation of local lists of species in common and rare habitats at AVON sites.




Polar desert species, Hayes Island, Frans Josef Land, Russia. *Saxifraga oppositifolia, Papaver dahlianum, Cetrararia delisii,* numerous species on a moss pollster. Photos D.A. Walker and I. Timling.



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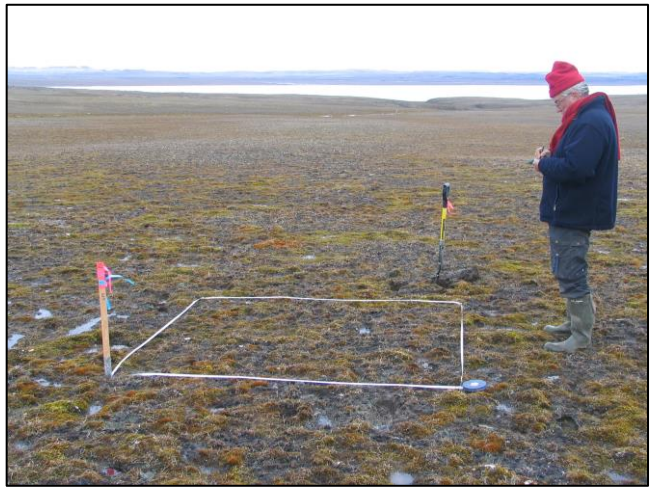
Methods for collecting vegetation plot data

- A methods guidebook with standardized protocols
- Adoption of new methods where feasible (e.g. DNA barcoding, drone surveys)

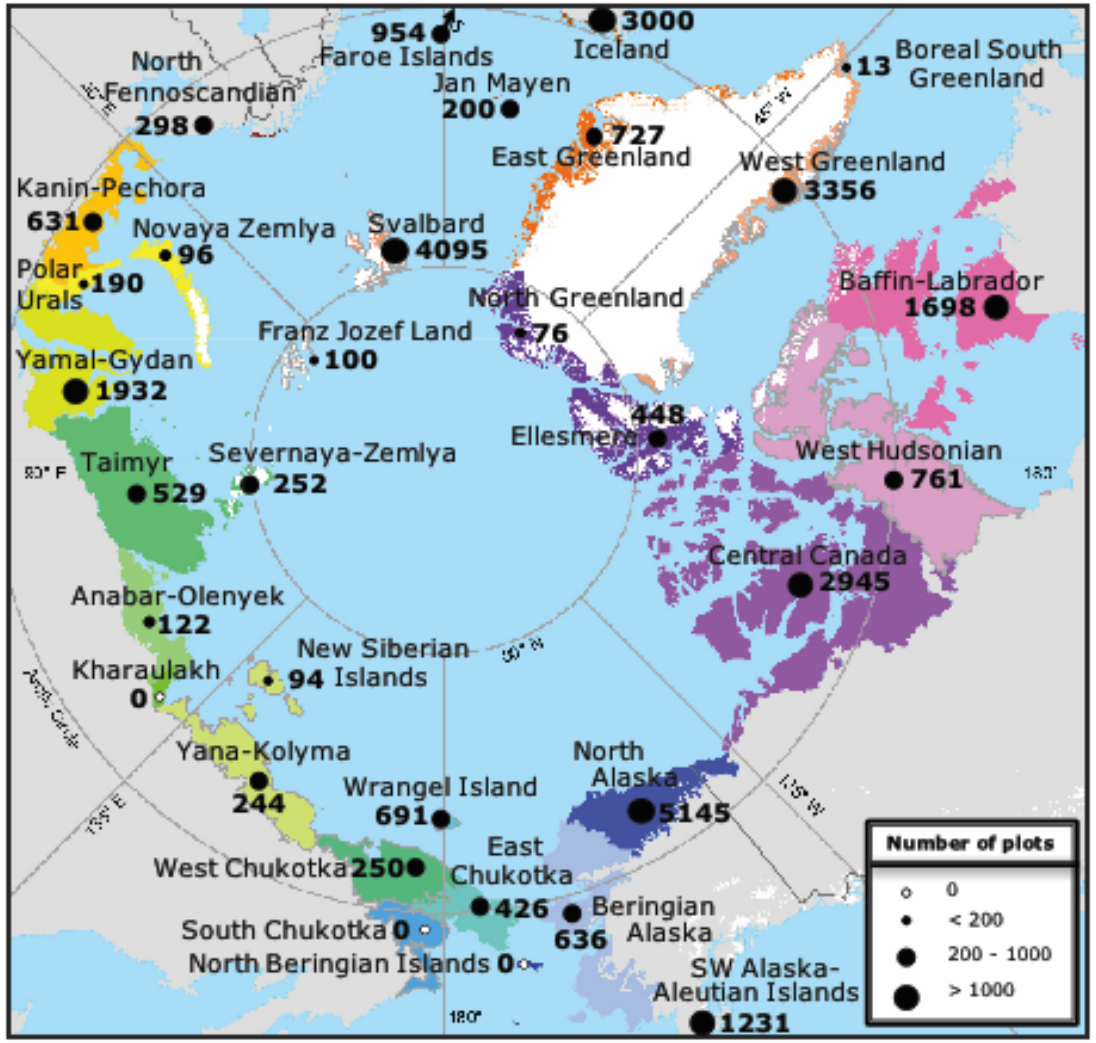


Fred Daniëls surveying 2 x 2 m plot Ellef Rignes Island, Canada

Rescuing legacy plot data

Approximately 31,000 vegetation plots were identified for potential inclusion in the AVA (Walker et al. 2018).

Map shows distribution of the plots by Arctic floristic subprovinces of Yurtsev (1994).

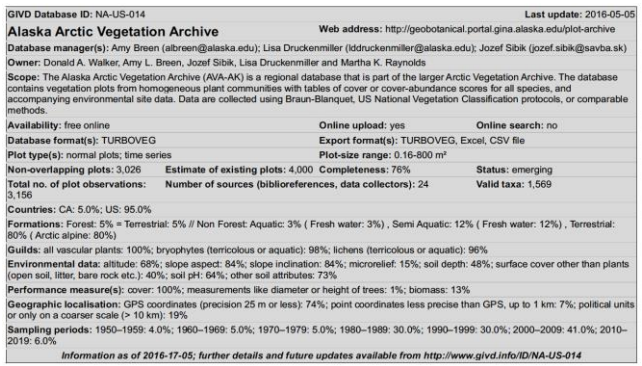


Protocols for surveying and classifying plant community plot data

Archiving Arctic plot data

- Database archives are a key conceptual elements of a digital plot database.
- TURBOVEG3 vegetation data management system (Hennekens 2015) and is the primary database for the Alaska, Russian, and European Arctic Vegetation Archives (AVA-AK, AVA-RU, and AVA-EU),
- Data in Canada are stored in a Vpro Database that uses ACCESS and Excel database functions.
- Plot data from Arctic countries are also stored in a variety of other databases including the Global Index of Vegetation-Plot Databases (GIVD, Dengler et al. 2011). An open source CKAN Catalog library for the AVA-AK, the NASA ORNL-DAAC for U.S. Arctic datasets, and the VegBank archive used by the Ecological Society of America..
- CAVSI would develop a plan is to eventually merge the regional databases into a common circumpolar database.

Global Inventory of Vegetation Databases


GIVD Database ID: NA-US-014 — Last update: 2016-05-05

Alaska Arctic Vegetation Archive — Web address: http://geobotanical.portal.gina.alaska.edu/plot-archive

Database manager(s): Amy Breen (albreen@alaska.edu); Lisa Druckenmiller (lddruckenmiller@alaska.edu); Jozef Sibik (jozef.sibik@savba.sk)

Owner: Donald A. Walker, Amy L. Breen, Jozef Sibik, Lisa Druckenmiller and Martha K. Raynolds

Scope: The Alaska Arctic Vegetation Archive (AVA-AK) is a regional database that is part of the larger Arctic Vegetation Archive. The database contains vegetation plots from homogeneous plant communities with tables of cover or cover-abundance scores for all species, and accompanying environmental site data. Data are collected using Braun-Blanquet, US National Vegetation Classification protocols, or comparable methods.

Availability: free online — Online upload: yes — Online search: no

Database format(s): TURBOVEG — Export format(s): TURBOVEG, Excel, CSV file

Plot type(s): normal plots; time series — Plot-size range: 0.16-800 m²

Non-overlapping plots: 3,026 — Estimate of existing plots: 4,000 — Completeness: 76% — Status: emerging

Total no. of plot observations: 3,156 — Number of sources (biblioreferences, data collectors): 24 — Valid taxa: 1,569

Countries: CA: 5.0%; US: 95.0%

Formations: Forest: 5% = Terrestrial: 5% // Non Forest: Aquatic: 3% (Fresh water: 3%) , Semi Aquatic: 12% (Fresh water: 12%) , Terrestrial: 80% (Arctic alpine: 80%)

Guilds: all vascular plants: 100%; bryophytes (terricolous or aquatic): 98%; lichens (terricolous or aquatic): 96%

Environmental data: altitude: 68%; slope aspect: 84%; slope inclination: 84%; microrelief: 15%; soil depth: 48%; surface cover other than plants (open soil, litter, bare rock etc.): 40%; soil pH: 64%; other soil attributes: 73%

Performance measure(s): cover: 100%; measurements like diameter or height of trees: 1%; biomass: 13%

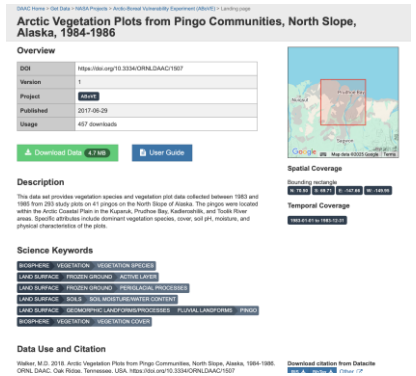
Geographic localisation: GPS coordinates (precision 25 m or less): 74%; point coordinates less precise than GPS, up to 1 km: 7%; political units or only on a coarser scale (> 10 km): 19%

Sampling periods: 1950–1959: 4.0%; 1960–1969: 5.0%; 1970–1979: 5.0%; 1980–1989: 30.0%; 1990–1999: 30.0%; 2000–2009: 41.0%; 2010–2019: 6.0%

Information as of 2016-17-05; further details and future updates available from http://www.givd.info/ID/NA-US-014

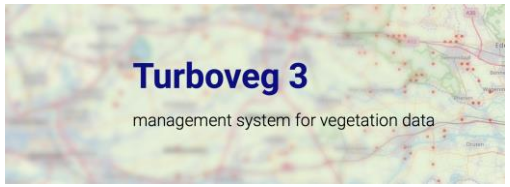
Alaska Arctic Geobotanical Atlas Plot Archive (CKAN catalog)

ORNL DAAC



VegBank (US ESA)

TurboVeg (Europoe ESA)



Protocols for surveying and inventory of plant communities

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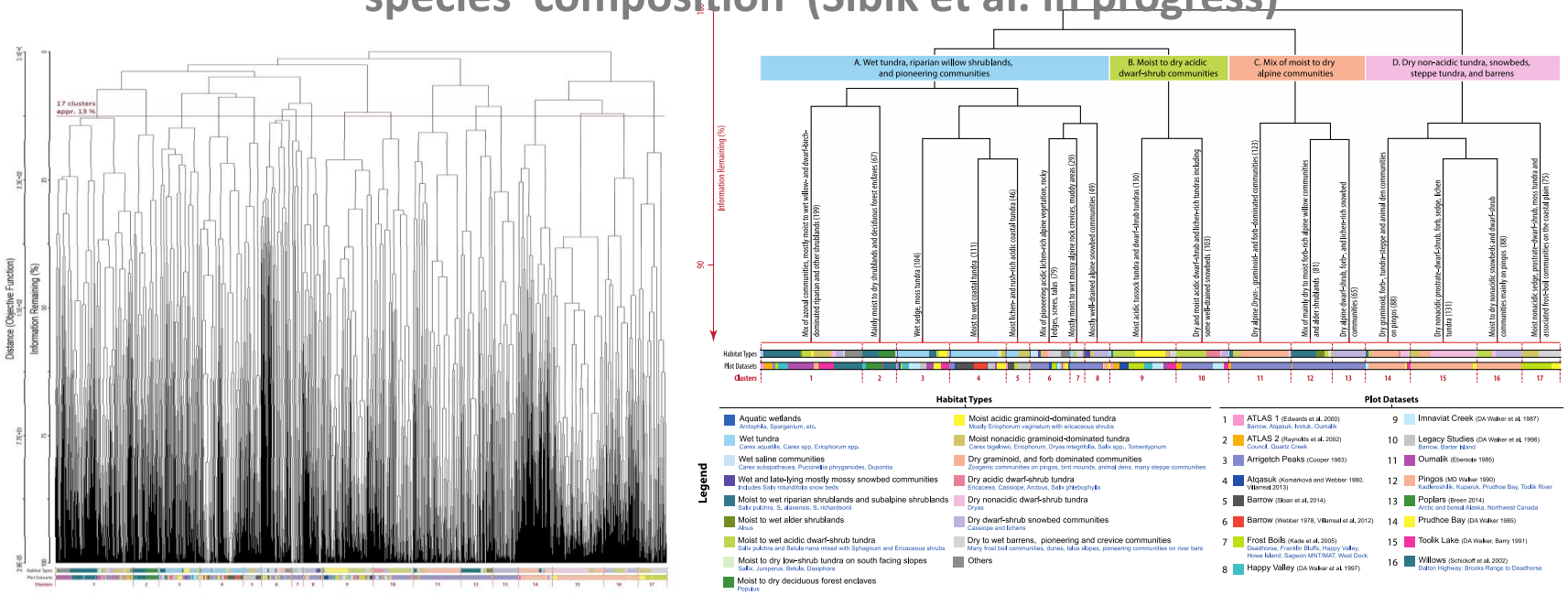
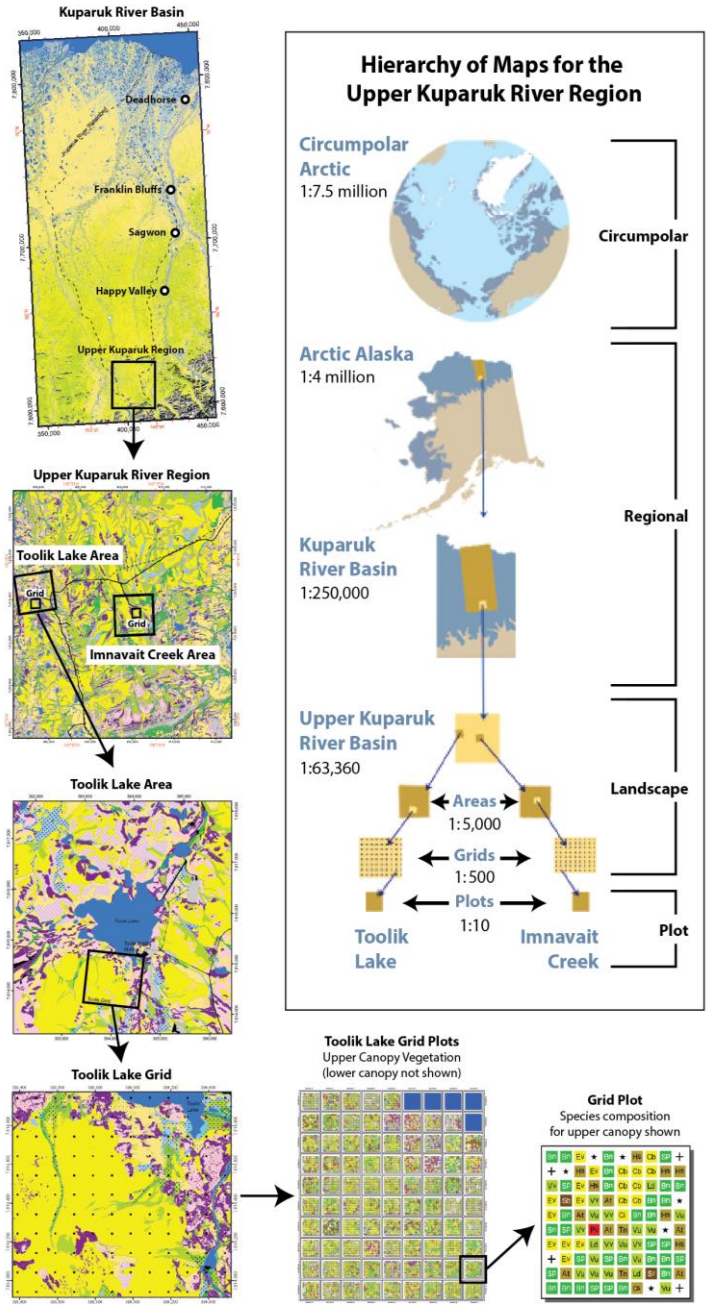
Harmonizing and classifying plot data

- In Europe and Russia, the Braun-Blanquet approach (Mucina et al. 2016) is the most widely used approach; whereas in the U.S. and Canada national the EcoVeg methods (Faber-Langendoen et al. 2014).
- A possible middle ground between the floristic-based Braun-Blanquet classification approach and the USNVC could use the EUNIS habitat types (e.g., Bruenheide et al. 2021) as the basic units of differentiation with crosswalks to plant communities described in both the European and USNVC approach.

Numerical cluster analysis of 16 dataset (1,565 plots) in northern Alaska, based on similarity of plot species composition (Sibik et al. in progress)



Walker, D. A., et al. (2018). Circumpolar Arctic Vegetation Classification. *Phytocoenologia*, *48*(2), 181–201.



Mapping Arctic vegetation

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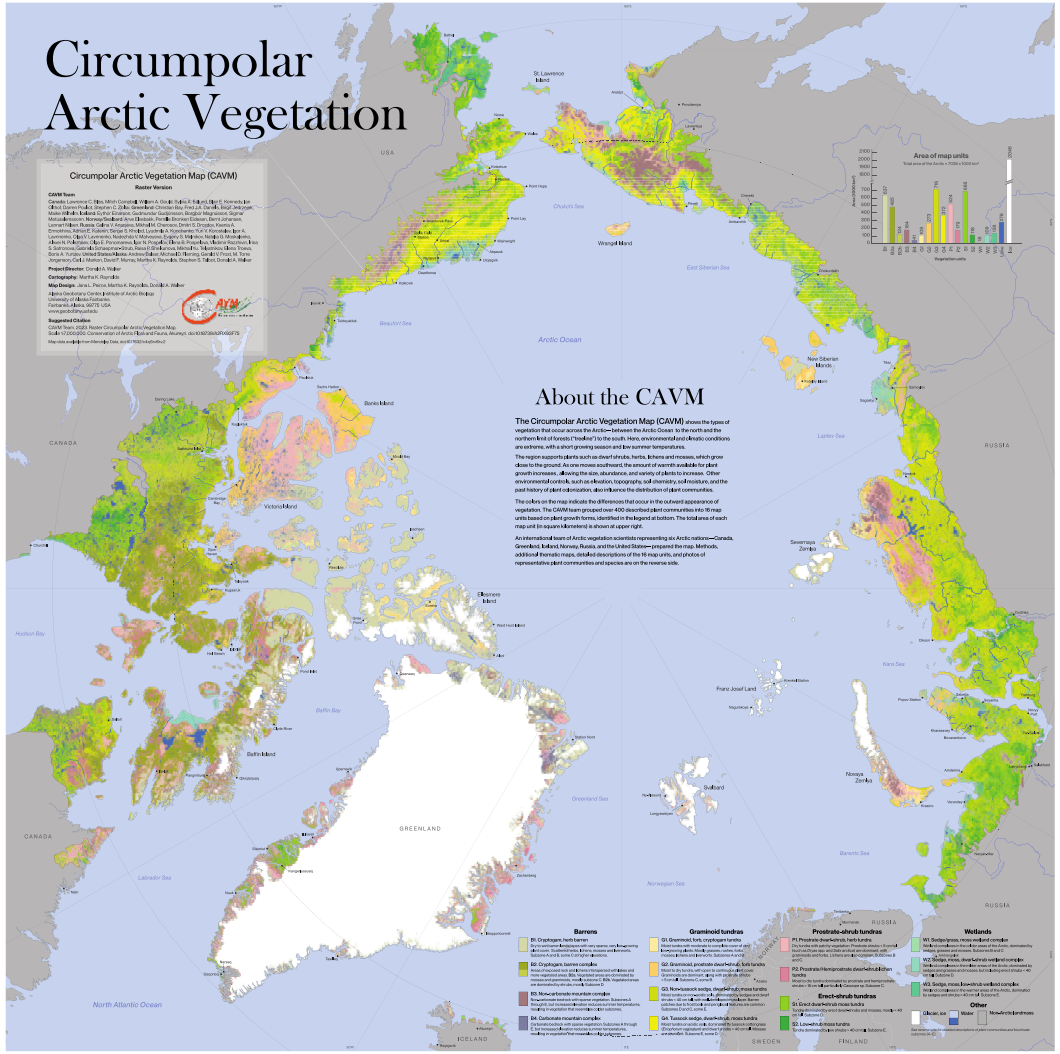
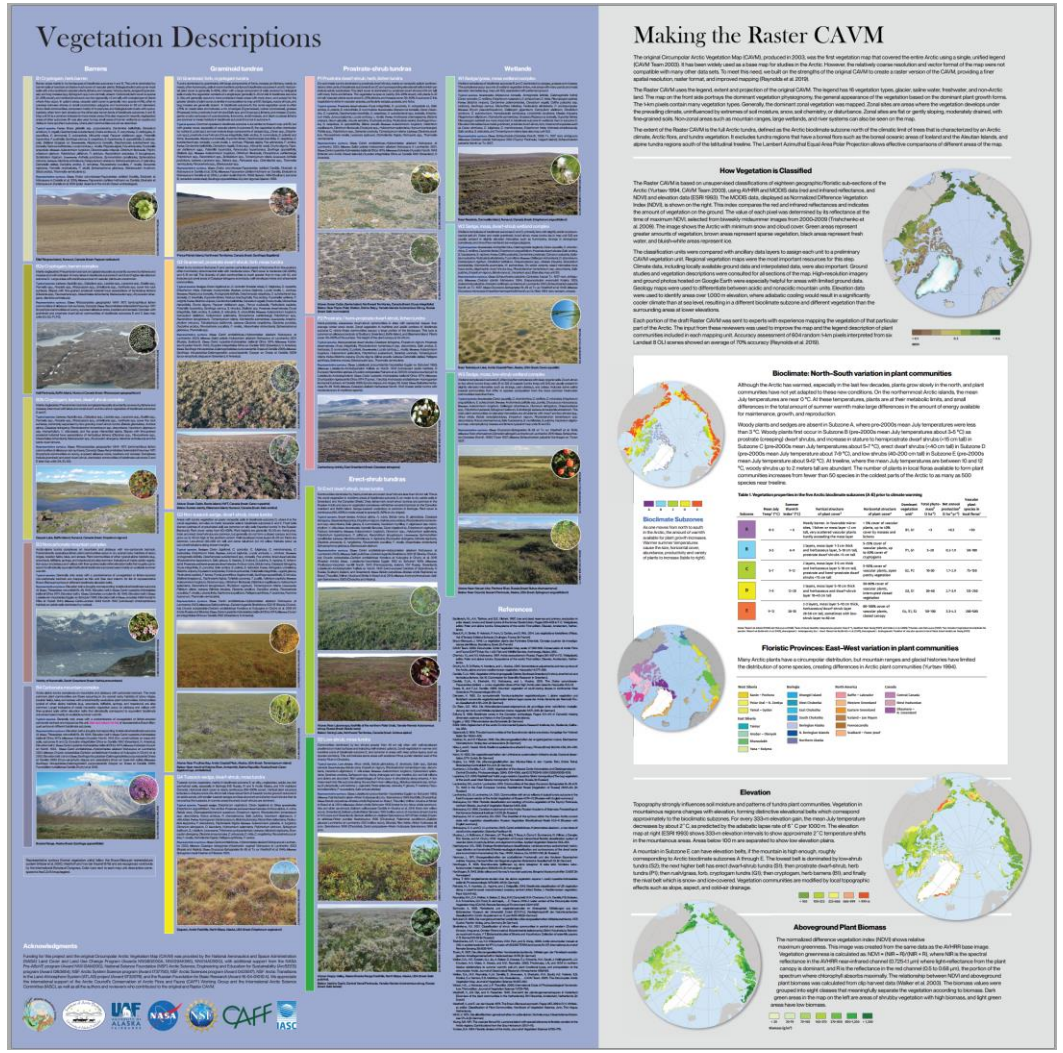
- Plot to circumpolar scales
- Development of protocols for consistent legends and map colors for hierarchical vegetation maps
- Raster and vector data
- Need for easy-to-navigate map catalogs

Prototype for plot- to circumpolar-scale maps in central northern Alaska

Walker, D. A., et al. (2016). Circumpolar arctic vegetation: a hierarchic review and roadmap toward an internationally consistent approach to survey, archive and classify tundra plot data. *Environmental Research Letters*, *11*(5), 055005.

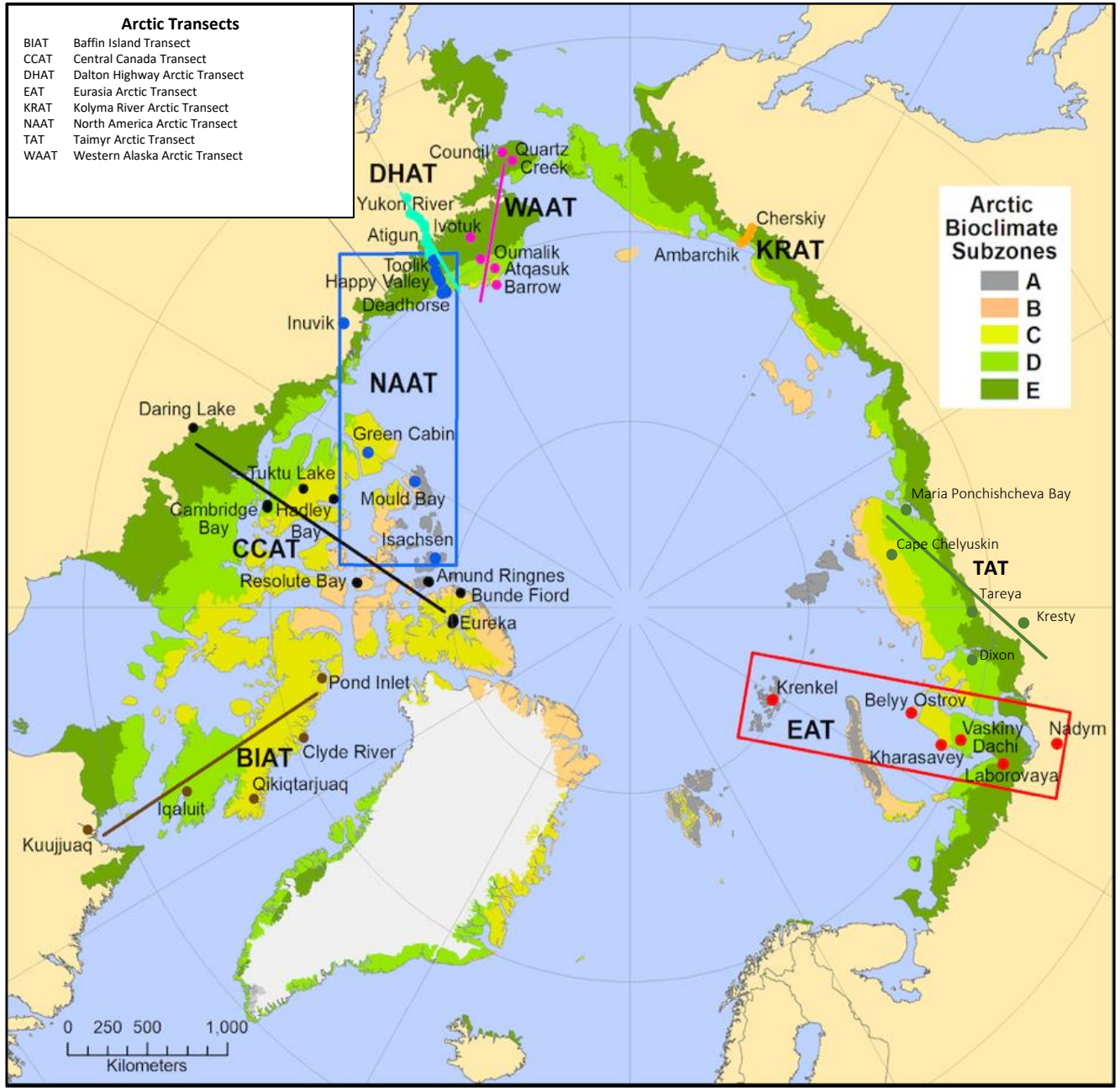
Circumpolar Arctic Vegetation Map, v.2





CAVM, v. 2, Raster format, 1:7 M scale; Derived from MODIS (250-m) data. (Raynolds et al. 2019, CAVM Team 2024)

Applications. Looking toward IPY 5



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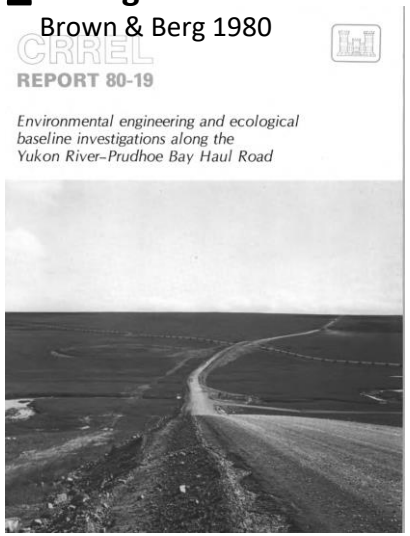
Arctic Transects

Document the circumpolar state of Arctic vegetation during IPY-5 along existing bioclimate transects.

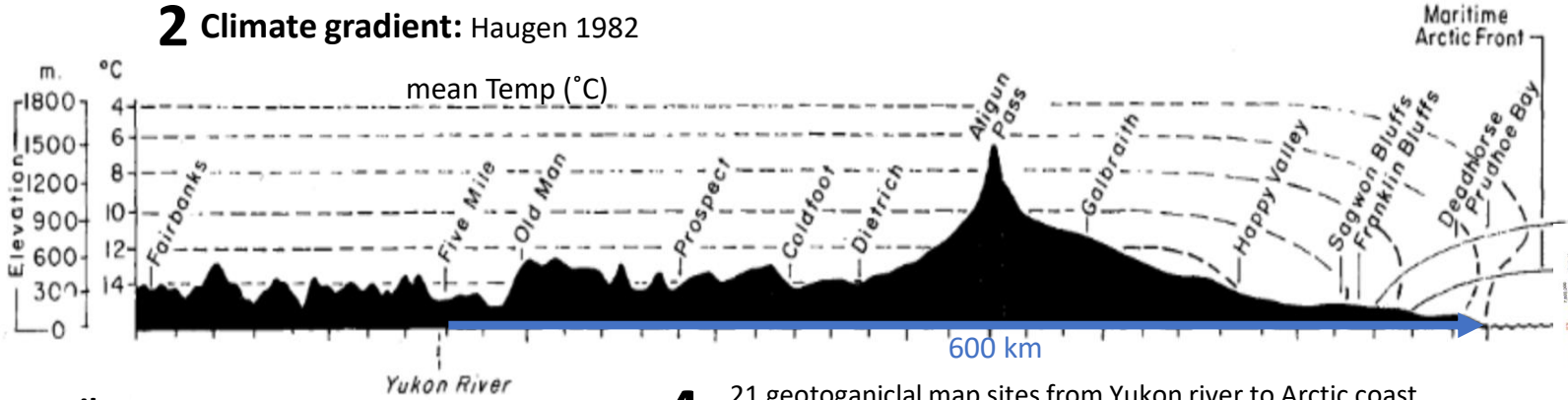
- Many of the sites have changed dramatically since they were established (e.g. Raynolds et al. 2014; Farquharson et al. 2016; Betaway-May et al. 2025).
- Relocate, photograph and sample as many of 8 Arctic transect's sites and plots as possible.
- Start with examining the feasibility of using existing transects, if there is need to incorporate new transects in gaps.

Example transect: Dalton Highway: Six decades of change (1974-2033)

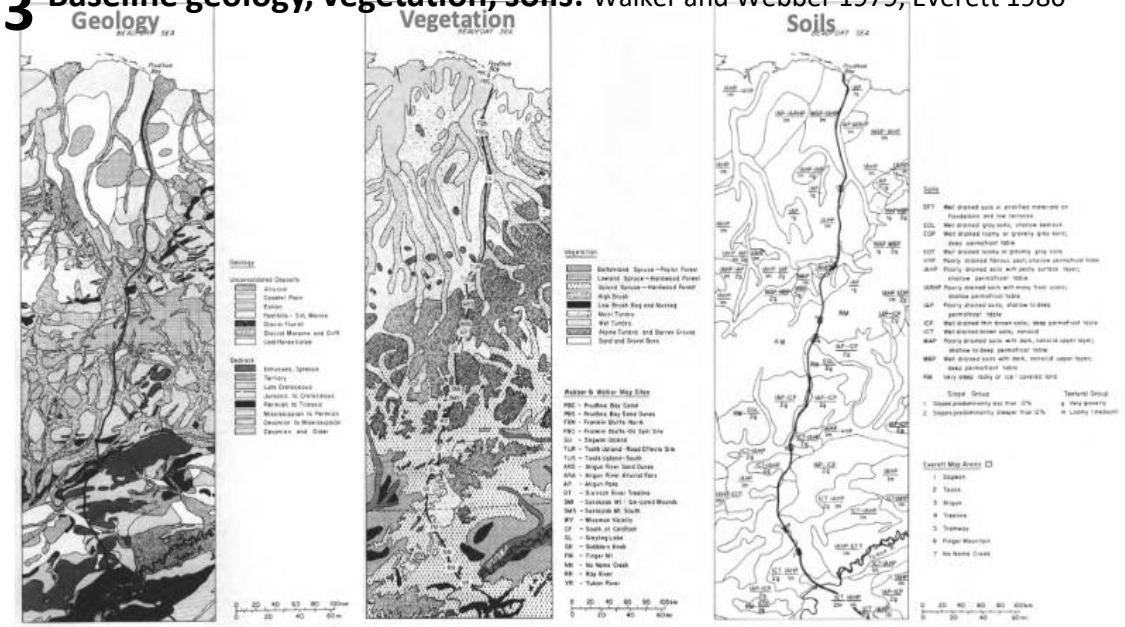
1 Ecological baseline: Brown & Berg 1980



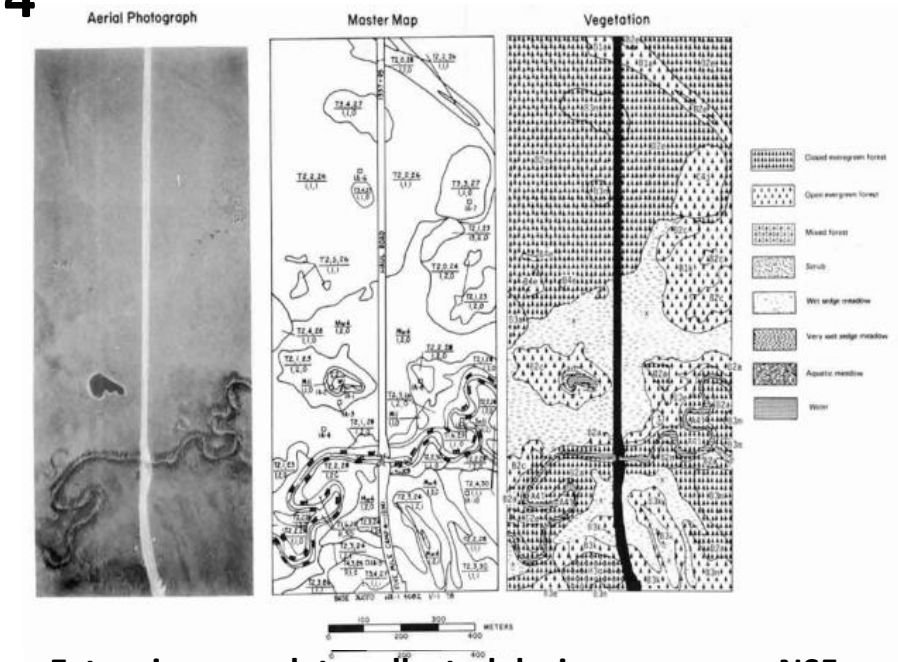
2 Climate gradient: Haugen 1982



3 Baseline geology, vegetation, soils: Walker and Webber 1979, Everett 1980



4 21 geotoganiclal map sites from Yukon river to Arctic coast.



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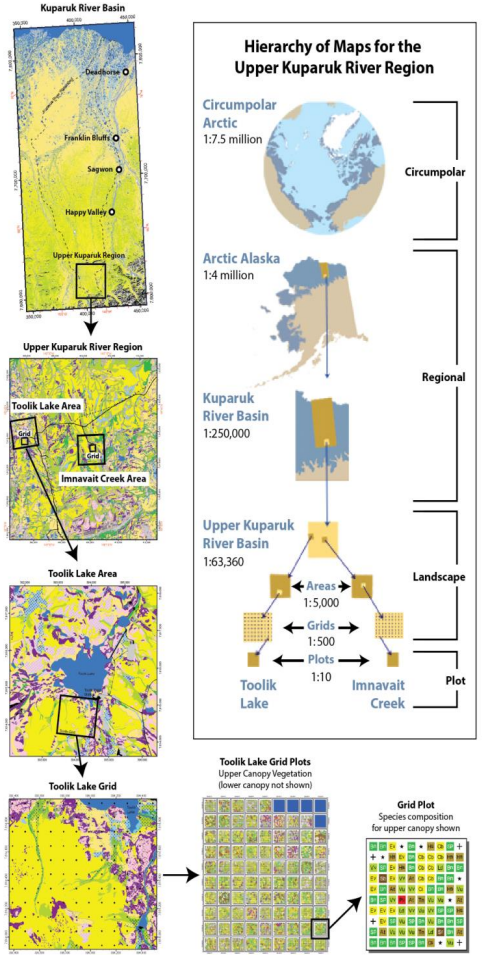

6 Permafrost monitoring: CALM grids, Temperature boreholes: Osterkamp and Romanovsky boreholes.

7 Long-term ecological monitoring: Toolik, Imnaviat Creek, Prudhoe Bay. Beaufort Lagoon coastal areas

8 Extensive new data collected during numerous NSF, DOE, and NASA initiatives: : e.g. DOE R4D, FLUX, ATLAS, Bioconplexity of Patterned Ground, ARCSEES, ABOVE, NNA-IRPS

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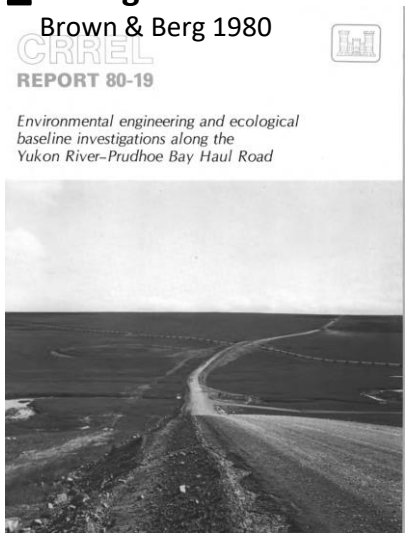

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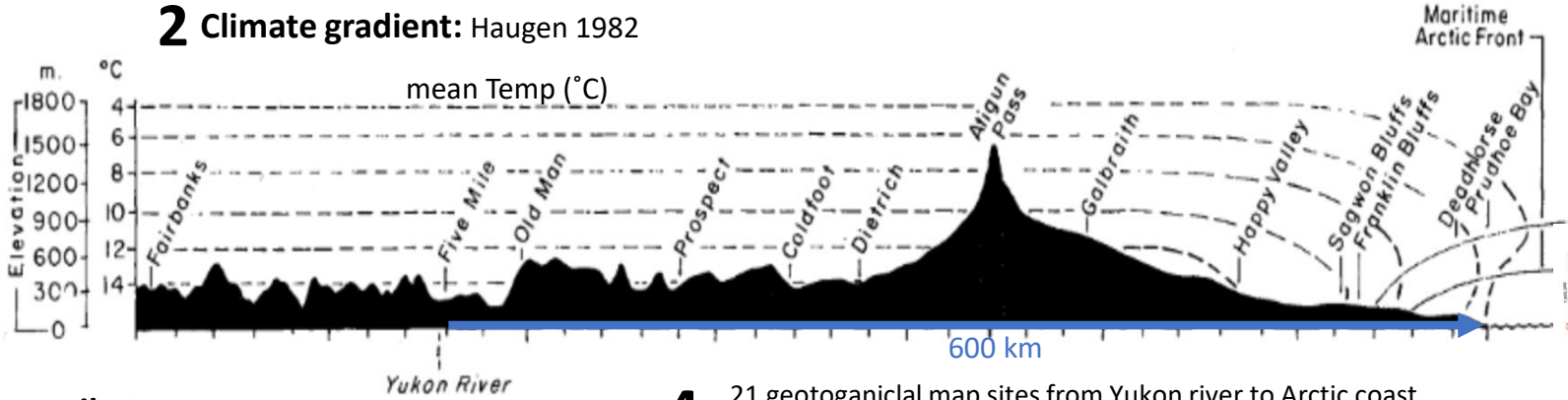

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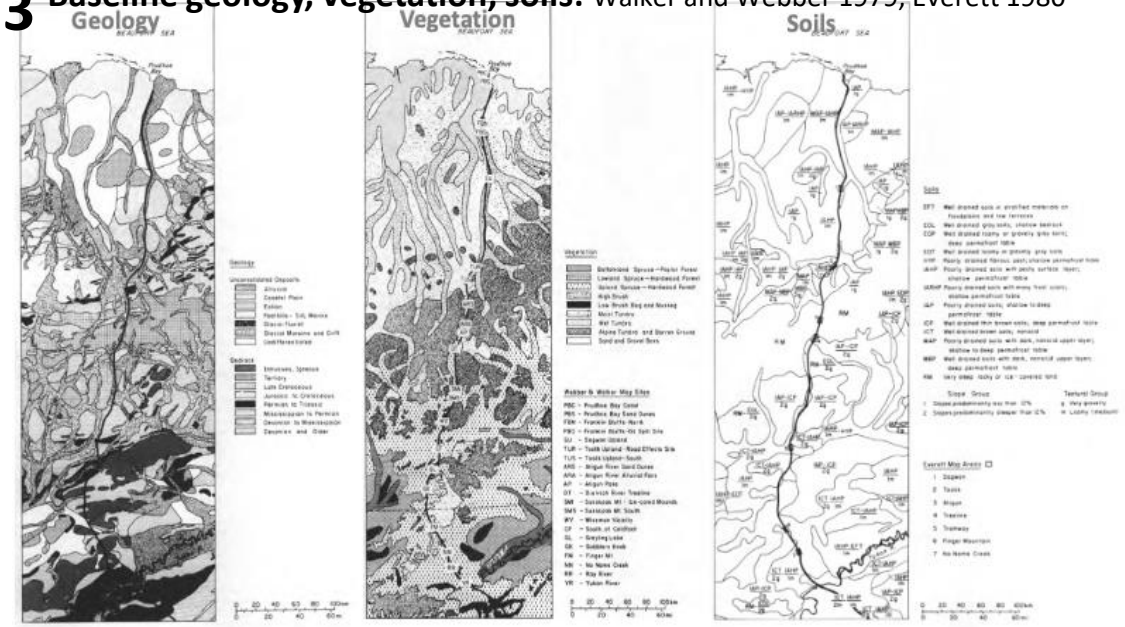

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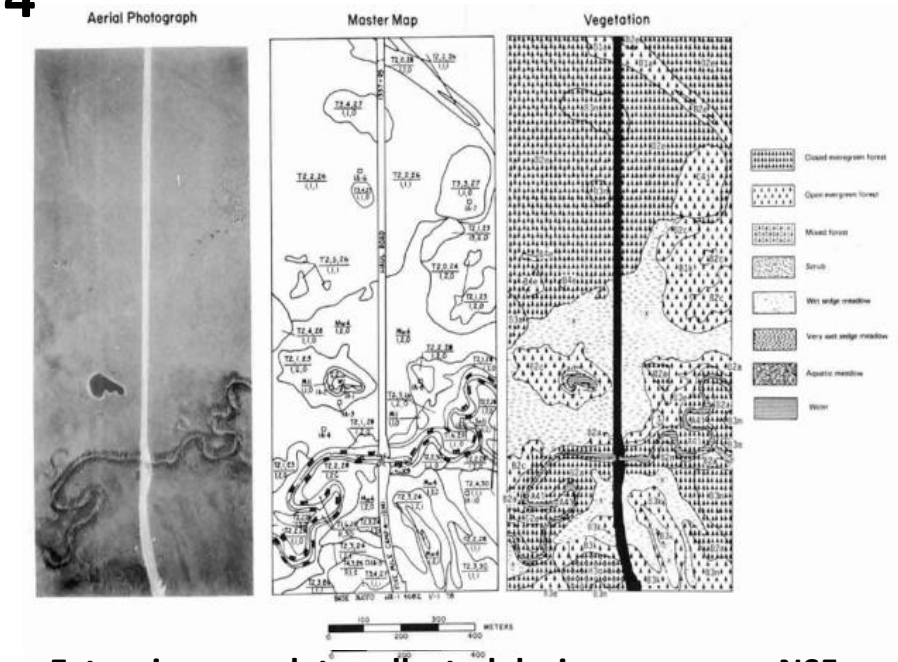

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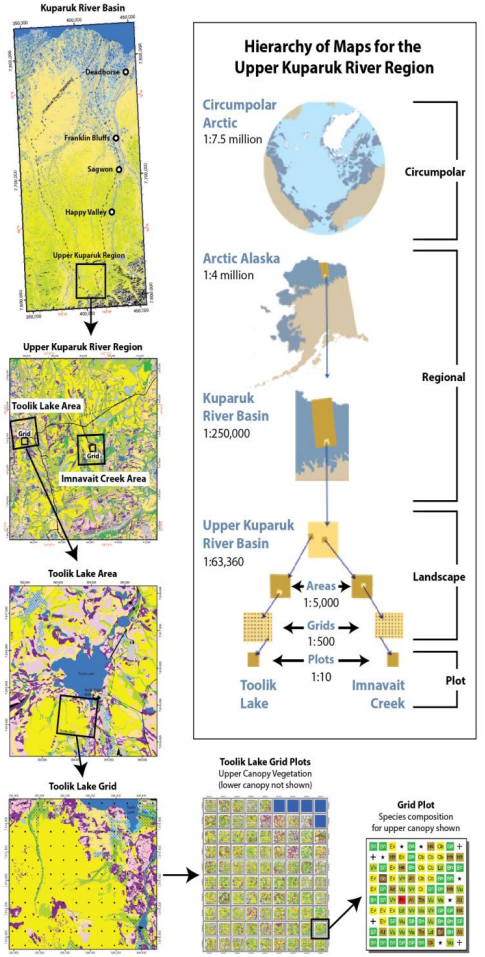

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Credits

The CAVSI Organizing Group

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Howard Epstein, University of Virginia
Ramona Heim, University Münster, Germany
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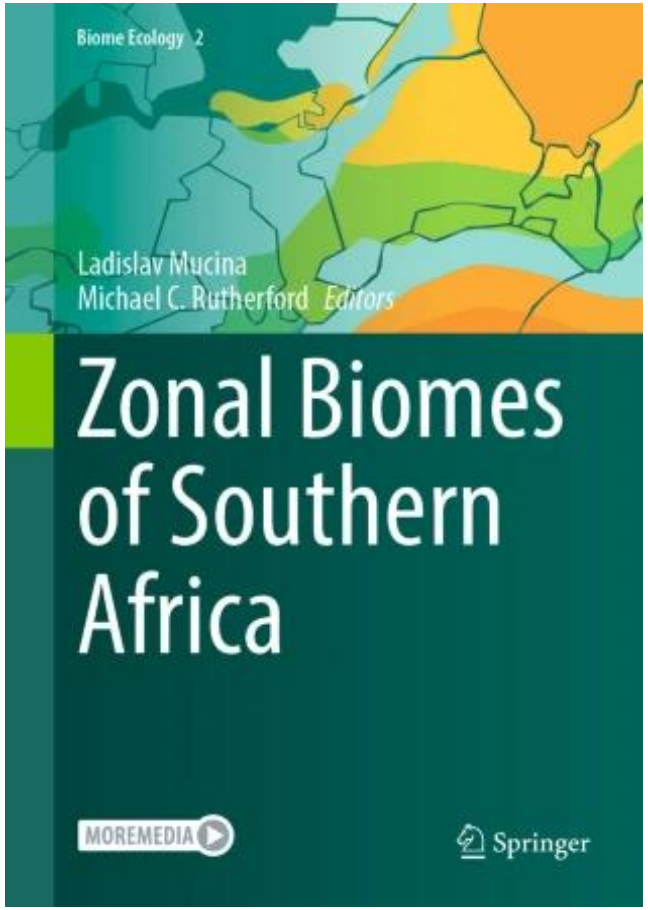
Maria Šibíkova, Slovak Academy of Science, Bratislava
Craig Tweedie, University of Texas at El Paso
Marilyn Walker, retired, Boulder, CO
Skip Walker, University of Alaska, Fairbanks
Vitalii Zemlianskii, University of Zurich

Institutional support and funding:

IV. Applications. Looking toward IPY-5

Defining and mapping Arctic biomes

- Hierarchical global context to facilitate comparisons with adjacent and similar biomes.
- Possibly using The Global Hierarchical Biome System (GHBS) of Mucina (2019, 2023). Leading to a book of the *Circumpolar biomes of the Arctic.*

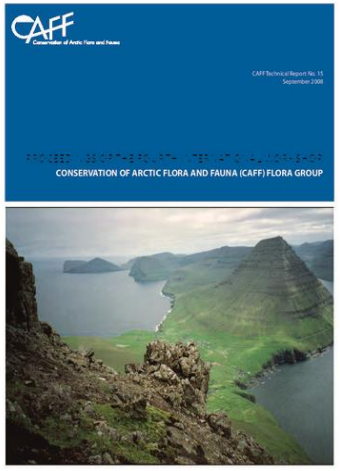


IV. Applications. Looking toward IPY 5

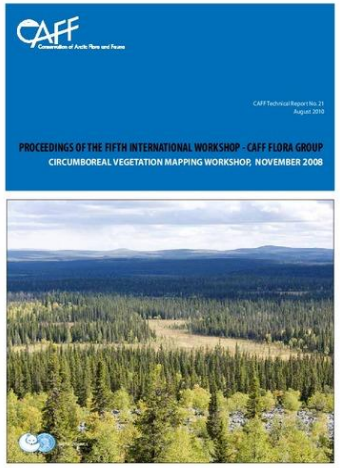
B.2. Arctic edges

- Alpine, treeline, northern boreal, and oceanic areas
- Extension of the CAVM southern boundary beyond the northern limit of trees to include treeline and adjacent boreal alpine areas, and northern boreal oceanic areas.
- Groundwork for this was laid in CAFF proceedings volumes from 5 Circumboreal Vegetation Mapping (CBMP) workshops (Talbot et al. 2007, 2008, 2011, Saucier 2012) and two CAFF Strategy series volumes, (Talbot and Meades 2011, Jorgenson and Meidinger 2015).

2007, Torshavn

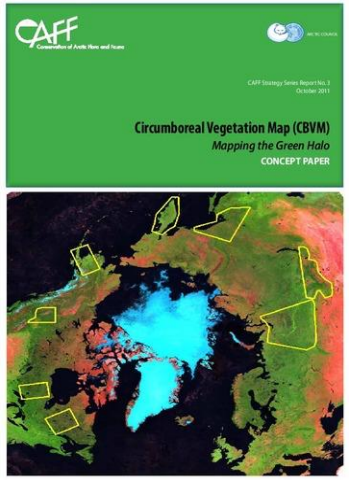


2008, Helsinki

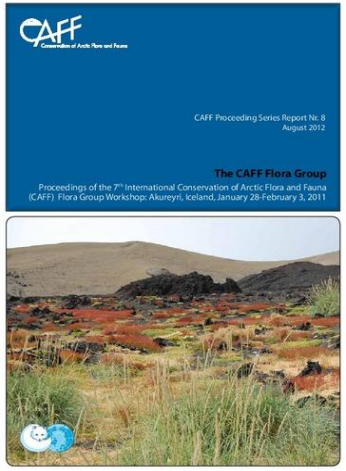


2011, Upasala

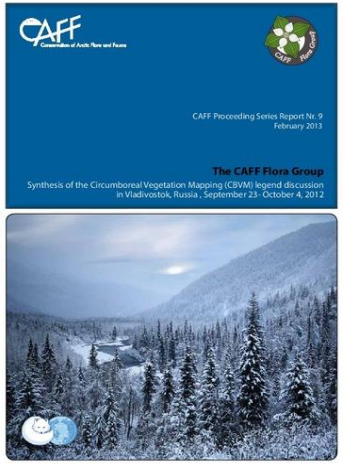
2011, Concept Paper



2011, Akureyri



2012, Vladivostok



2015 Alaska-Yukon Map