Arctic Vegetation Archive and Classification Hybrid Workshop

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Abstracts

Oral Presentations

Overview of the Arctic Vegetation Archive and Classification: Past, Present, and Future

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Past

After the hiatus of AVA/AVC in-person workshops during Covid crisis, it is worthwhile to refocus by revisiting the original goals (M.D. Walker et al. 1995) and workshop proceedings volumes from the past 30 years. These show a rather remarkable adherence to the original vision that was presented at the 1992 Arctic Workshop in Boulder, CO, which consisted of three main objectives: (1) a database archive of relevé (plot) data using the Panarctic Flora as a common taxonomical reference; (2) a comprehensive synthesis of this plot information through publication of a checklist and classification of Arctic vegetation; and (3) compilation and publication of a circumpolar Arctic vegetation map at 1:7.5 million scale (the CAVM). The proceedings include many insightful papers and concepts that has led to the key elements of the archive, including: a unified Pan Arctic Species List; standardized plot data; web-based approaches for accessing plot species and environmental data, GIS-based maps of datasets and plot locations, a wide variety of ancillary data sets, also accessible online, including maps, photos, analyses, other derived products, and the beginning of a harmonization of North America (USNVC) and European (Br.-Bl.) classification approaches.

In the beginning (1992–2005), the circumpolar arctic vegetation map was the priority. A lack of a common taxonomical framework for datasets from separate areas of the Arctic prevented rapid progress on the AVA until the PanArctic Flora was completed (Nordal and Razzhivin 1999, Elven et al. 2012). The CAVM required several workshops, and an international expedition to all five Arctic bioclimate subzones in the Canadian Arctic (Gonzalez et al. 2000) for members to agree that North America and Eurasia could be mapped using the same AVHRR satellite base-map imagery, the same zonal mapping units as in Russia, and a GIS-based integrated terrain-unit approach (Walker et al. 2002) for drawing the map polygons, and several years for each country to draw the map polygons. The map vector-based polygon map (CAVM Team 2003) and the supporting journal article (Walker et al. 2005) were the basis for many circumpolar-scale analyses, including the Arctic Biodiversity Assessment (CAFF 2013). A new hard-copy of the raster-based CAVM (Raynolds et al. 2019) is a milestone that will make the map more useful for a wide variety of analyses and models that use pixel-based imagery and raster-based spatial information. The map will be presented during this conference in session ID 10 (Raynolds and CAVM Team 2023) and will soon be available in a 2-sided hard-copy color map.

In 2007–2015, the focus shifted to a similar circum-boreal vegetation map with workshops in Torshavn in 2007 (Talbot 2008), Helsinki in 2008 (Talbot et al. 2010), Uppsala in 2009 (Talbot, 2011), Akureyri in 2011 (Talbot 2012), Vladivostok In 2012 (Saucier 2013); and concept paper (Talbot and Meades 2011). A prototype map of the Alaska-Yukon boreal forest was made (Jorgenson and Meidinger 2015), but a full map of the boreal zone was never completed for lack of funds, difficulties in developing a comprehensive legend, and loss of advocates to push the initiative through government agencies in each of the Arctic countries. The project lost momentum through a series of retirements of key participants in the U.S., Canada, and Russia.

Momentum for an international arctic vegetation database was revived in a CAFF strategy paper that described the key conceptual elements of a digital plot data base (Walker and Raynolds 2011). Four AVA/AVC workshops supported by IASC were held in Krakow in the Spring 2013 (Walker et al. 2013), Boulder in Fall 2013 (Walker 2014), Prague (2017) and Arkhangelsk (2019) (Walker et al. 2019).

Present

Despite the intervention of the COVID-19, the Ukraine War, and the lack of consistent sources of funding (outside of the IASC workshop grants), I am pleased to see that international collaboration is still alive among Arctic vegetation scientists. Outstanding recent progress has been made in Russia with the publication of a checklist of syntaxa for the Russian Arctic (Matveyeva and Lavrinenko 2021), the description of a new zonal tundra vegetation class (Matveyeva et al. 2023), and several papers describing Russian plant associations with circumpolar counterparts (e.g. Ermokhina et al. 2022; Koroleva and Kulyugina 2015; Lavrinenko and Kulyugina 2015, Lavrinenko and Lavrinenko 2015, Lavrinenko and Kochergina 2022, 2016, Lavrinenko et al. 2014, 2022; Telyatnikov et al. 2013, 2019, 2021a, 2021b, 2022). Equally impressive is the progress of an online Russia Arctic Vegetation Archive (AVA-RU) (Zemlianskii et al. 2023 submitted?) that closely parallels many aspects of the Alaska Arctic Vegetation Archive (AVA-AK) (Walker et al. 2016, Breen et al. 2019). Canada has been making steady progress on Canadian National Vegetation Classification (Baldwin et al. 2019) using a VPro data management software (Mackenzie and Klassen 2009) that is compatible with the U.S. EcoVeg principles for natural vegetation classification (Faber-Langendoen et al. 2014, 2018). Also, approximately 287 relevés has been collected from a long latitudinal transect on Baffin Island by Martha Raynolds, Helga Bültmann, and Shawnee Kasanke. In Greenland, Fred Daniëls' book *Vegetation of Greenland* will be submitted for publication in April 2023!

Future

This afternoon several papers will give overviews of recent progress in Russia, Canada, Greenland, and Alaska. This be followed by a discussion that will focus on several topics that I suggest here, but we can modify:

1. ***Update on status of plots in each of the Arctic phytogeographic provinces.*** The map of potential plots published in 2019 needs to be updated with new datasets, how many plots are appropriate for inclusion, and how many are now in regional archives.
2. ***Unification of the AVA-RU and AVA-AK***. The next step should probably be unification of two most similar archives, the AVA-RU and the AVA-AK, into a single

archive. This will require considerable thought about how to unify the species lists and cross-reference aspects of each archive that are not common to both archives.

- Continued push is needed to update the panarctic species list or develop an acceptable approach for making a panarctic list that can be updated as new species are found and the existing Latin names change to reflect new knowledge.
- More steps are needed to standardize data in the national AVAs, including use of unique Turboveg relevé numbers (e.g., Alaska (10000-19999), Russia (20000-29999), Canada (30000-39999), etc.); development of country archive coordinators; development of species synonym lists for each country linked to the current Pan-Arctic Species List (PASL).

3. ***An International Circumpolar Vegetation Group***. This could be a subgroup within the IASC Terrestrial Working Group that focuses on development of the key circumpolar vegetation maps, plot archives, classification, and application of these to the core biodiversity- and circumpolar ecosystem-change. This could include an Arctic Vegetation Network to improve communication, share publications, data, and coordination regarding arctic vegetation data, regular monthly Zoom meetings to start, and possibly a more formal organization with dues, website, etc. if it seems useful and necessary
4. ***Plan for ICARP IV.*** We should also discuss an IASC proposal for a Circumpolar Arctic Vegetation workshop at ICARP IV 2025 and if we should have a more formal science plan for the next decade (2026–2035) of Circumpolar Arctic Vegetation research.

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The Alaska Arctic Vegetation Archive (AVA-AK): Achievements, status and lessons learned

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The Arctic Vegetation Archive (AVA) is a data repository of vegetation-plot observations for the Arctic tundra biome. The geographic scope of the AVA spans seven countries across the circumpolar region and maritime boreal tundra areas. Work on the AVA is being accomplished within individual Arctic countries with the long-term goal to develop a Pan-

Arctic Vegetation Classification. For our presentation, we provide an overview of the status of the Alaska prototype for the AVA (AVA-AK).

The AVA-AK not only contains ground-based vegetation plot data, but also associated environmental data and related information from over 3,000 plots in Arctic and near-Arctic Alaska, as well as a few sites in the Canadian high Arctic. These data are open access via the online Alaska Arctic Geobotanical Atlas, created by the Alaska Geobotany Center and the Geographic Information Network of Alaska. In 2020, the data portal migrated to the open-source CKAN platform and navigation improvements were made, including an ArcGIS Online companion site for data discovery and map-based browsing (https://arcticatlas.geobotany.org/).

Since its creation in 2012, the AVA-AK evolved to contain 44 datasets with over 3,000 non-overlapping plots. Of these datasets, we estimate approximately two-thirds have geo-location data with 25-m or better precision. In addition, new vegetation plot datasets from the Coastal Plain, Brooks Range and Seward Peninsula in Alaska and Baffin Island in Canada were collected and will be added to the archive over time. We will share these achievements and an overview of recent projects and publications since the 2019 AVA Workshop.

Russian Arctic Vegetation Archive update

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The Russian Arctic Vegetation Archive (AVA-RU) aims to bring together and harmonize vegetation plot data collected in the Russian Arctic or by Russian geobotanists into a publically accessible web-based archive.

At present, AVA-RU consists of 4742 Braun Blanquet plots, with 72% of the samples georeferenced. The data were collected between 1927 and 2020 and include observations of over 1730 vascular plant and cryptogam species and subspecies. The plots were sampled in Arctic Russia and Scandinavia (including Svalbard). Plots in Russia covered areas from the West to the East, including the European Russian Arctic (Kola Peninsula, the Bolshezemelskaya and Malozemelskya tundra, Kolguev island) , Western Siberia (Northern Urals, Yamal, Taza and Gydan peninsulas), Central Siberia (Taymyr peninsula, Severnaya Zemlya islands), Eastern Siberia (Indigirka basin) and the Far East (Wrangel island). The data is stored at https://avarus.space/ and has a backup at the University of Zurich, and is regularly updated with new plots.

A data paper on AVA-RU's progress is under review. The publication of the Russian part of the Arctic Vegetation Archive will provide full and open access to Russian Arctic vegetation data, filling the gap in the assessment and prediction of plant biodiversity and ecosystem functioning in the Russian Arctic.

Progress on the Canadian Arctic Vegetation Archive, Classification, and Mapping

William H. MacKenzie, *Smithers, BC, Canada*

The Canadian Arctic Vegetation Archive (CAVA) has expanded incrementally in the 3 years since the Archangelsk workshop. A planned field program of the Canadian High Arctic Research Station (CHARS) to sample extensively in the central Canadian arctic was cancelled due to Covid in 2020. A modest program to finalize sampling for the subzones C and D of Victoria Island, NU in 2021 was hampered by poor weather and a limited set of 40 releves was acquired. A dataset of 150 plot from southern Baffin Island have been acquired from industry partners filling an important geographic void in the archive.

A set of scripts in the R programming languages has been produced to align taxonomic standards between different authorities and applied to the CAVA to harmonize with the larger North American data set. The CAVA now houses 8735 plots and consolidation of project metadata will identify plot collection standards and quality. The archive continues to be kept in VPRO, a programmed ACCESS database designed for management of vegetation and environmental reléves and classification hierarchies. Under new management, the CHARS is building expertise and infrastructure to be a long-term host of the archive.

Classification work using the archive has been completed for the Yukon arctic (MacKenzie et.al. 2022) following the methods of the Biogeoclimatic Ecosystem Classification system (McClennan et al. 2017). Similar work is on-going in the CHARS experimental area to support ecosystem mapping. Modelled down-scaling of the Circum Arctic Vegetation Map (CAVM) subzones to a scale of 1:50 000 has been undertaken for the Central Canadian arctic using the CAVA as training data (in part) for machine learning algorithms. Significant expansion of the C and B subzones into higher areas of Victoria Island, NU were confirmed by overflight and field visits in 2021.

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Overview of the AVA Greenland update

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Some progress has been made in assembling the data in one Turboveg version on one computer. Most of the data from PhD students of Fred are stored that way. These datasets have been reviewed and need some work to repair lost species names in datasets stemming from the oldest Turboveg-version (DOS) and to screen the several versions of the same sets in the newer datasets. Most probably some last minute corrections in the PhD-theses will not be found in the datasets. There are still datasets in old table formats (e.g. "TAB").

All those digital data have been assembled and stored together. While the data are safe, some tedious work is needed to make the data ready for analysis together with the datasets in the main AVA.

The vegetation types stored in the databases will be presented and possible procedures to progress discussed.

Progress on the European Vegetation Archive (EVA)

Stephan Hennekens, *Wageningen University, The Netherlands*

The European Vegetation Archive (EVA) currently comprises almost 2,4 million plot observations and much different taxonomy. By integrating a crosswalk between the many different taxonomies (already more than 40), an analysis of such large heterogeneous data sets has become feasible. For the dissemination of the data the EVA Data Property and Governance Rules are followed (http://euroveg.org/download/eva-rules.pdf).

The EVA database is managed with TURBOVEG3. This software tool harmonizes the species names by using a taxonomic backbone in which the various taxonomies are present and mapped to a common concept. TURBOVEG3 also has EXPERT integrated, a tool to identify plot observations to vegetation types. Regarding the EVA data identification rules for EUNIS (European Nature Information System) habitat types have been developed. Based on the assignment of vegetation plots to EUNIS habitat types distribution maps of the habitat types can be created which can serve as input for habitat suitability modelling. Suitability maps show the potential area of a habitat, based on predictors (climate, soil and topography parameters, as well as RS-enabled EBV’s).

POSTERS

Improving the classification of Arctic wetlands to better understand their role in the carbon and energy cycles

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Wetlands in the Arctic play a significant role in regulating carbon levels and have various physical characteristics, such as hydrological conditions and vegetation, that affect their interactions with climate and their exchange of greenhouse gases. While some models only recognize a few types of Arctic wetlands, there are at least ten different types based on biogeographic classification. In order to accurately represent the role of wetlands in the Arctic carbon cycle in modeling studies, it is necessary to find a balance between capturing the diversity of wetland types and the information that is typically available.

To do this, a database was created using data from published studies on Arctic wetland characteristics, including carbon pools and fluxes, for the period 1988-2019. The data, primarily collected using flux chamber techniques, includes site characteristics and methane and carbon dioxide fluxes. However, there is limited data available for some parameters, such as permafrost depth, pH, and water table level. To address this, remotely-sensed data was also included, though it is often less precise. Using statistical analysis, the data was divided into wetland categories based on their methane and carbon dioxide fluxes and their response to environmental factors. The results of this classification are presented for a range of total numbers of categories, allowing for the selection of the most appropriate scheme for a given modeling study.

Bryophyte diversity along a site moisture gradient

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Bryophytes are important part of arctic tundra ecosystems. They reach high diversity and abundance and play a key role in many ecological processes. Unfortunately, species identification of mosses in the field is difficult, often requiring determination of microscopic characters. This report examines distribution of bryophyte life forms that occur across a moisture gradient at a research site in the Prudhoe Bay Oilfield, Alaska. Several approaches for classifying bryophyte life forms were reviewed, but only a few focused on arctic flora. Here we propose seven distinct life-forms that occur in the Prudhoe Bay study area. Species diversity, abundance and composition, and life-forms are studied in relation to nine vegetation types across a local site moisture gradient covering dry, moist, wet and aquatic tundra. Results show an obvious trend in all studied aspects of bryophyte diversity. Species richness is highest in moist sites on raised microrelief features and decreases towards aquatic sites. In contrast, abundance increases towards aquatic sites. Distribution of species and life-forms in an ordination diagram follows the studied gradient. Erect species, including those in turfs, are abundant in dry and moist sites, prostrate species, often occurring as mats, dominate to wet and aquatic sites. These results suggest that using life-forms in ecological studies can improve understanding of processes in arctic environments.

Mapping and monitoring of arctic vegetation using NaturaSat software

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Environmental and anthropogenic factors coshape plant species richness across the Western Siberian tundra

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