PROCEEDINGS OF THE CIRCUMPOLAR ARCTIC VEGETATION SCIENCE INITIATIVE (CAVSI)

ASSW 2025 & ICARP IV SCIENCE SESSIONS

25 & 27 MARCH 2025
BOULDER, COLORADO

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CAVSI
Circumpolar Arctic Vegetation Science Initiative

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SCIENCE SESSIONS | ASSW 2025 & ICARP IV SUMMIT

25 & 27 MARCH 2025, BOULDER, COLORADO

A. L. Breen, D. A. Walker, and G. Schaepman-Strub, editors

Alaska Geobotany Center, University of Alaska Fairbanks

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Circumpolar Arctic Vegetation Science Initiative

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We are grateful to the researchers, early career scientists, and community members who participated in the CAVSI workshop and contributed presentations to the Back to the Future sessions. Your enthusiasm and collaboration made these discussions rich, forward-thinking, and grounded in shared purpose. We also thank the ASSW 2025 and ICARP IV Summit organizing committees for their dedication in bringing the international Arctic research community together in Boulder.

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COVER PHOTOGRAPH

View from the Third Flatiron just after sunrise, with Boulder, Colorado, in the distance. (Credit: David Stillman, 2010. Creative Commons license CC BY-NC 2.0)

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PREFACE

This proceedings volume brings together a collection of Arctic vegetation science abstracts presented during two linked sessions at the ICARP IV Summit at Arctic Science Summit Week in Boulder, Colorado (25–28 March 2025): *Back to the Future II – Linking Past and Future IPY Terrestrial Biodiversity Efforts* and *Building a Time Machine Out of a DeLorean: Observing, Reconstructing, and Predicting Vegetation Change in the Arctic*. These sessions drew inspiration from the 4th International Polar Year (IPY4, 2007–2008), when the "Retrospective and Prospective Vegetation Change in the Polar Regions: Back to the Future" project (BTF) catalyzed a wave of re-measurement and re-analysis across the tundra biome (Callaghan et al. 2011). As a PhD student during that IPY4, I find it especially meaningful to now look ahead to IPY5 in 2032-2033, reflecting on the scientific legacy we carry forward – and what remains to be done.

The *Back to the Future* theme resonates in both time and place: the return to Boulder recalls the first international meeting of Arctic vegetation scientists in 1992, which took place just after the Cold War and created new opportunities for collaboration across geopolitical lines (Walker et al. 1994; Fig. 1). That workshop laid the foundation for a pan-Arctic vegetation science framework and articulated three ambitious goals:

1. Create a database of type relevé data, using the Panarctic Flora database as a common taxonomic base.
2. Develop a comprehensive Arctic vegetation classification (AVC), including a Prodromus of syntaxa and a revised circumpolar syntaxonomical framework.
3. Compile and publish a circumpolar Arctic vegetation map and accompanying legend.

Over the past three decades, major progress has been made: the Panarctic Flora (Elven et al. 2011) and the Circumpolar Arctic Vegetation Map (CAVM; Raynolds et al. 2019) are now complete, while the Arctic Vegetation Archive (Walker et al. 2018; Zemlianskii et al. 2023) remains underway but is advancing steadily toward completion by each country independently. Yet the creation of a formal Arctic Vegetation Classification—the cornerstone for global comparisons and coordinated mapping—remains unfinished.

Figure 1. Group photo of most of the participants in the first International Workshop on Classification of Arctic Vegetation held at the Institute of Arctic and Alpine Research, University of Colorado, Boulder, CO, USA, 5-9 March 1992.

Figure 2. Group photo of the participants in the CAVSI Workshop held at the University of Colorado, Boulder, CO, USA, 21-23 March 2025. For list of participants, see CAVSI (2025).

To fulfill this legacy and chart a path forward, the Circumpolar Arctic Vegetation Science Initiative (CAVSI) has emerged (CAVSI Organizing Group 2025). With participation from 85 scientists representing 15 countries, the first CAVSI Workshop was held during the ASSW Business and Community Meetings (21–23 March 2025; Fig. 2). The meeting produced key recommendations to address Arctic research priorities in the coming decade leading up to the Fifth International Polar Year (IPY-5, 2032-2033).The recommendations include tasks to: (1) establish a CAVSI organizing group and an early-career Arctic vegetation science group; (2) develop an Arctic Vegetation Observing Network (AVON); (3) adopt standardized protocols for species lists, vegetation sampling, monitoring, archiving, classification, and mapping; and (4) apply the products to priority IPY5 research topics.

Notably, the 2025 ASSW Summit took place during challenging geopolitical circumstances, which restricted participation by individuals representing Russian institutions. As a result, Russian attendance at ASSW was limited to those working outside their home country. This constraint posed difficulties for achieving a comprehensive circumpolar view, given that Russia encompasses the largest share of Arctic land. While the perspectives included here remain incomplete, in-person and pre-recorded updates during the CAVSI Workshop from vegetation scientists working in Russia enrich this volume and are compiled in the proceedings Appendix.

Together, the research presented in these sessions spans temporal scales from the Holocene to future climate scenarios, and spatial scales from fine-resolution polygonal tundra to pan-Arctic remote sensing. Thirty-nine oral and poster presentations showcased innovations in field methods, genetics, remote sensing, ecological modeling, and community collaboration—including the integration of Indigenous knowledge systems. Lead authors represented over 35 institutions across 11 countries underscoring the global commitment to Arctic vegetation science.

In many ways, we now stand at a threshold as we are armed with tools, partnerships, and shared purpose that was only just emerging in 1992. Yet the current moment also reminds us of the fragility of scientific collaboration, even today, in the face of geopolitical challenges. With IPY-5 on the horizon, the task before us is to both complete the ambitious vision launched more than three decades ago and to extend it into the future. We look *back to the future* with renewed clarity—ready to observe, reconstruct, and predict the changing Arctic through a collaborative lens that aspires to be truly circumpolar and beyond.

SCIENCE SESSION 2.6
BACK TO THE FUTURE II: LINKING PAST AND FUTURE IPY TERRESTRIAL BIODIVERSITY EFFORTS

25 MARCH 2025 | 13:30–15:30 (MDT)

Open Session - HYBRID

ORGANIZERS: GABRIELA SCHAEPMAN-STRUB[1] AND AMY BREEN[2]

[1] Department of Evolutionary Biology and Environmental Studies, University of Zurich, Switzerland; [2] International Arctic Research Center, University of Alaska Fairbanks, USA

SESSION DESCRIPTION: The aim of this session is to reflect on urgent questions we would like to answer during the 5th IPY, what results and data are existing from previous efforts and how to link those to new measurements during the 5th IPY and beyond. This session will therefore serve to recap current knowledge and data and reflect on how to move towards measurement standards and protocols that can be applied by taxonomic and non-taxonomic specialists to secure long-term records of terrestrial biodiversity and ecosystem functions. Reporting on existing results of past efforts and reflecting on gaps and future sampling needs, methods across biological organization and scales and designs are especially welcome. We invite everybody interested in the coordination of IPY terrestrial microbial, bryophyte, lichen, and vascular plant diversity assessments and synthesis to submit contributions, and to start coordination of these efforts, across disciplines and knowledge systems.

EDNA COULD FACILITATE RAPID ESTIMATES OF PLANT DIVERSITY IN ARCTIC TUNDRA LANDSCAPES DURING THE IPY 2032-33 — JAKOB J. ASSMANN

University of Zurich, Switzerland

COAUTHORS: Debora S. Obris, Erin Cox, Gilda Varliero, Beat Frey, Gabriela Schaepman-Strub. **FORMAT:** Oral in-person

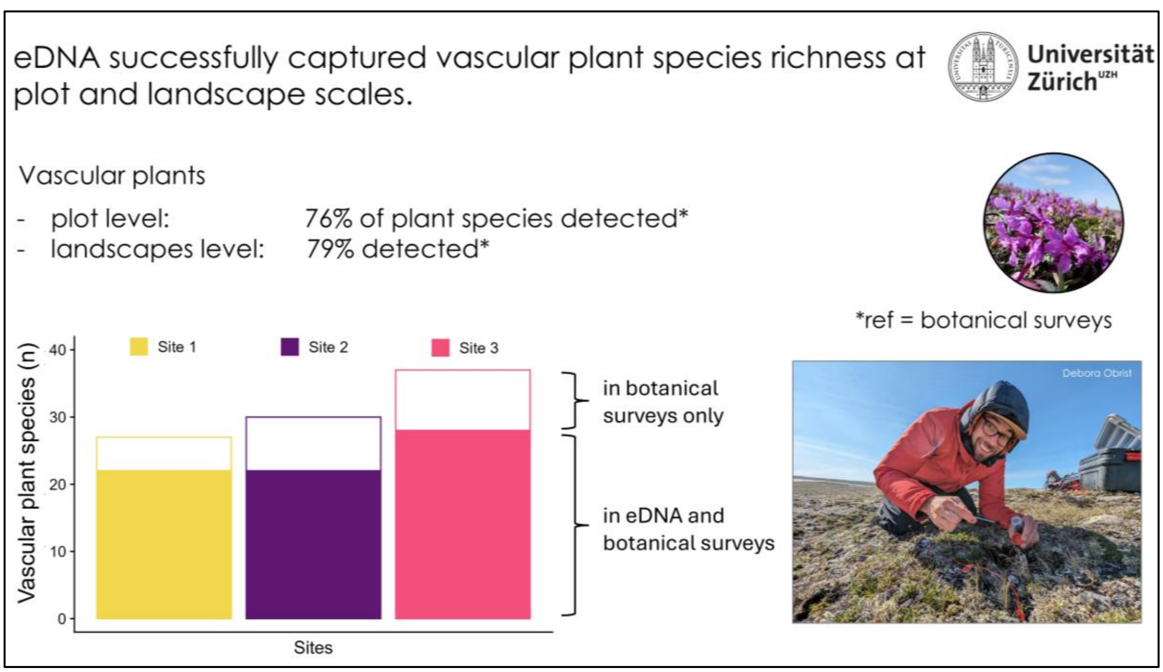
ABSTRACT: Climate change and industrial development are changing the Arctic tundra. However, baseline data of plant diversity are missing for much of the biome, especially at higher latitudes and for non-vascular plants. These data-gaps limit our understanding of changes in plant diversity and their drivers, as well as the identification of priority locations for conservation efforts.

With the upcoming International Polar Year (IPY) 2032-33 in mind, we developed and tested a new protocol for the rapid assessment of tundra plant species richness at the landscape-scale.

We sampled three 300 m x 300 m landscapes in Nunavut, Canada using a combined systematic and random sampling design. For each landscape, we collected botanical observations and soil samples and acquired multispectral drone imagery. We extracted soil DNA and carried out metabarcoding using off-the-shelf equipment and next generation sequencing provided by commercial providers.

We found that detailed botanical observations were needed to detect rare plant species, but eDNA metabarcoding allowed for the fast detection of a large proportion (79%) of the vascular plant richness in the landscapes). Bryophyte species made up the largest component of the plant diversity in the studied landscapes, but the detection rates in eDNA were much lower than for vascular plants (30%), suggesting the need to further refine this component of the workflow.

Using post-hoc subsampling, we optimized the protocol for short time-windows (3-4 hours) such as those found during helicopter and ship-based campaigns. Our findings demonstrate the potential for eDNA metabarcoding to accelerate plant diversity surveys in the tundra. The simplicity of the soil sampling may also enable citizen and non-expert collections.



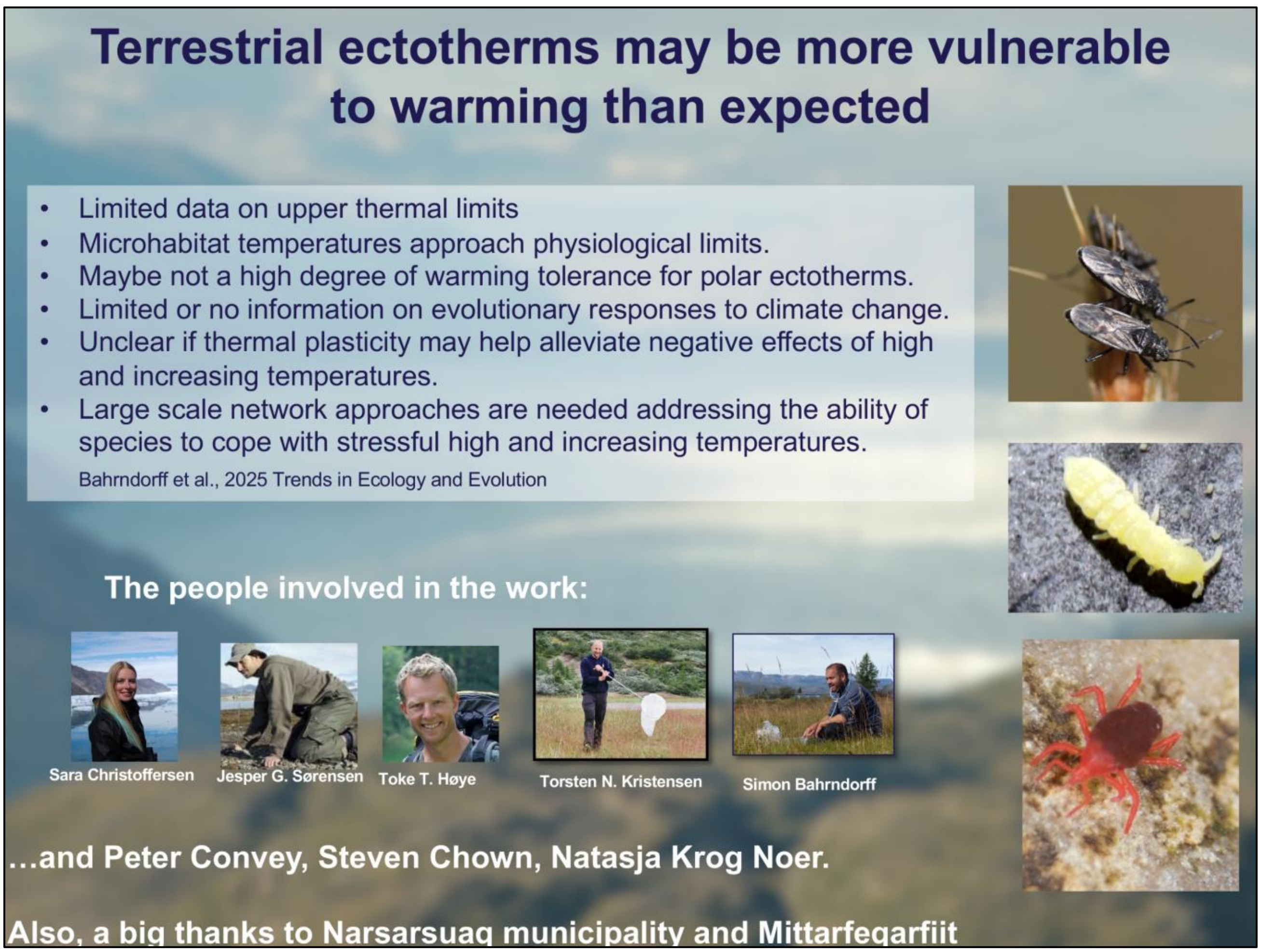
Results showing our protocol captured vascular plant richness at plot and landscape scales sufficiently but requires further refinement to capture rare species.

THERMAL ADAPTATION OF TERRESTRIAL ARTHROPODS TO HEAT STRESS IN POLAR REGIONS — SIMON BAHRNDORFF

Aalborg University, Aalborg, Denmark

FORMAT: Oral in-person

ABSTRACT: Terrestrial arthropods in polar regions are exposed to extreme and variable temperatures. Further, climate change is predicted to be especially pronounced in polar regions. However, available ecophysiological studies on terrestrial ectotherms from polar regions typically focus on the ability of species to tolerate the extreme low temperatures, whereas studies investigating species plasticity and the importance of evolutionary adaptation to periodically high and increasing temperatures are limited. It is clear that very little data are available on the heat tolerance of arthropods in polar regions, but, based on literature, results suggest that large variation in arthropod thermal tolerance exists across polar regions, habitats, and species. Further, our work on terrestrial arthropods in the Arctic suggests unique physiological adjustments to heat stress, such as species ability to respond quickly to increasing or extreme temperatures, but that they cannot cope with high temperatures for long periods of time. We thus suggest that more large-scale network approaches are needed addressing the ability of species to cope with stressful high and variable temperatures to understand the consequences of climate change on terrestrial biodiversity in polar regions.



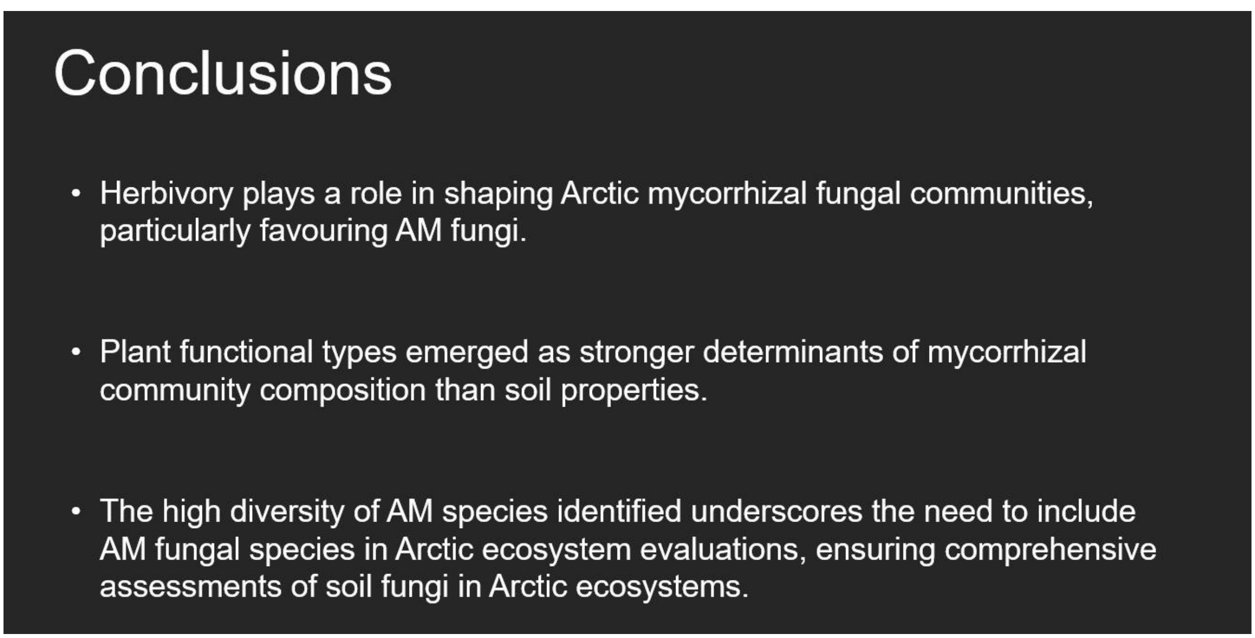
THE INFLUENCE OF ARCTIC HERBIVORY ON MYCORRHIZAL FUNGI COMMUNITIES AND SOIL CARBON DYNAMICS: AN HERBIVORY NETWORK COLLABORATION — ROBERT G. BJÖRK

University of Gothenburg, Göteborg, Sweden

COAUTHORS: Cole G. Brachmann, Martin Ryberg, Brendan R. Furneaux, Anna Rosling, Tinghai Ou, Alf Ekblad, Isabel C. Barrio, M. Syndonia Bret-Harte, Hannu Fritze, Laura Gough, Robert D. Hollister, Ingibjörg S. Jónsdóttir, Oula Kalttopää, Elin Lindén, Päivi Mäkiranta, Johan Olofsson, Rauni Partanen, Kirsten A. Reid, Aleksandr Sokolov, Svetlana Abdulmanova, Maija S. Sujala, Maja K. Sundqvist, Otso Suominen, Craig E. Tweedie, Amanda Young | **FORMAT:** Oral in-person

ABSTRACT: The Arctic, one of the most soil carbon (C) rich biomes of the world, is warming much faster than the global average which is changing vegetation and biotic interactions. Shrub expansion constitutes one of the most striking climate-driven vegetation changes, with herbivores having the potential to inhibit this expansion. As most plants form symbiotic relationships with mycorrhizal fungi, herbivores may impact mycorrhizal fungi communities and subsequently influence soil C and nutrient cycling. But how this affects the Arctic's C storage is still uncertain.

We collected soils from 15 herbivore exclusion experiments across the Arctic and sequenced mycorrhizal fungi communities to assess the impact of herbivory on Arctic soils. Simultaneously, we measured decomposition rates and stabilization under deciduous (*Betula nana*) and evergreen (*Empetrum nigrum*) shrubs in two of the exclusion experiments. Herbivore exclusion had a generally weak effect on the arbuscular mycorrhizal (AM) fungi community across the Arctic, however, pH differences among sites were related to changes in AM composition. Ectomycorrhizal fungi were the most diverse group and most strongly influenced by climatic and edaphic factors, while herbivore impacts were observed predominantly at individual sites. Herbivores had the strongest impact on C stabilization under *Betula* shrubs by regulating the primary source of organic material either via shifting the plant input and/or the microbial community. Thus, shifts in mycorrhizal fungi communities and composition of shrubs, along with herbivory, have implications for C dynamics in Arctic soils. However, not to the extent that it could mitigate potential climate-driven C losses from Arctic ecosystems.



KITIKMEOT BRYOPHYTE BIODIVERSITY: FILLING THE SAMPLING GAP — ERIN COX

Polar Knowledge Canada; University of Alberta, Canada

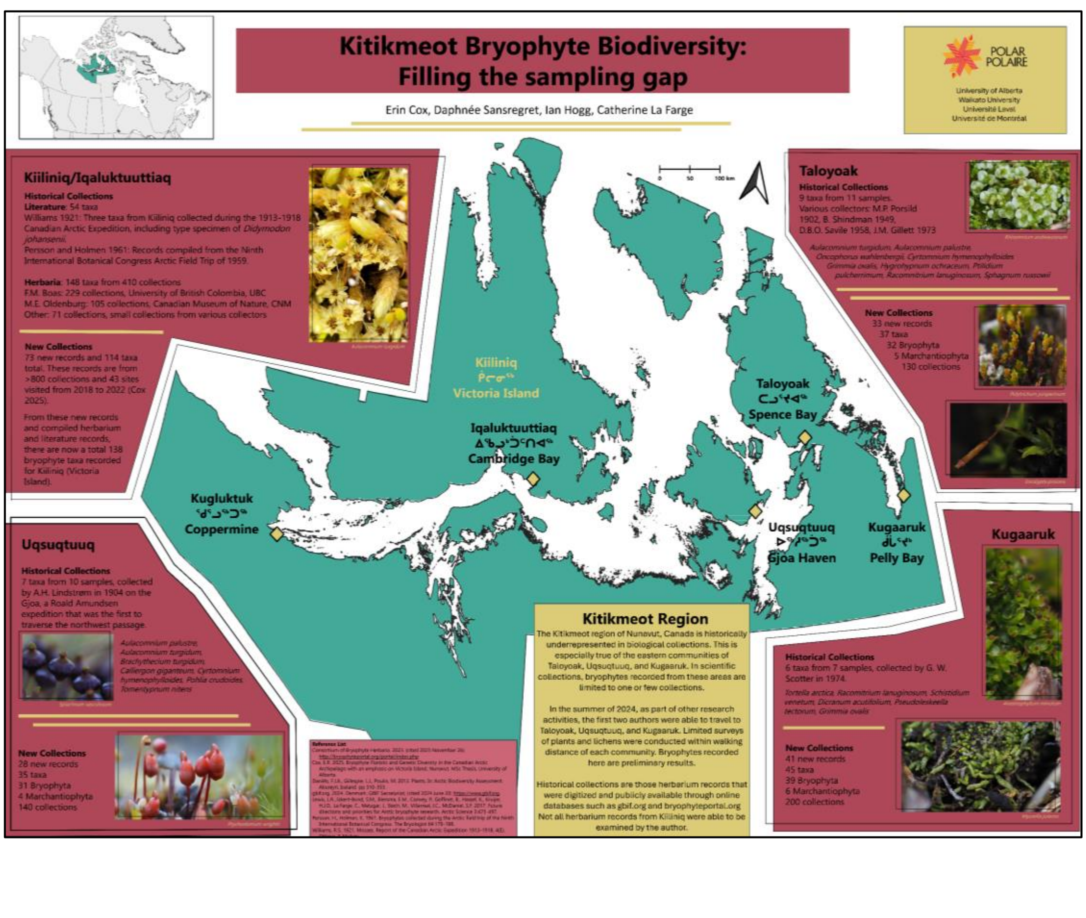
COAUTHORS: Daphnée Sansregret, Ian Hogg, Catherine La Farge | **FORMAT:** Poster virtual

ABSTRACT: The Kitikmeot Region of Nunavut is in a pivotal transition zone between the boreal tree line and Low Arctic, where rapid climate related changes are occurring. This region has been historically unrepresented in plant collections in the Canadian Arctic, particularly for bryophytes. As a prominent component of the Arctic tundra, changes in bryophyte diversity and cover can have a multitude of ecosystem consequences.

Bryophyte sampling was performed on Victoria Island during the summers of 2018-2021 and elsewhere in the Kitikmeot near Kugaaruk (Pelly Bay), Uqsuqtuuq (Gjoa Haven), and Taloyoak (Spence Bay) in 2024. Floristic habitat sampling (FHS) was utilized to attempt maximum capture of species diversity within short time periods.

Collections on Victoria Island have revealed 73 new taxa previously unrecorded for the island including one undescribed species. Additional records from literature (18) and herbarium records (6) not collected in the study bring the current total for Victoria Island to 138 taxa. Despite a similar geology, there was high beta diversity among sites on Victoria Island indicating limited sharing of taxa, likely explained by microhabitat variation. The more recent sampling elsewhere in the Kitikmeot has already produced at least 20 new records of bryophytes for each community.

The fieldwork data generated begins to fill a crucial sampling gap and enhances both herbaria (Canadian High Arctic Research Station Herbarium, CHARS, Cambridge Bay, Nunavut) and genetic records (International Barcode of Life, iBOL). These records provide valuable baseline data for future studies and ongoing monitoring of climate-driven changes.



STANDARDIZED SAMPLING PROTOCOLS FOR NON-STANDARDIZED SPECIES: LESSONS FROM A MESSY SPECIES COMPLEX, THE DWARF BIRCHES — MARIA DANCE

Scott Polar Research Institute, University of Cambridge, Cambridge, UK

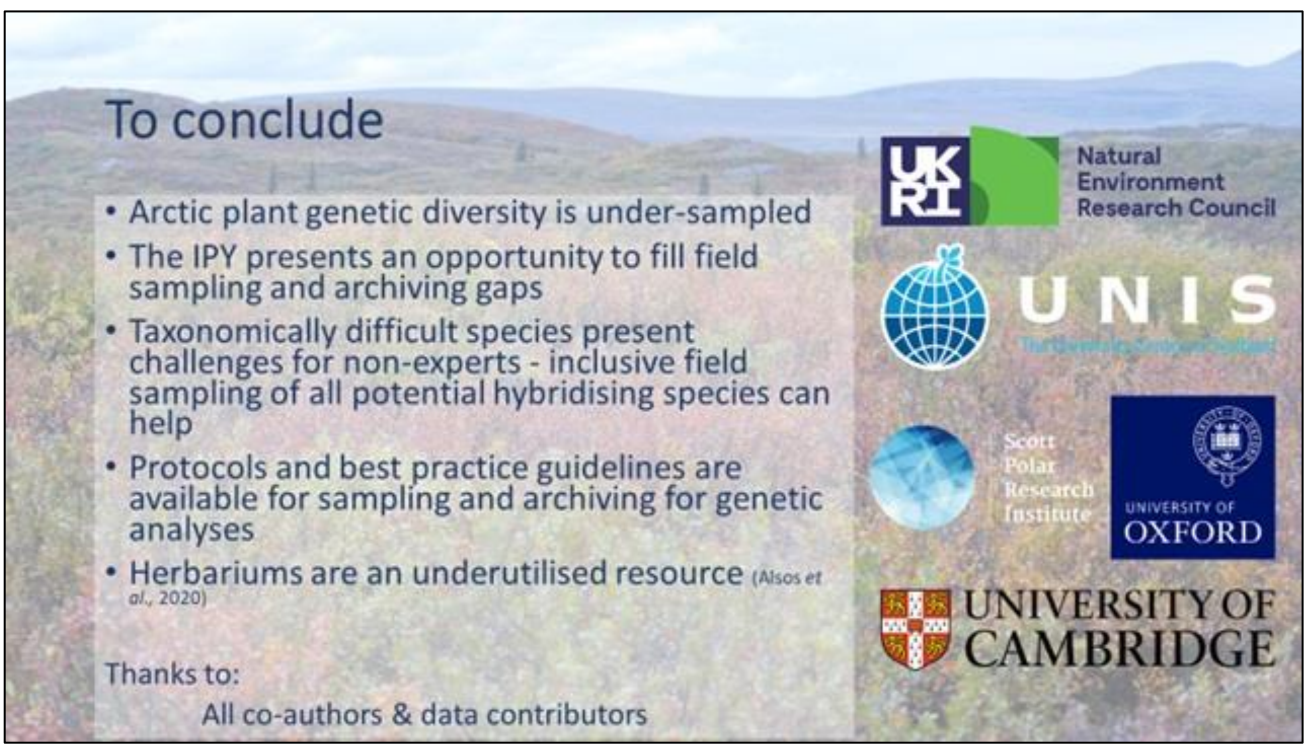
COAUTHOR: Marc Macias-Fauria **| FORMAT:** Oral in-person

ABSTRACT: Genetic diversity is an important component of biodiversity that is essential for species' long-term adaptation to climate change (Hoffmann & Sgrò 2011). The genetic diversity of northern plants is expected to decline because of climate-induced range shifts (Alsos et al. 2012). Standardized protocols that sample the full range of genetic diversity of a species are therefore crucial to long-term monitoring of Arctic biodiversity. However, taxonomically and genetically complex species pose a challenge, particularly for collectors with less taxonomic expertise.

An international collaboration conducted panarctic sampling for a project investigating the genetic response of dwarf birch to past and current climate change. The dwarf birches (*Betula nana* and *Betula glandulosa*) exhibit a morphological continuum due to hybridization in their area of range overlap (Ashburner & McAllister 2013; Elven et al. 2011; Furlow 2004). Samples were collected according to a standardized protocol, usually alongside primary fieldwork projects.

Our results illustrate some of the unexpected challenges and opportunities of this sampling approach: hybrids between *Betula glandulosa* and unknown species were unintentionally collected and analyzed which were not useful for the study objectives. Yet unintentional sampling of *B. nana*—*B. glandulosa* hybrids enabled a robust reconstruction of their joint population history during glaciations and shed light on the full genetic diversity of the two species.

We also propose solutions for IPY assessment and long-term monitoring of genetic diversity: favoring inclusive sampling of a species complex over targeting individual species, preserving specimens for taxonomic revisions, and using both scientific literature and Indigenous Knowledge.



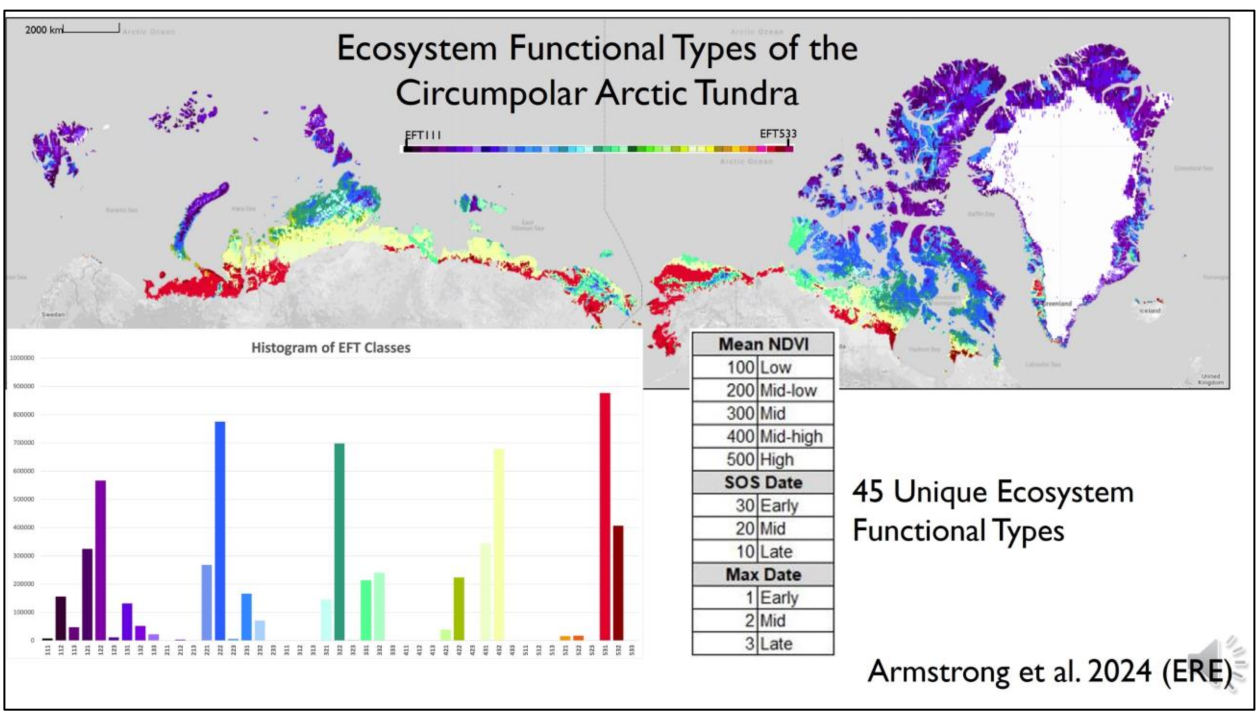
ECOSYSTEM FUNCTIONAL TYPES AND DIVERSITY OF THE CIRCUMPOLAR ARCTIC TUNDRA AND A CASE STUDY OF THE YAMAL PENINSULA, RUSSIA — HOWARD EPSTEIN

University of Virginia, Charlottesville, Virginia, USA

COAUTHORS: Amanda Armstrong, Domingo Alcaraz-Segura, Martha Raynolds, Morgan Tassone

FORMAT: Oral in-person

ABSTRACT: Biodiversity, when viewed through the lenses of compositional, structural, and functional components, provides for a holistic understanding of diversity found within community assemblages and ecosystems. However, advancement in our understanding of how ecosystem functional diversity interacts with structural and compositional diversity is lacking. This study presents a methodology to construct ecosystem functional types (EFTs), or areas of the land surface that function similarly, using the MODIS NDVI record, for the terrestrial circumpolar Arctic. EFTs were derived from the seasonal dynamics of NDVI across the Arctic tundra at 250 m resolution and compared to bioclimate subzones, and to structurally and compositionally defined vegetation units of the Circumpolar Arctic Vegetation Map (CAVM). Correspondence analyses of CAVM EFTs to previously delineated CAVM bioclimatic subzones, physiognomic (vegetation) units and floristic provinces indicated convergence across composition, structure, and function; yet also demonstrated substantial functional variability even within bioclimate subzones and vegetation units. Strong latitudinal gradients in ecosystem function are present. Locally, the mountainous regions of northern Alaska, and eastern and western Siberia had high spatial variability in ecosystem functioning. A case study of the Yamal Peninsula in northwestern Siberia examined the environmental controls on ecosystem functional diversity (EFD), with hydrology and soil factors being the dominant drivers of spatial patterns in EFD. We found overall that EFTs varied widely within individual mapped vegetation units, successfully capturing the functional dimension of biodiversity across the circumpolar Arctic tundra.



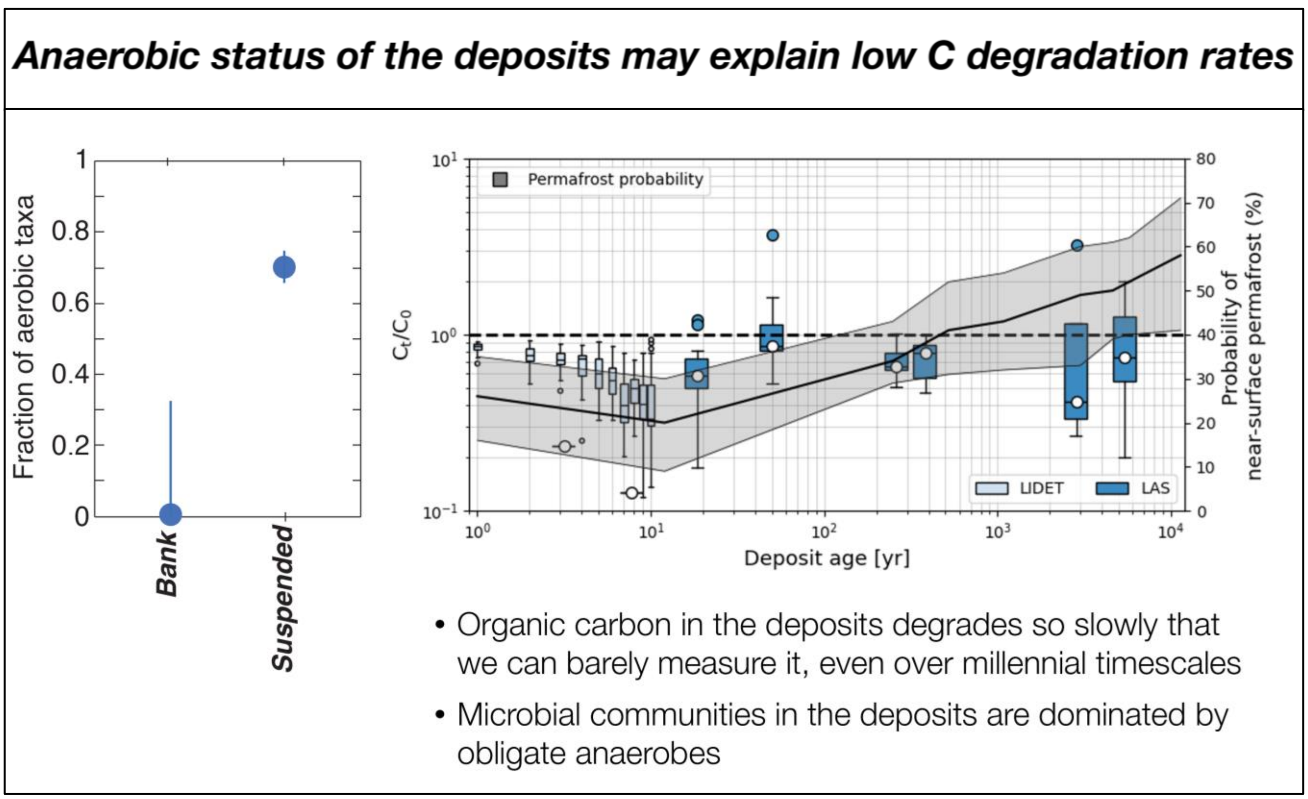
Map showing the circumpolar distribution of the 45 derived EFTs and histogram showing their abundance within the CAVM area of interest.

MICROBIAL COMMUNITY DYNAMICS FOLLOWING RIVERBANK EROSION ACROSS PERMAFROST FLOODPLAINS IN THE YUKON RIVER BASIN — WOODWARD W. FISCHER

California Institute of Technology, Pasadena, California, USA

COAUTHORS: Katie Huy, John Magyar, Philippa Richter, Josh Anadu, Yutian Ke, Emily Geyman, Michael Lamb, Isabel Smith, Emily Seelen, Josh West, Anna Godduhn, Edda Mutter | **FORMAT:** Oral in-person

ABSTRACT: Much of the organic-rich permafrost deposits in the Arctic lie in riverine floodplains where thaw due to polar amplification of climate change has accelerated bank erosion, leaving permafrost carbon deposits vulnerable to degradation by microorganisms. As sediments harbored in the riverbank erode, they are subjected to sediment transport processes, interact with the water column, and are eventually re-deposited in bar forms on an opposing riverbank. Using a suite of culture-independent amplicon and shotgun metagenomic sequencing of samples collected from the Yukon River and its major tributary the Koyukuk River, we set out to understand microbial community succession associated with this process and simultaneously provide baseline observations about how bank erosion might impact water quality via the ingrowth of taxa harmful to human and/or ecosystem health. Results revealed few occurrences of potential microbial pathogens, but that permafrost deposits operate as a 'seed bank' that generates a pattern of succession toward an aerobic community capable of rapid carbon degradation during erosion and transport—a pattern that may help explain why carbon burial in river floodplains is so efficacious.

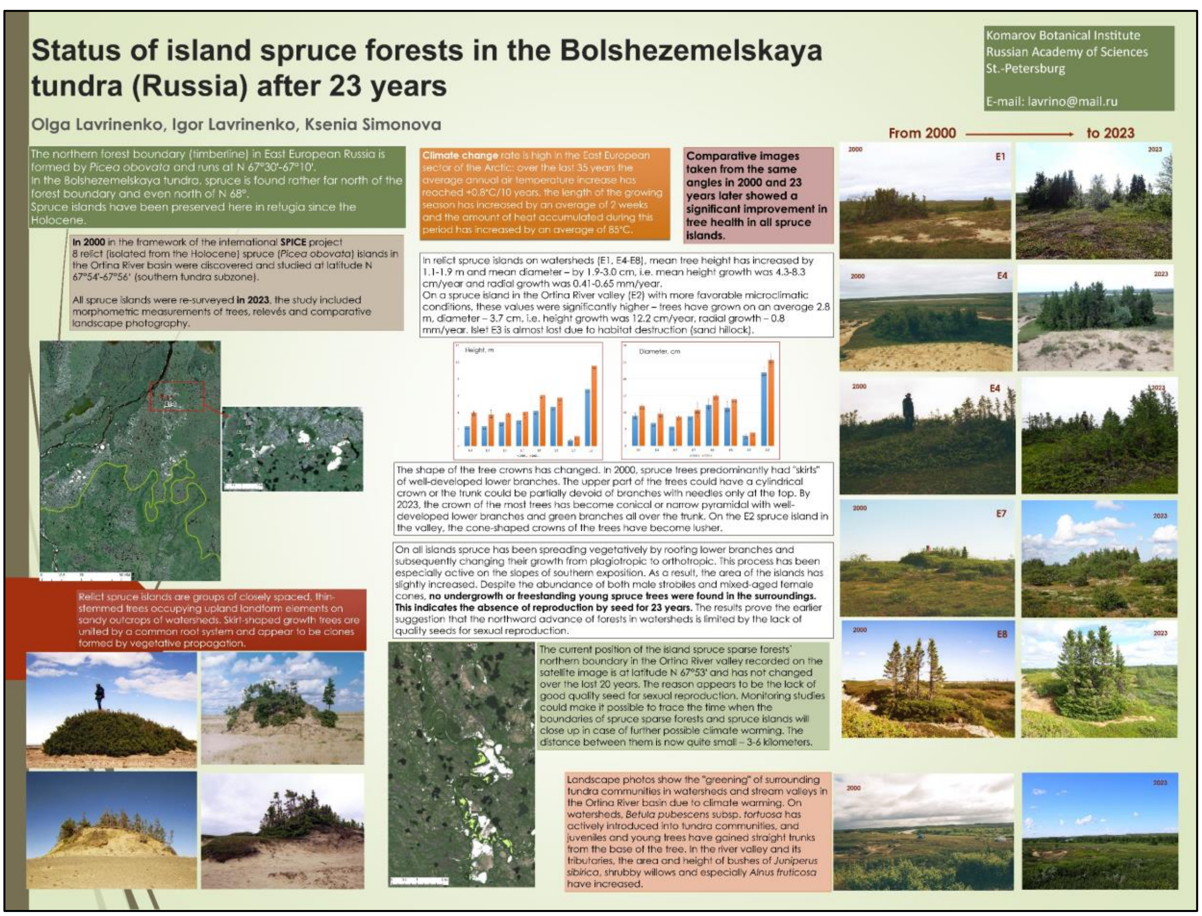


STATE OF ISLAND SPRUCE FORESTS AFTER 23 YEARS — OLGA LAVRINENKO

Komarov Botanical Institute, Russian Academy of Sciences, St. Petersburg, Russia

COAUTHORS: Igor Lavrinenko, Ksenia Simonova | **FORMAT:** Poster virtual

ABSTRACT: A re-investigation (23-year interval) of relict spruce (*Picea obovata*) islands, isolated since the Holocene, was conducted 23 years after the initial study. In watershed areas in the Ortina River basin (N 67°54'–67°56'; Bolshezemelskaya tundra, Russia), mean tree height increased by 1.1–1.9 cm (4.3–8.3 cm/year) and mean diameter by 1.9–3.0 cm (radial growth 0.41-0.65 mm/year). Growth rates were higher in the river valley, with height increasing by 2.8 m (12.2 cm/year) and diameter by 3.7 cm (0.8 mm/year). In 2000, spruce crowns predominantly exhibited "skirt-like" morphology with dense lower branches. By 2023, most trees developed conical crowns with green branches extending along the trunk. Vegetative spread via rooting of lower branches (plagiotropic to orthotropic transition) was observed across all islands, resulting in slight expansion of their total area. Despite abundant male strobili and female cones, no seedling establishment or young spruce individuals were detected in surrounding areas, indicating a 23-year absence of sexual reproduction. This suggests that northward forest advance in watersheds is constrained by insufficient viable seeds. Landscape photographs revealed "greening" in adjacent tundra communities. On watersheds, *Betula pubescens* subsp. *tortuosa* has actively colonized tundra habitats. In the river valley, *Juniperus sibirica*, shrubby willows (*Salix* spp.), and *Alnus fruticosa* exhibited increases in both spatial coverage and height. Satellite imagery confirms the northern boundary of spruce sparse forests in the Ortina River valley remains stable at N 67°53', showing no shift over the past two decades.

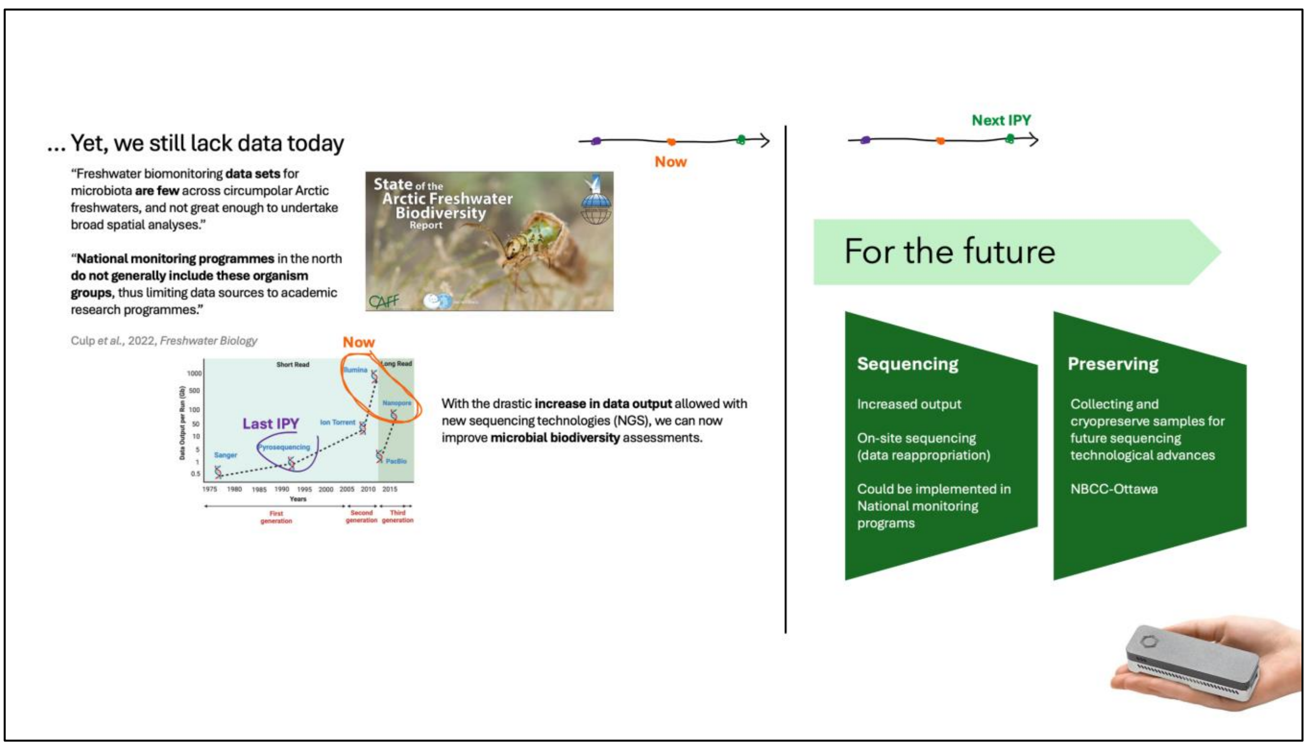


CHANGES IN LANDSCAPE CONNECTIVITY AND IMPACTS ON MICROBIAL DIVERSITY AND FRESHWATER ECOSYSTEM FUNCTIONING — ALIZÉE LE MOIGNE

Institut National de la Recherche Scientifique, Centre Eau Terre Environnement, Quebec City, Quebec, Canada

COAUTHOR: Jérôme Comte | **FORMAT:** Oral in-person

ABSTRACT: Most of the lakes on Earth are in the Arctic and sub-Arctic regions. The particularly fast climate warming in the Arctic is currently promoting both the expansion and shrinkage of lakes depending on the location, altering connectivity among aquatic ecosystems. Changes in connectivity will affect the movement of microorganisms in the landscape, with largely unknown repercussions for the functioning of these sentinel ecosystems. Northern lakes sustain global biodiversity by providing essential habitats to numerous species. They also offer crucial resources to the Arctic inhabitants and play an important role in climate regulation. We are evaluating the consequences of climate-induced changes in the connectivity of Arctic freshwater lakes on microbial communities, and the ecosystem functions they support. We focus on 2 continuous permafrost regions in Canada: Bylot Island, Nunavut, where the number of lakes is increasing, and Ts'udé Nilįné Tuyeta protected area, Northwest Territories, where lakes are drying out. We are 1) Assessing the taxonomic and functional diversity of bacterial communities along local connectivity gradients, 2) Comparing bacterial diversity and ecosystem functions at the 2 sites with contrasting regional connectivity and 3) Examining the mechanisms controlling ecosystem functioning. We would like to reflect on how we could upscale local studies on microbial biodiversity with the help of new sequencing technologies and how to link this microbial biodiversity to the functional properties of these dynamic ecosystems.



Roadmap to upscale from local studies to link biodiversity to ecosystem function using emerging sequencing technology.

THE ARCTIC HOLOCENE BIODIVERSITY DATABASE: CONSIDERING PALEO-DATA IN ARCTIC BIODIVERSITY ASSESSMENTS — ANDREW MARTIN

Scott Polar Research Institute, University of Cambridge, Cambridge, England

COAUTHOR: Marc Macias Fauria | **FORMAT:** Oral in-person

ABSTRACT: Paleo-ecological data provide invaluable information on long-term ecological dynamics, offering the possibility of examining baselines under new lights that when done with observational data alone. Thousands of paleo-ecological studies have been conducted in the Arctic, providing information on biodiversity over the last millennia. However, this wealth of information has not yet been considered by the Circumpolar Biodiversity Monitoring Program (CBMP) within the Conservation of Arctic Flora and Fauna. The body of paleo-data on Arctic biodiversity is dispersed, displaying unstandardized, multiple taxonomies, recording biological entities over a wide range of taxonomic resolutions, and dated employing varied methods and standards that make chronologies difficult to compare.

Here we present the Arctic Holocene Biodiversity Database (AHBD), which results from a systematic mapping exercise that has extracted biodiversity data covering the Arctic and the last 10,000 years. This has involved coding and data extraction from > 4,000 full text publications. The database is available online, features standardized taxonomies and chronologies, and has a YAML data format, making it compatible with other paleo-ecological databases such as the Neotoma Paleoecology Database. The AHBD features timeseries of Essential Biodiversity Variables at millennial scales. Moreover, it is integrated with a database on abiotic variables obtained from the CHELSA database. This allows placing recent changes in Arctic biodiversity within a long framework.

We discuss the need to consider long-term biodiversity data when compiling information on Arctic biodiversity and the potential to integrate the AHBD with Arctic biodiversity data efforts such as the Arctic Biodiversity Data Service (ABDS).

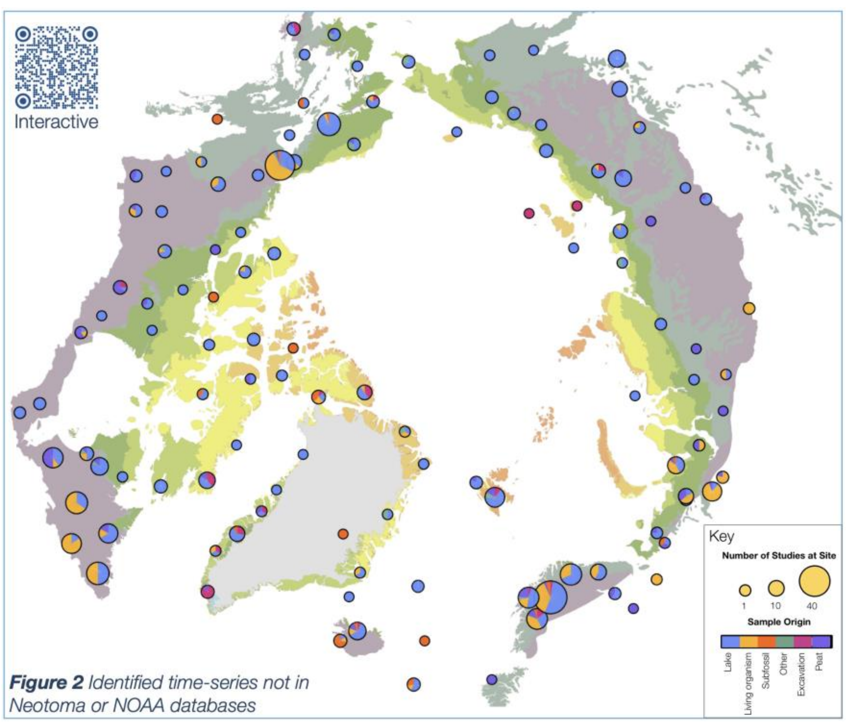


Figure 2 Identified time-series not in Neotoma or NOAA databases

Identified individual time-series of biodiversity information that have been included in the systematic map as relevant evidence of Arctic Holocene biodiversity change. The map includes 1,379 time-series in 1,224 locations as of May 2025. Only time-series that were not in Neotoma or the NOAA paleoclimate database (as of Dec 2024) are shown.

SCIENCE SESSION 2.8

BUILDING A TIME MACHINE OUT OF A DELOREAN: OBSERVING, RECONSTRUCTING, AND PREDICTING VEGETATION CHANGE IN THE ARCTIC

27 MARCH 2025 | 10:30–12:00 AND 16:00–18:00 (MDT)

Open Session - HYBRID

ORGANIZERS: AMY BREEN[1], DONALD WALKER[2], GABRIELA SCHAEPMAN-STRUB[3]

[1] International Arctic Research Center, University of Alaska Fairbanks, USA; [2] Institute of Arctic Biology, University of Alaska Fairbanks, USA; [3] Department of Evolutionary Biology and Environmental Studies, University of Zurich, Switzerland

SESSION DESCRIPTION: Arctic landscapes are rapidly changing due to factors such as climate alterations, accelerated nutrient cycling, and increased disturbances like wildfires and resource development. These changes drive shifts in vegetation composition and function, serving as key indicators of broader transformations in topography, hydrology, and permafrost.

The Circumpolar Arctic Vegetation Science Initiative (CAVSI) is proposed for ICARP IV to establish a framework for classifying, mapping, and monitoring Arctic vegetation. It aims to create a network of sites with permanent plots representing diverse Arctic conditions, using standardized methods for vegetation surveys and data management. This initiative builds on existing monitoring sites in northern Alaska and could be integrated into U.S. and international Arctic observing networks. Alternatively, the community may identify a need to establish a novel Arctic Vegetation Observatory Network.

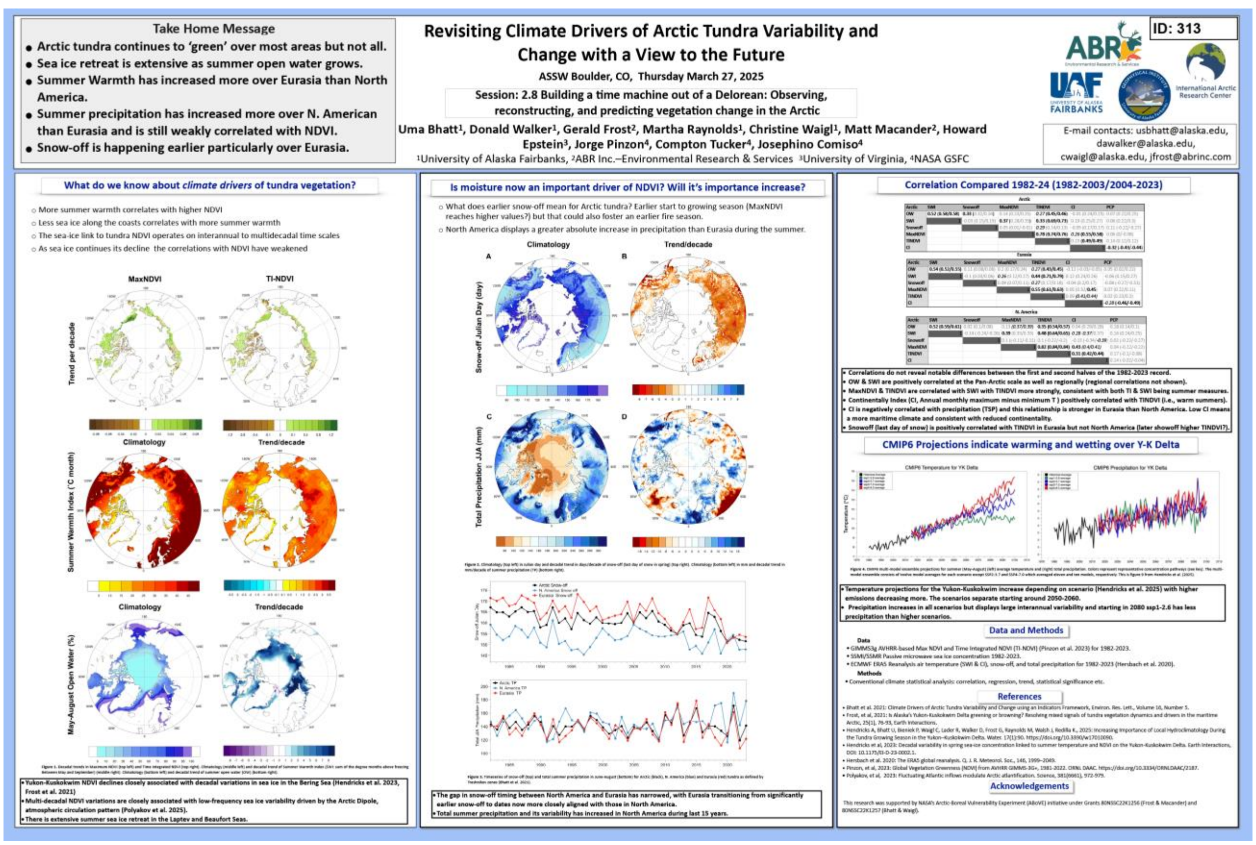
The session will highlight recent advances in Arctic vegetation classification and monitoring, particularly as we look ahead to the 5th International Polar Year (2032–2033), with the goal of implementing CAVSI based on lessons learned from other networks and putting forth a framework that aligns with the research priorities identified by ICARP IV. We also invite studies on the impacts of vegetation change on processes such as hydrology, permafrost degradation, and carbon balance. We welcome diverse research approaches to monitor vegetation across temporal and spatial scales, including field surveys, remote sensing, and Earth system models, thereby contributing to a deeper understanding of Arctic ecosystems.

REVISITING CLIMATE DRIVERS OF ARCTIC TUNDRA VARIABILITY AND CHANGE WITH A VIEW TO THE FUTURE — UMA BHATT

University of Alaska Fairbanks, USA

COAUTHORS: Donald Walker, Gerald Frost, Martha Raynolds, Christine Waigl, Matthew Macander, Howard Epstein, Jorge Pinzon, Compton Tucker, Josephino Comiso | **FORMAT:** Poster in-person

ABSTRACT: Much of the large-scale variability in the Normalized Difference Vegetation Index (NDVI) is driven by climate variations in the Arctic. Declining coastal sea ice and associated warmer temperatures were found to be significantly correlated with NDVI in a study that covered the period 1982-2008 (Bhatt et al. 2010). As the climate has continued to warm and late summer sea ice is largely absent along the Arctic coast, the relationships among sea ice, summer temperatures, and NDVI are changing at varied rates across the Arctic tundra biome. This spatially varying response to change across the Arctic necessitates an updated regional analysis of NDVI and climate drivers over tundra vegetation regionally. This analysis will employ the NASA GIMMS-3g+ biweekly NDVI derived from circumpolar AVHRR satellite observations, which now covers more than four decades (1982-2023), ERA5 climate reanalysis, passive microwave sea ice concentration, and select local station data. The climate variables for the analysis will include seasonal air temperature, precipitation, snow water equivalent, and others. Climate and NDVI data will be analyzed for trends and interannual-to-decadal variations in the context of atmospheric teleconnections. Analysis of temperature and precipitation from CMIP6 future climate scenarios to 2100 will be conducted to anticipate what climate conditions the Arctic tundra will experience at the end of this century.

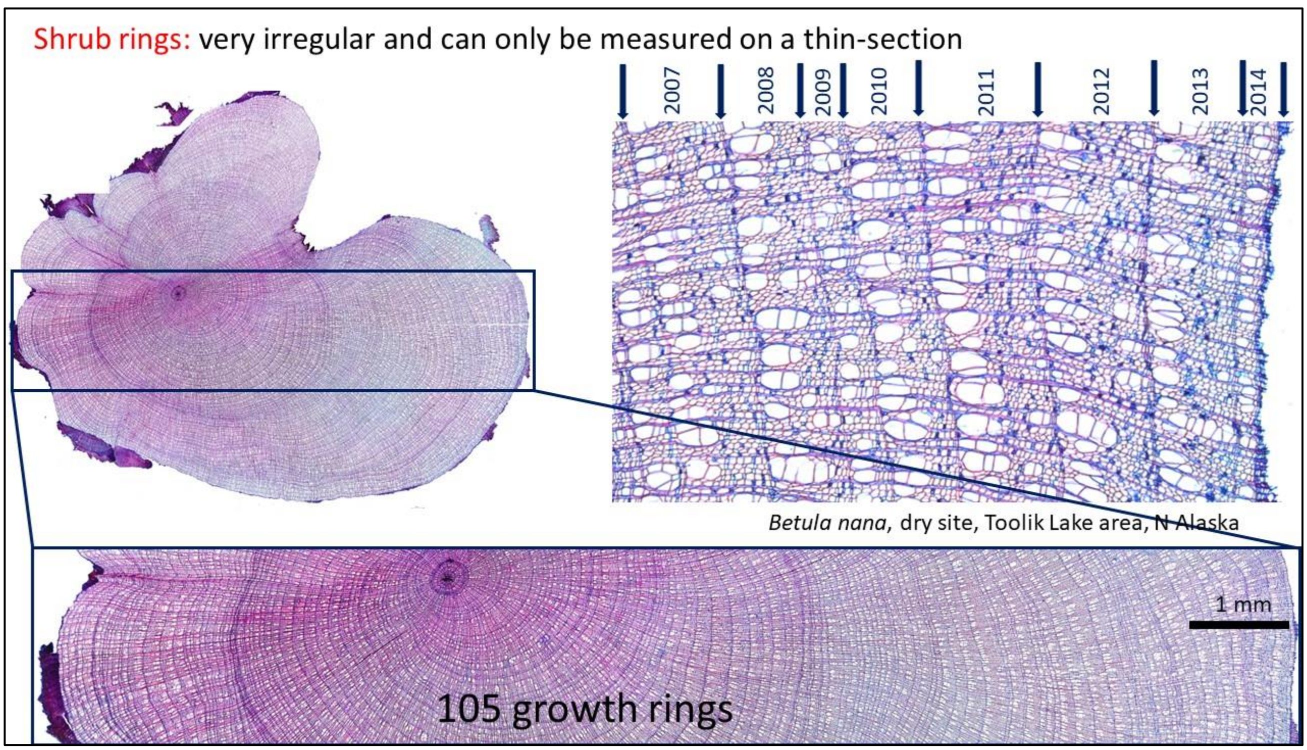


DENDROCHRONOLOGY AND CLIMATE CHANGE: INSIGHTS FROM THE ARCTIC TUNDRA SHRUB GROWTH — AGATA BUCHWAL

Laboratory of Tree-Ring Research, Tucson, University of Arizona, USA

COAUTHOR: Adam Mickiewicz | **FORMAT:** Oral in-person

ABSTRACT: Climate change in the Arctic, characterized by rising air temperatures and shrinking sea ice extent, is altering the conditions crucial for the growth of the region's northernmost woody plants, specifically tundra shrubs. Understanding these changes is vital for multiple aspects of Arctic ecosystem functioning, including heat and water flux, the carbon cycle, and herbivore dynamics. This study examines the influence of changing climatic conditions, particularly air temperature, on the radial growth of key shrub species such as *Betula* and *Salix* in Spitsbergen, Greenland, and Alaska, along with *Juniperus* in the Low Arctic. I will highlight the heterogeneous growth responses of these species and explore the use of wood anatomy to investigate climate-growth relationships in tundra shrubs.



Wood anatomy of an arctic shrub (Betula nana).

THE VEGETATION OF THE LITTLE ICE-AGE AND EARLIER COULD BE STUDIED FROM ENTOMBED VEGETATION UNDER THE BARNES ICECAP WITHOUT A TIME-MACHINE — HELGA BÜLTMANN

University of Münster, Germany

COAUTHORS: Shawnee Kasanke, Martha Raynolds | **FORMAT:** Oral in-person

ABSTRACT: The Barnes Ice Cap, Baffin Island, Nunavut is a remnant of the Laurentide Ice Sheet and is expected to disappear within 300 years (Gilbert et al. 2017). For the IPY “Back to the Future” project (BTF no. 214), a vegetation survey from 1964 was repeated in 2007 (Dr. Patrick J. Webber), demonstrating rapid changes over forty years. In 2022 the vegetation near the southern Barnes Ice Cap was studied, including a few samples of emergent vegetation that had been entombed by progressing ice of the Little Ice Age (radiocarbon dating, Raynolds et al. 2025). The entombed vegetation was in extraordinarily shape and was not unique. Other sites could only be sampled for carbon dating due to logistic restraints. Even older vegetation will thaw out the next decades as the Barnes Ice Cap continues to retreat and could be a source of valuable data for reconstructing past vegetation of the Arctic. Data sampling could include vegetation (relevé), lichenometry, plant wax isotopes, DNA from plants and soil (ancientDNA (aDNA), eaDNA), radiocarbon dating. The window for data collecting is short as the sites erode quickly, and the organic remains are colonized by new vegetation. If not sampled, the data source will be lost. We propose an initiative sampling the vegetation being exhumed by the Barnes Ice Cap. The entombed vegetation is a unique chance to truly observe, record and map ancient vegetation. The monitoring of ancient vegetation should follow the retreating ice in a longer but regular timespan.

Emergent vegetation that was entombed beneath the Barnes Ice Cap.

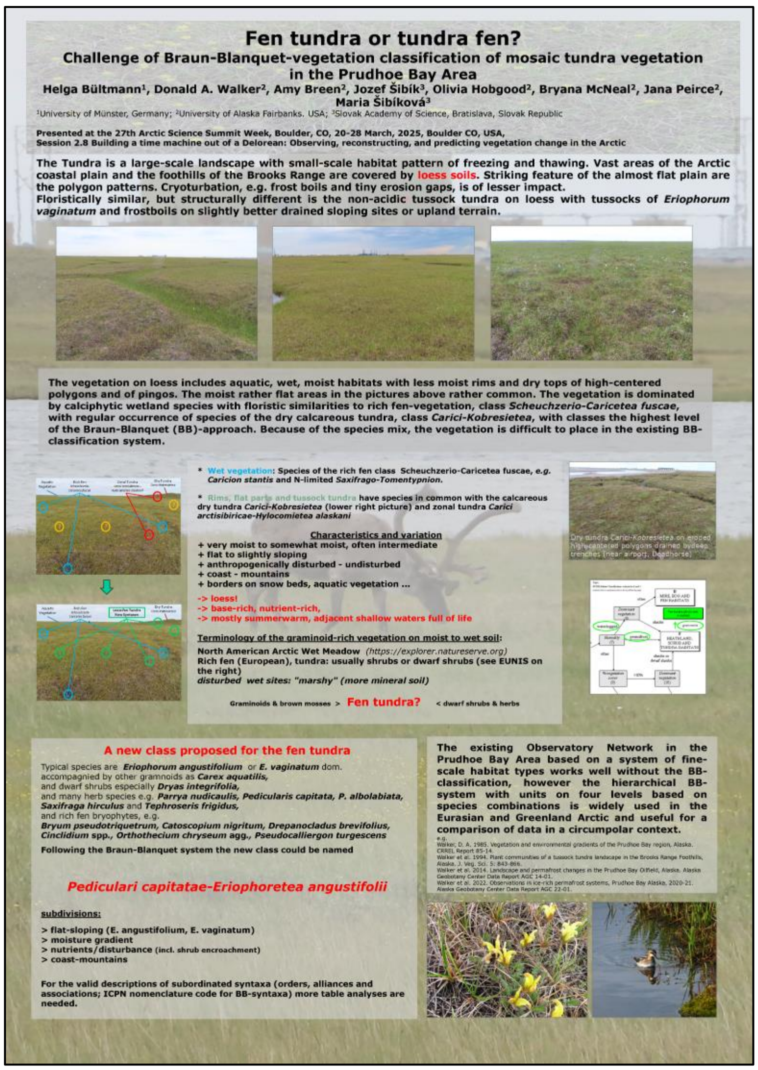
FEN TUNDRA OR TUNDRA FEN? — CHALLENGE OF BRAUN-BLANQUET-VEGETATION CLASSIFICATION OF MOSAIC TUNDRA VEGETATION IN THE PRUDHOE BAY AREA — HELGA BÜLTMANN

University of Münster, Germany

COAUTHORS: Donald Walker, Amy Breen, Jozef Šibík, Olivia Hobgood, Briana McNeal, Jana Peirce, Maria Šibíková

FORMAT: Poster in-person

ABSTRACT: The tundra is a large-scale landscape with small-scale habitat pattern of freezing and thawing. The striking habitat feature of the polygon loess tundra vegetation of the Alaskan Arctic Plain in the Prudhoe Bay area is that while there are aquatic, wet (marl) and dry habitats (rims), common is a type between: not wet, but with species, which are strict wetland species in azonal vegetation elsewhere and with those species occurring far into dry habitats e.g. ruderal sites with shrubs and even slight depressions on pingo tops. Crucial factor is permafrost, a habitat complex creating a moisture gradient working from within. Cryoturbation and tiny erosion gaps, which are characteristic of so many vegetation types of Arctic and mountain tundra, are of lesser impact. This variation is difficult to place with the existing Braun-Blanquet-classification system. We are considering denoting a new unit, a new syntax on a higher level for this fen-tundra or tundra-fen. We will explain the relation of Braun-Blanquet-syntaxa and habitat types of D. A. Walker (1985). We will discuss pros and cons of different classification systems and contextualize the Prudhoe Bay vegetation with communities from other tundra vegetation and azonal fen. We will present a scheme where to place the Prudhoe Bay tundra vegetation in the existing Braun-Blanquet system. We do not propose to change the method of recording for any existing observation network, but the hierarchical structure of an additional Braun-Blanquet classification may facilitate comparison with networks from other parts of the Arctic.

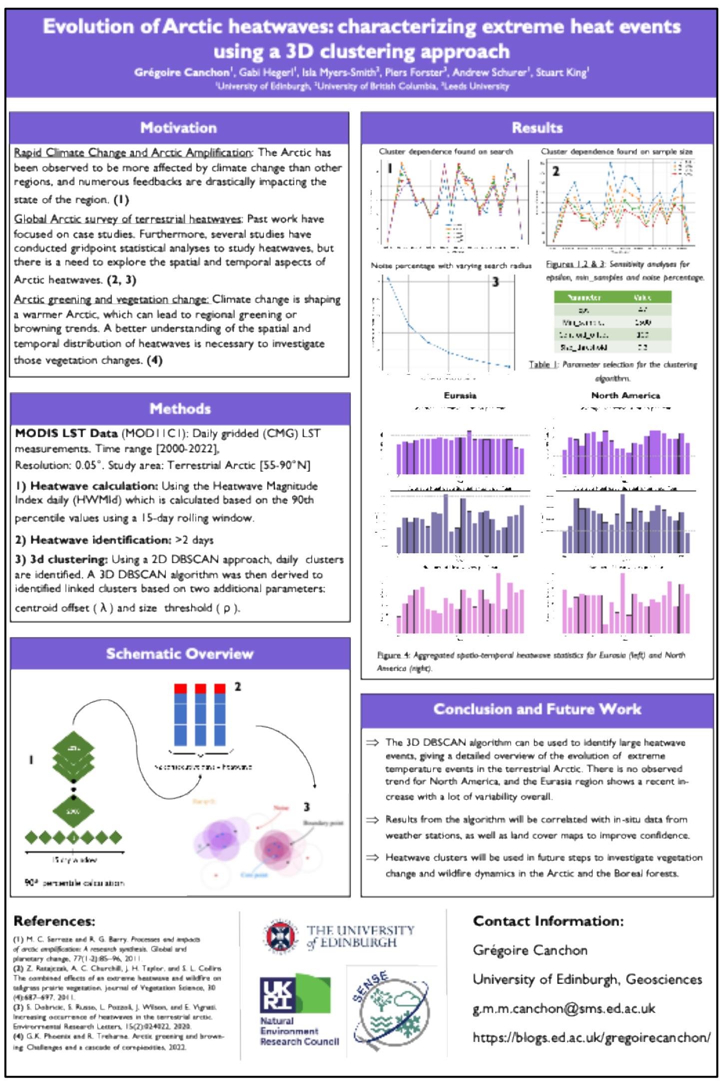


EVOLUTION OF ARCTIC HEATWAVES: CHARACTERIZING EXTREME HEAT EVENTS USING A 3D CLUSTERING APPROACH — GRÉGOIRE CANCHON

University of Edinburgh, Scotland

COAUTHOR: Gabriele Hegerl | **FORMAT:** Poster in-person

ABSTRACT: The first year of my PhD project has been spent assessing and characterizing Arctic heatwaves using satellite data (MODIS Land Surface Temperature). The MODIS dataset product used in this project offers 23 years of data, which has been used to understand how Arctic heatwaves have evolved over time, by investigating changes in amplitude, frequency, duration, etc. This is done by calculating the 90th percentile values of the dataset using a rolling window of 11 days and then plotting trends and timeseries. Additionally, I aim to present a unique method I used to cluster and classify Arctic heatwaves. I implemented a 2D DBSCAN algorithm to identify spatio-temporal heatwaves. This method allows to explore the differences between Arctic regions (Siberia, North America, Northern Europe) and compare heatwave clusters. Ultimately, this research will be tied to land cover information, to try and understand the dynamics between vegetation-covered or snow-covered grounds with heatwave characteristics. This will allow for a better understanding of Arctic heatwave formation, as well as providing a solid starting point to investigate the impact of heatwaves on Arctic greening/browning, and wildfire occurrences.

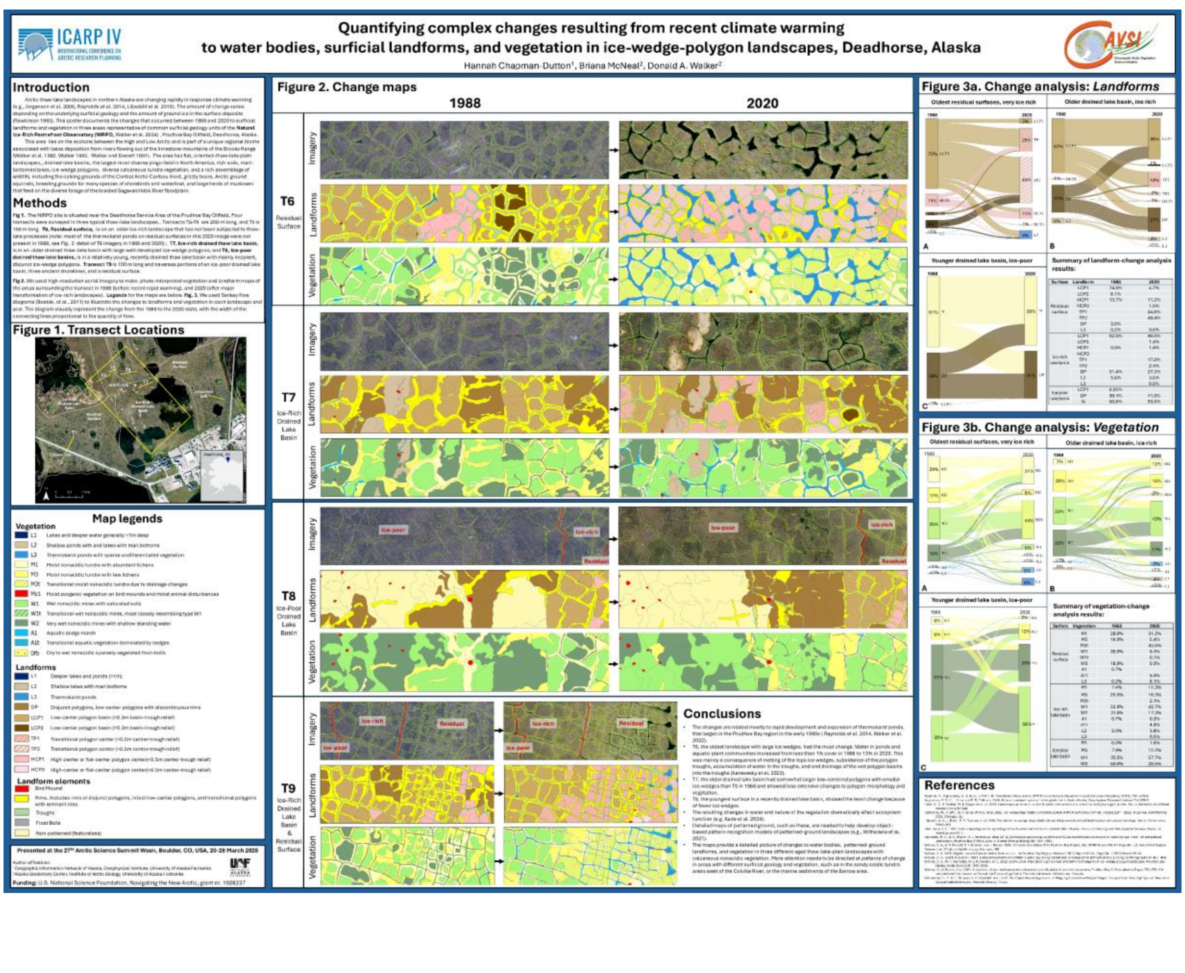


QUANTIFYING CHANGES RESULTING FROM RECENT CLIMATE WARMING TO WATER BODIES, SURFICIAL LANDFORMS, AND VEGETATION IN ICE-WEDGE-POLYGON LANDSCAPES, DEADHORSE, ALASKA — HANNAH CHAPMAN-DUTTON

University of Alaska Fairbanks, USA

COAUTHORS: Briana McNeal, Donald Walker | **FORMAT:** Poster in-person

ABSTRACT: Arctic thaw-lake landscapes are made up of thaw lakes, drained lake basins (DLBs), and residual surfaces (areas that have not been subjected to thaw-lake processes). On residual surfaces and DLBs with well-developed low-center ice wedge polygons, the quickly warming climate is driving formation of ice-wedge thermokarst ponds and transitional polygon morphologies and plant communities. Using high-resolution aerial imagery as well as digital surface models and accuracy points and visual image interpretation from 1987/88, and 2020, we produced detailed (1:500 scale) maps of the surficial geology, surface features, and vegetation of four transects that represent a surface-age gradient near Deadhorse, Alaska. We then calculated the change in landforms and vegetation type from 1987/88 to 2020. We use Sankey flow diagrams (Bostok et al. 2011) to illustrate the changes to landforms and vegetation. The most dramatic changes were in the residual surface which showed the following percentages increases or decreases in landform areas: ponds, +9%; low-center polygons, -78% with 14% decrease in rim area and a 47% decrease in basin area; high-center polygons, -3%; disjunct polygons, -3%; transitional polygons (low- to high-center), +74%. Percentage cover of moist, wet, and aquatic vegetation types changed from 14%/28%/1% in 1988 to 15%/7%/5% in 2020. This work contributes to developing improved modeling of landscape and ecosystem changes based on changes that can be detected in high-resolution remote-sensing products.

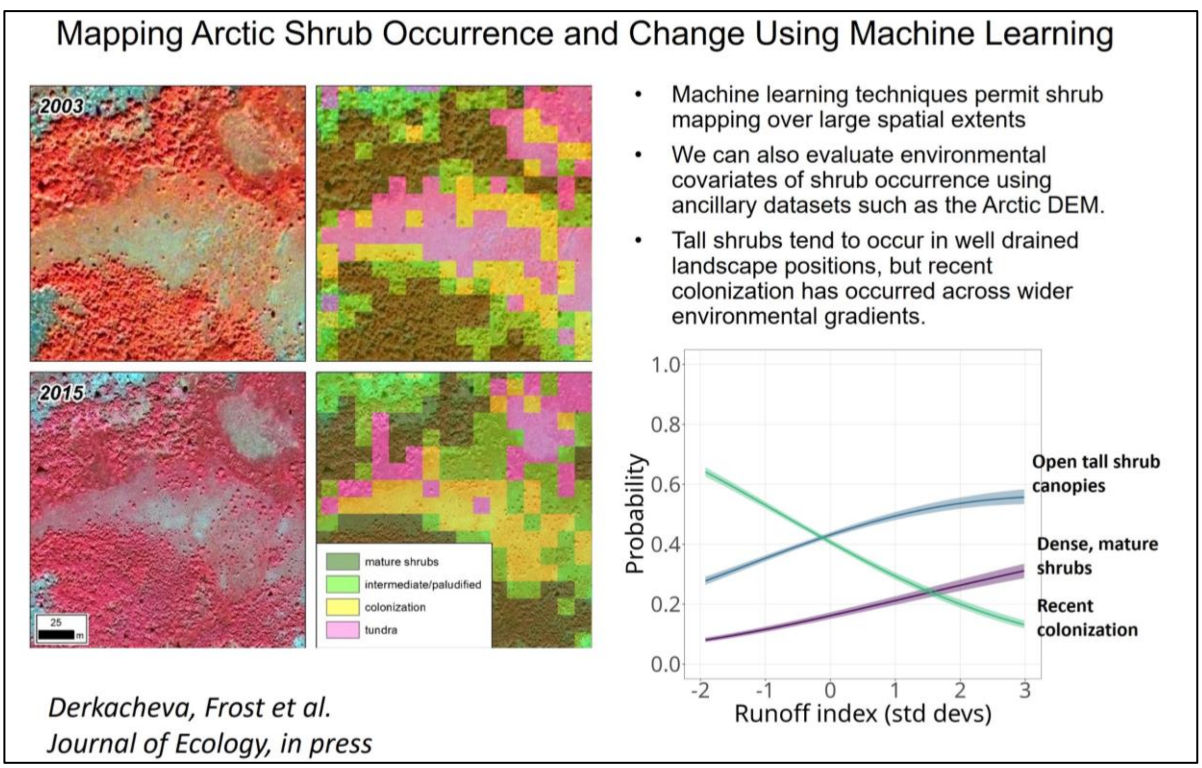


MONITORING ARCTIC SHRUBIFICATION AND ITS ENVIRONMENTAL COVARIATES USING MACHINE LEARNING — GERALD FROST

Alaska Biological Research, Inc., Fairbanks, Alaska, USA

COAUTHORS: Matthew Macander, Paul Montesano, Anna Derkacheva, Jordan Caraballo-Vega, Mark Carroll, Howard Epstein, Ksenia Ermokhina, Nora Fried, Christopher Neigh | **FORMAT:** Oral virtual

ABSTRACT: Tundra shrub expansion is a crucial form of change in warming Arctic ecosystems, but spatio-temporal patterns of shrubification vary across multiple spatial scales, complicating efforts to understand its drivers and consequences. Here we demonstrate imagery analysis workflows using Convolutional Neural Networks (CNNs) to identify spatio-temporal patterns of tall shrub expansion in very-high resolution satellite image pairs acquired 10–23 years apart (circa 2000–2023). We also examine patterns of change and stability to identify relationships between shrub occurrence, landscape-scale environmental covariates, and antecedent shrub cover in diverse Arctic landscapes. In our first workflow we apply a tile-based image analysis framework to map four canopy cover classes within 12 x 12 m map tiles in three Low Arctic landscapes in northwestern Siberia. Our models detected shrub increase in all three landscapes, but with substantial variation in the rate of increase (+2.4–26.1% decade-1). Locally, the distribution of canopy cover classes was strongly influenced by metrics of soil wetness and potential insolation derived from the ArcticDEM. Our second workflow uses a more scalable approach that applies a K-means clustering algorithm to high-resolution imagery that has been processed to pseudo-surface reflectance, with a canopy height estimate applied as a fifth band, to map shrub ecotypes at 2 m resolution across large spatial extents in Arctic Alaska. Collectively, this work demonstrates the strengths and limitations of different machine learning workflows and mapping units in addressing key knowledge gaps regarding Arctic shrub expansion and its environmental covariates.



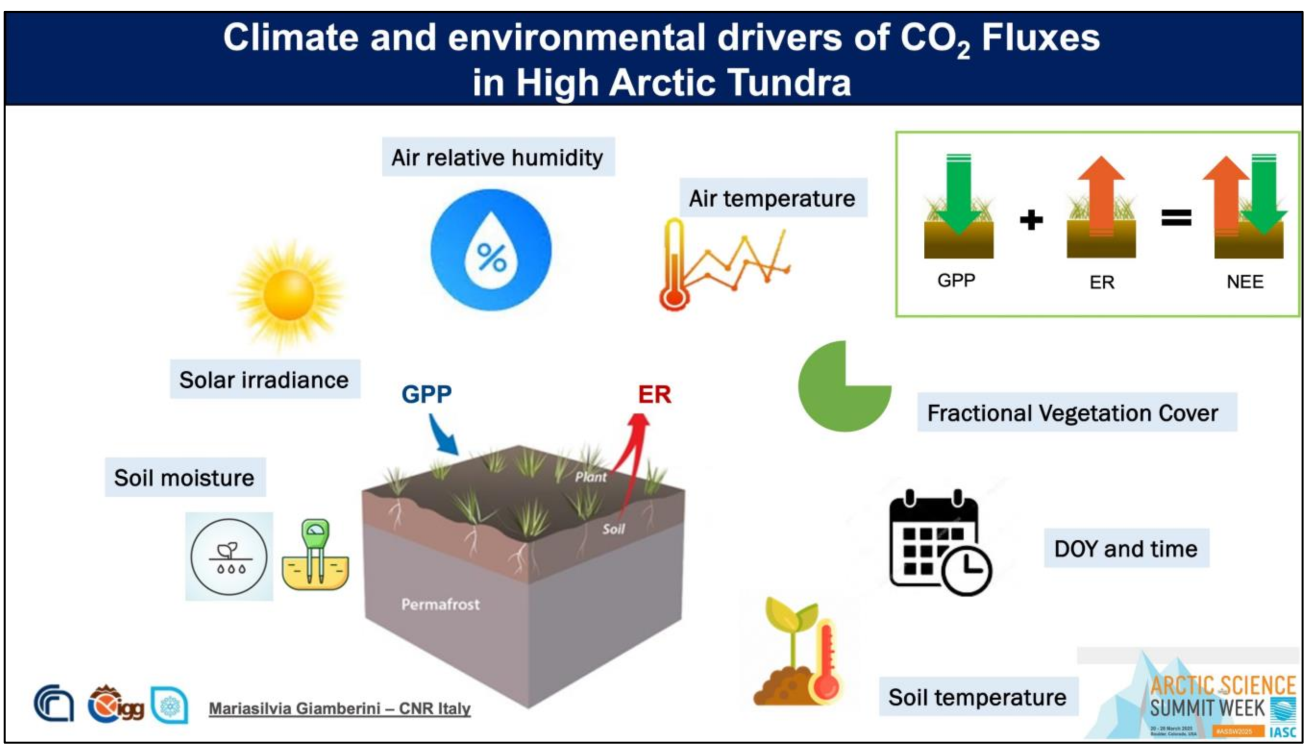
Results from our study showing we were able to successfully map Arctic shrub dynamics using machine learning.

HOW CLIMATE VARIABLES AFFECT CO2 FLUXES FROM THE HIGH ARCTIC TUNDRA VEGETATION? MODELLING FLUX CLIMATE DRIVERS AS A STEP TOWARDS THE ESTABLISHMENT OF A PAN-ARCTIC CRITICAL ZONE OBSERVATION NETWORK — MARIASILVIA GIAMBERINI

Institute of Geoscience and Earth Resources, National Research Council of Italy, Pisa, Italy

COAUTHORS: Francesca Avogadro di Valdengo, Ilaria Baneschi, Marta Magnani, Silvio Marta, Antonello Provenzale, Gianna Vivaldo | **FORMAT:** Oral in-person

ABSTRACT: Terrestrial ecosystems regulate the carbon cycle, and therefore atmospheric CO_2 and Earth climate. The Arctic plays a major role in this cycle, due to the large amount of carbon stored in Arctic soil and vegetation. During the Holocene, the tundra has been acting as a carbon sink, but it is not clear if the Arctic warming will turn it into a carbon source. Yet, data regarding Arctic CO_2 fluxes are scarce and the modelling of their dynamics and fate is affected by large uncertainties. Aiming at investigating the tundra soil and vegetation dynamics under climate pressures, CNR established the Bayelva Critical Zone Observatory in Ny Ålesund, Svalbard, since 2019, equipped with an Eddy Covariance tower and flux chambers for measuring Gross Primary Productivity (GPP) and Ecosystem Respiration (ER) at ecosystem scale, and correlating such variables to climate and environmental parameters, vegetation types and functions, and phenology. We quantified the dependence of CO_2 fluxes from several parameters at the local scale. We are proposing the creation of a network of pan-arctic observatories with different vegetation composition and climate features to generalize the CO_2 fluxes modelling effort and provide a sound database as a benchmark for models at various scales, including their use for validating remote-sensing estimates that link climate and vegetation composition and phenology to CO_2 fluxes. This will facilitate the identification of the main variables to be used in general vegetation models and allowing future projections of CO_2 fluxes under different climate change scenarios in the Arctic tundra.

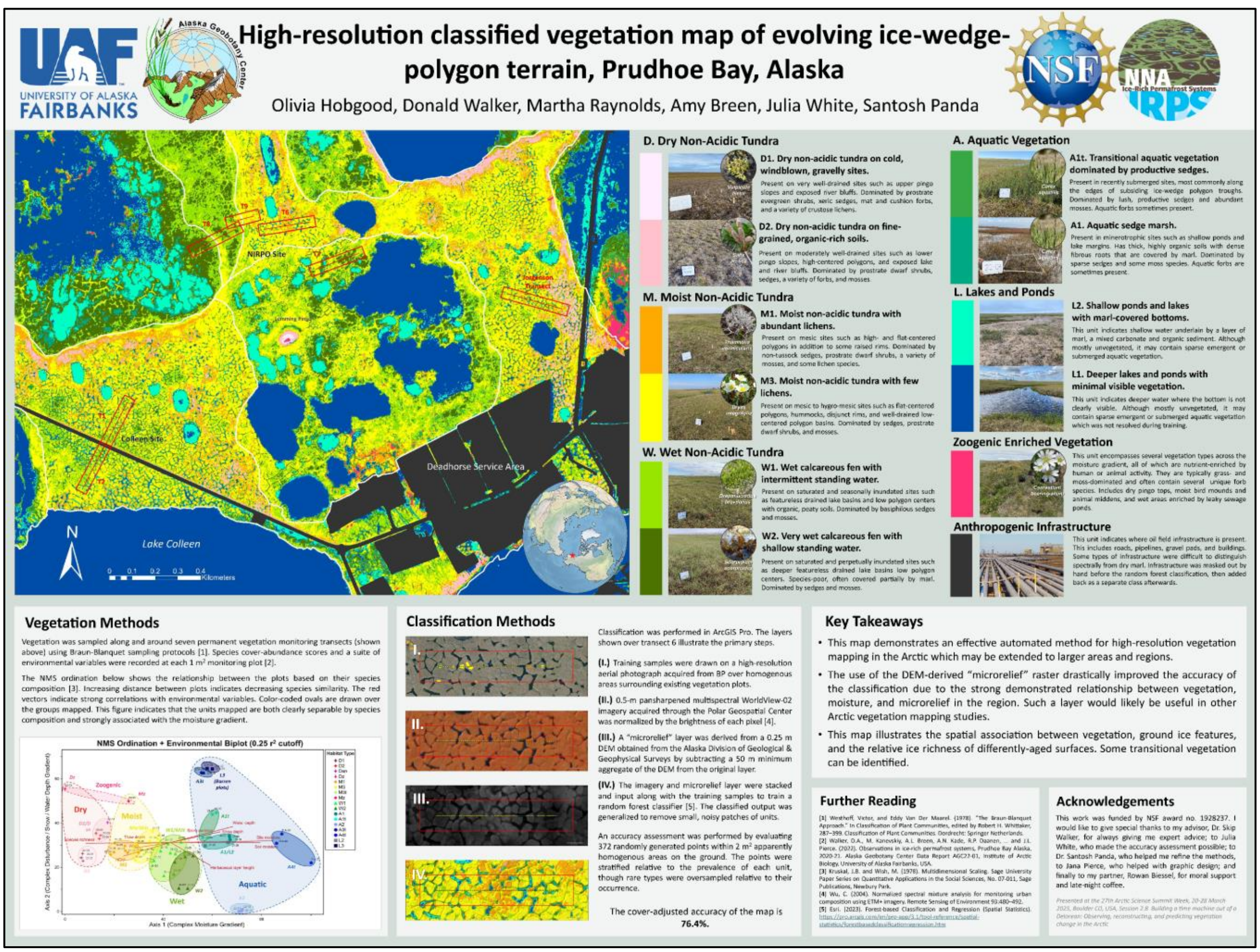


HIGH-RESOLUTION CLASSIFIED VEGETATION MAP OF EVOLVING ICE-WEDGE-POLYGON TERRAIN, PRUDHOE BAY, ALASKA — OLIVIA HOBGOOD

University of Alaska Fairbanks, USA

COAUTHORS: Donald Walker, Martha Raynolds, Amy Breen, Julia White | **FORMAT:** Poster in-person

ABSTRACT: Many Arctic regions are experiencing rapid changes due to ice-wedge degradation and the formation of new thermokarst ponds. Because vegetation is a stationary, above-ground reflection of many factors, such as air temperature, precipitation, hydrology, animal activity, and soil chemistry, mapping vegetation is a useful method for investigating the multiple facets of landscape evolution. Although modern pan-Arctic vegetation maps exist, few have mapped vegetation at the ice-wedge-polygon scale, and none have mapped the unique non-acidic vegetation at Prudhoe Bay at this scale. We present a vegetation map of a 5.7-km^2 area near Deadhorse, Alaska, created using an automated machine-learning classifier trained on field data. The source imagery is an 8-band, 0.46-m resolution WorldView-02 image taken in July 2022; due to the high source resolution, the classified map shows how vegetation varies across polygonal landscape features, such as troughs, centers, and rims. At a broader scale, the map shows how vegetation composition changes between areas with different thaw-lake histories and relative ice richness. Through extrapolation of field data, the map provides insights into how factors such as biomass, snow depth, and carbon flux vary across a changing landscape. We present the advantages and limitations of this efficient, repeatable approach to landscape monitoring.

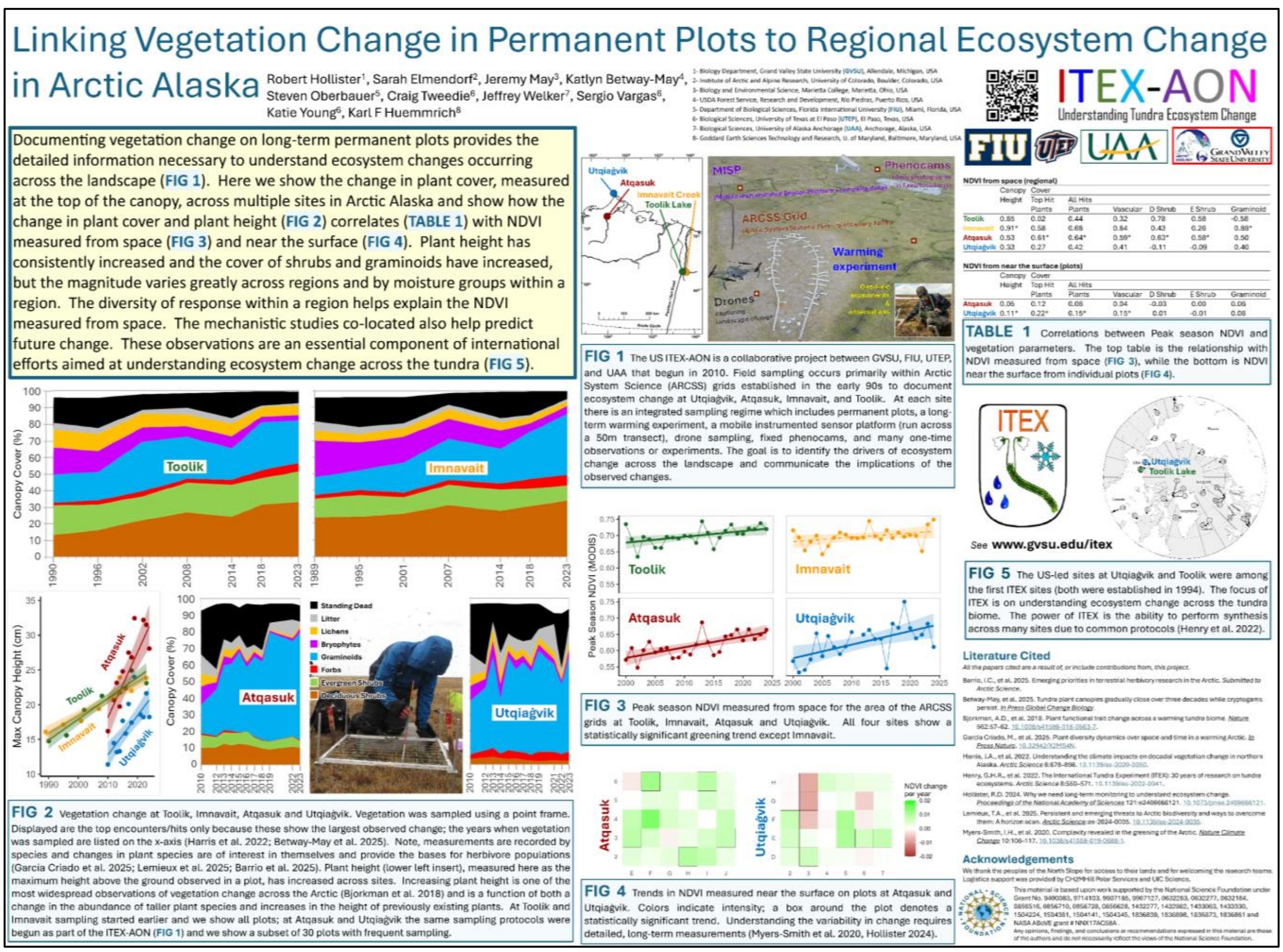


LINKING VEGETATION CHANGE IN PERMANENT PLOTS TO REGIONAL ECOSYSTEM CHANGE IN ARCTIC ALASKA — ROBERT HOLLISTER

Biology Department, Grand Valley State University, Allendale, Michigan, USA

COAUTHORS: Sarah Elmendorf, Jeremy May, Katlyn Betway-May, Steven Oberbauer, Craig Tweedie, Jeffrey Welker, Sergio Vargas, Katie Young, Karl F Huemmrich | **FORMAT:** Poster in-person

ABSTRACT: Documenting vegetation change on long-term permanent plots provides the detailed information necessary to understand ecosystem changes occurring across the landscape. Here we show the change in plant cover, measured at the top of the canopy, across multiple sites in Arctic Alaska and show how the change in plant cover and plant height correlates with NDVI measured near the surface and from space. Plant height has consistently increased and the cover of shrubs and graminoids have increased, but the magnitude varies greatly across regions and by moisture groups within a region. The diversity of response within a region helps explain the NDVI measured from space. The mechanistic studies co-located also help predict future change. These observations are an essential component of international efforts aimed at understanding ecosystem change across the tundra.



ARCTIC-ALPINE GLACIAL FORELANDS: REFUGIA HABITAT DEVELOPMENT COINCIDING WITH ONGOING RAPID CHANGE — SHAWNEE KASANKE

Washington State University, Pullman, Washington USA; Alaska Geobotany Center, University of Alaska Fairbanks, USA

COAUTHORS: Christopher Kasanke, Helga Bültman, Martha Raynolds | **FORMAT:** Oral in-person

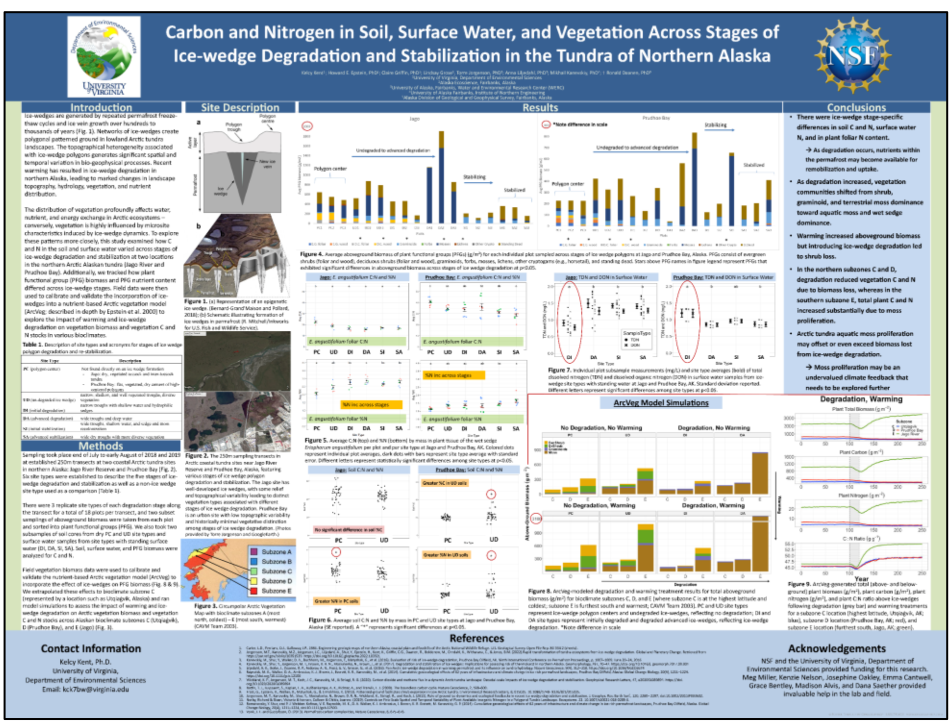
ABSTRACT: Primary succession by plants and microorganisms following major disturbances such as deglaciation largely governs soil development, moisture retention, and habitat formation on freshly exposed substrates. Glacial forelands have long been model systems for studying the process of primary succession, but Arctic alpine glacial forelands have largely been excluded. Pioneer organisms eventually develop habitat that can serve as refugia for Arctic taxa displaced by rapid warming and limited in range expansion opportunities. There is an urgent need to document the successional process and relationships between pioneer organisms in Arctic alpine glacial forelands to help predict ongoing effects of deglaciation and define when and what kinds of new habits will become available as a result. We propose an initiative to study primary succession in Arctic alpine glacial cirque forelands starting in the North American Arctic and expanding to Europe. Beginning this research within 40 years of glacial retreat is essential to accurately document primary succession and is a unique opportunity to establish long-term study sites to observe this process over time. Data collected will include identification of plant-microbe interactions influencing succession, soil formation, vegetation classification, rates of plant and microorganism establishment, community shifts, and wildlife use. We will compare communities forming on substrates of similar ages along glacial chronosequences spanning from recently deglaciated surfaces to glacial deposits from the Little Ice Age (~500-1000 years ago). To accurately collect these data, we will also update the lichenometric curve for the region to reflect increasing temperatures and use these measurements to date recent glacial deposits.

A CHANGING ARCTIC: ASSESSMENT OF CARBON AND NITROGEN IN SOIL, SURFACE WATER, AND VEGETATION ACROSS STAGES OF ICE-WEDGE DEGRADATION AND STABILIZATION IN THE TUNDRA OF NORTHERN ALASKA — KELCY KENT

University of Virginia, Department of Environmental Sciences, Charlottesville, Virginia, USA

COAUTHORS: Howard Epstein, Lindsay Grose, Torre Jorgenson, Claire Griffin, Mikhail Kanevskiy, Anna Liljedahl, Ronald Daanen | **FORMAT:** Poster in-person

ABSTRACT: Ice-wedge polygons–commonly found in Arctic tundra regions–produce high spatial variability in topography, hydrology, vegetation distribution, and biogeochemical processes at local to landscape scales. Recent warming has caused ice-wedge thaw, driving dramatic landscape changes. Water and nutrient availability can vary substantially across stages of ice-wedge degradation, impacting vegetation distribution, which can lead to further degradation or facilitate stabilization. These processes, however, are poorly understood, contributing to uncertainty in predicting future Arctic ecosystem trajectories. This study examined differences in carbon and nitrogen in the soil and surface water among stages of ice-wedge degradation and stabilization, as well as differences in plant functional group biomass and foliar N. To explore the impact of local conditions on these patterns, trends among ice-wedge stages were compared between two north Alaskan tundra sites (Jago River and Prudhoe Bay, Alaska). Field data were also used to calibrate and validate a nutrient-based Arctic vegetation model to assess the influence of ice-wedge degradation on Arctic vegetation communities and vegetative C and N stocks at coarser scales. At both sites, vegetation communities shifted from terrestrial moss, graminoid, and shrub-dominated to aquatic moss and hydrophilic sedge-dominated following degradation. There were ice-wedge stage-specific differences in soil and surface water nutrients, and differences in plant foliar N content. Modeled extrapolations suggest warming and ice-wedge degradation could significantly increase vegetation biomass due to the proliferation of aquatic moss. Increases in aquatic moss biomass could even exceed biomass loss following degradation, although this was specific to warmer, more southern Arctic locations.

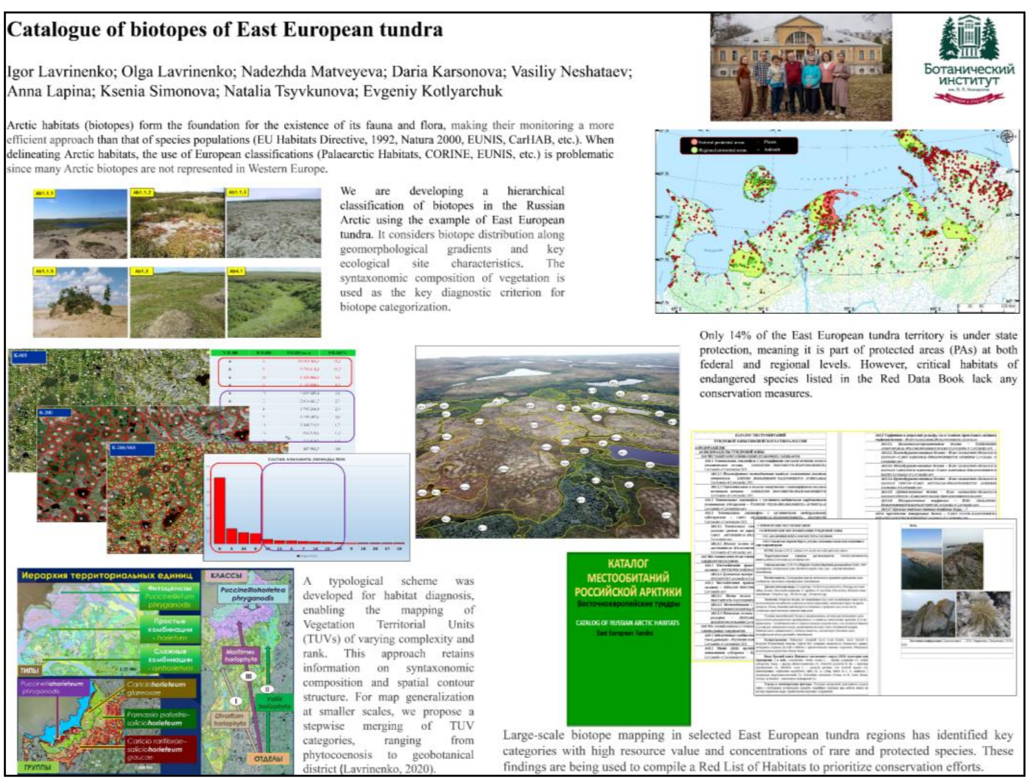


CATALOGUE OF BIOTOPES OF EAST EUROPEAN TUNDRA — IGOR LAVRINENKO

Komarov Botanical Institute, Russian Academy of Sciences, St. Petersburg, Russia

COAUTHORS: Olga Lavrinenko, Nadezhda Matveyeva, Daria Karsonova, Vasiliy Neshataev, Anna Lapina, Ksenia Simonova, Natalia Tsyvkunova, Evgeniy Kotlyarchuk | **FORMAT:** Poster virtual

ABSTRACT: Arctic habitats (biotopes) form the foundation for the existence of its fauna and flora, making their monitoring a more efficient approach than that of species populations (EU Habitats Directive (92/43/EEC) which resulted in the Natura 2000 protected areas network, European Nature Information System (EUNIS), Cartographie Nationale des Habitats Naturels et Semi-naturels (CarHAB; France's National Mapping Program for Natural and Semi-natural Habitats, etc.). When delineating Arctic habitats, the use of European classifications (Palaearctic Habitats, Coordination of Information on the Environment (CORINE), EUNIS, etc.) is problematic since many Arctic biotopes are not represented in Western Europe. We are developing a hierarchical classification of biotopes in the Russian Arctic using the example of East European tundra. It considers biotope distribution along geomorphological gradients and key ecological site characteristics. The syntaxonomic composition of vegetation is used as the key diagnostic criterion for biotope categorization. A typological scheme was developed for habitat diagnosis, enabling the mapping of Vegetation Territorial Units (TUVs) of varying complexity and rank. This approach retains information on syntaxonomic composition and spatial contour structure. For map generalization at smaller scales, we propose a stepwise merging of TUV categories, ranging from phytocoenosis to geobotanical district (Lavrinenko 2020). A critical aspect of habitat assessment is their resource value, both for native species and human use. Large-scale biotope mapping in selected East European tundra regions has identified key categories with high resource value and concentrations of rare and protected species. These findings are being used to compile a Red List of Habitats to prioritize conservation efforts.

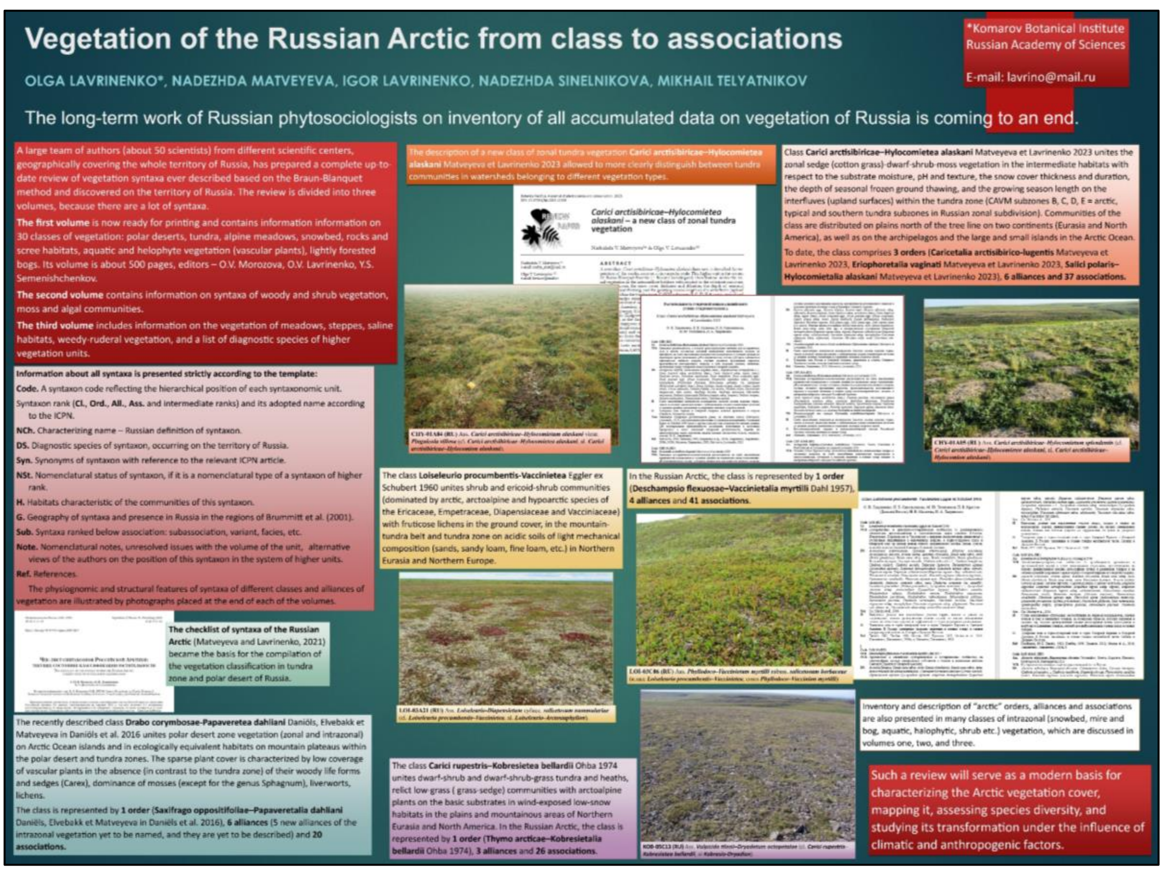


VEGETATION OF THE RUSSIAN ARCTIC FROM CLASS TO ASSOCIATIONS — OLGA LAVRINENKO

Komarov Botanical Institute, Russian Academy of Sciences, St. Petersburg, Russia

COAUTHORS: Nadezhda Matveyeva, Igor Lavrinenko, Nadezhda Sinelnikova, Mikhail Telyatnikov | **FORMAT:** Poster virtual

ABSTRACT: As part of a large-scale initiative (Plugatar et al. 2020) to develop the serial publication Prodromus of the Vegetation of Russia, a comprehensive inventory of Russian Arctic vegetation was conducted, classifying communities to the level of associations. The work builds on the Checklist of Syntaxa of the Russian Arctic (Matveyeva & Lavrinenko 2021), which serves as the foundation for the Prodromus. Key Arctic vegetation classes include: (1) Drabo corymbosae–Papaveretea dahliani Daniëls, Elvebakk & Matveyeva in Daniëls et al. 2016: 1 order, 6 alliances (5 requiring formal description), 20 associations; (2) Carici arctisibiricae–Hylocomietea alaskani Matveyeva & Lavrinenko 2023: 3 orders, 6 alliances, 37 associations; (3) Carici rupestris–Kobresietea bellardii Ohba 1974: 1 order, 3 alliances, 26 associations; (4) Loiseleurio procumbentis–Vaccinietea Eggler ex Schubert 1960: 1 order, 4 alliances, 41 associations. For all syntaxonomic units, the following metadata are provided: unique code, valid name, synonyms, diagnostic species, habitat characteristics, geographic range, subsyntaxa, and data sources. Descriptions of Arctic syntaxa (orders, alliances, associations) are also integrated into classes of intrazonal vegetation (e.g., snowbed, mire, aquatic, halophytic). This synthesis will serve as a contemporary framework for characterizing Arctic vegetation cover, large-scale mapping, assessing species diversity, analyzing transformations driven by climatic and anthropogenic factors.

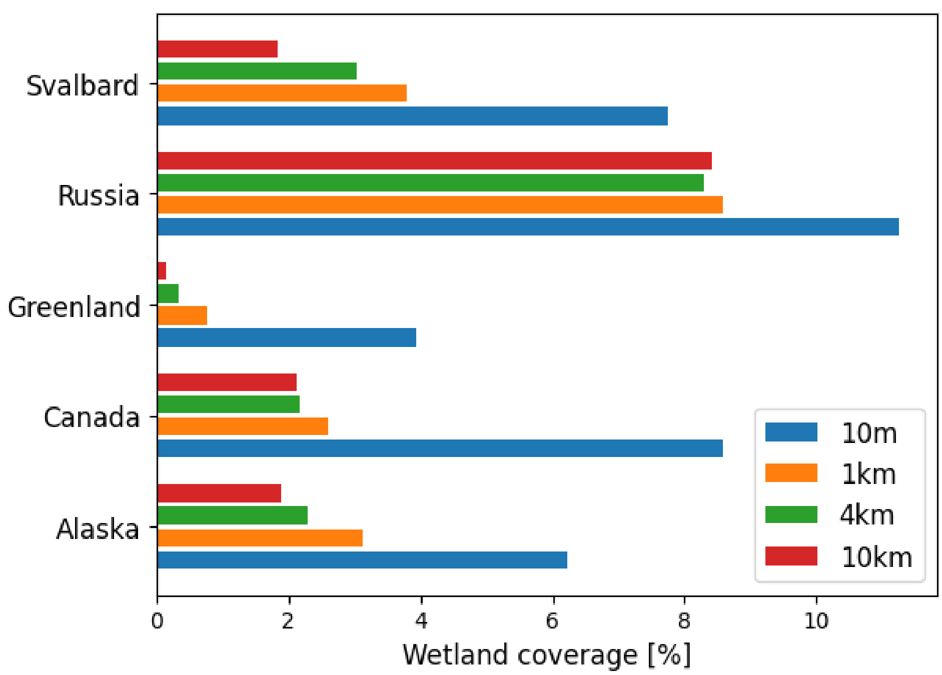


EXAMINING THE IMPACTS OF LAND COVER UPSCALING ON WETLAND EXTENT AND REGIONAL CARBON BALANCE PROJECTIONS — BENJAMIN MAGLIO

Institute of Arctic Biology, University of Alaska Fairbanks, USA

COAUTHORS: Valeria Briones, Doğukan Teber, Ruth Rutter, Tobey Carman, Anja Kade, Howard Epstein, Donald Walker, Anna Liljedahl, Elchin Jafarov, Brendan Rogers, Hélène Genet | **FORMAT:** Oral virtual

ABSTRACT: The Arctic tundra, which occupies ∼10% of the terrestrial land surface, contains about a third of the global carbon stocks. Over half of the region is characterized by ice-wedge polygonal tundra rich in wetland systems. As the region is experiencing rates of warming up to four times greater than the rest of the planet, permafrost thaw can impact both carbon and water balances and modulate the release of methane from these wetlands. Terrestrial biosphere models (TBMs) are used to predict the impact of climate-driven permafrost thaw on ecosystem carbon balance. However, TBMs usually simulate the landscape heterogeneity at coarse spatial resolutions that are much greater than the actual scale of wetlands, resulting in underestimation of the extent and variability of Arctic wetlands. In this study, we evaluated the consequences of the misrepresentation of wetland spatial distribution in the Arctic terrestrial carbon balance. We used a state-of-the-art TBM specifically developed for Arctic regions. We compare simulations of the Alaskan coastal plain using majority-selection upscaled CircumArctic Land cover Units (CALU, 10-m resolution) at 1 and 4 km resolution to inform vegetation and soil communities in DVM-DOS-TEM, a TBM developed for the high latitudes. We compared the associated carbon budget of these simulations, with a carbon budget built on simulations representing sub-grid wetland percent cover estimated from the original 10 m resolution product. Our study shows discrepancies between carbon budgets calculated at differing resolutions and emphasizes the importance for TBMs to represent sub-grid landscape distribution in producing regional carbon budgets in the Arctic.



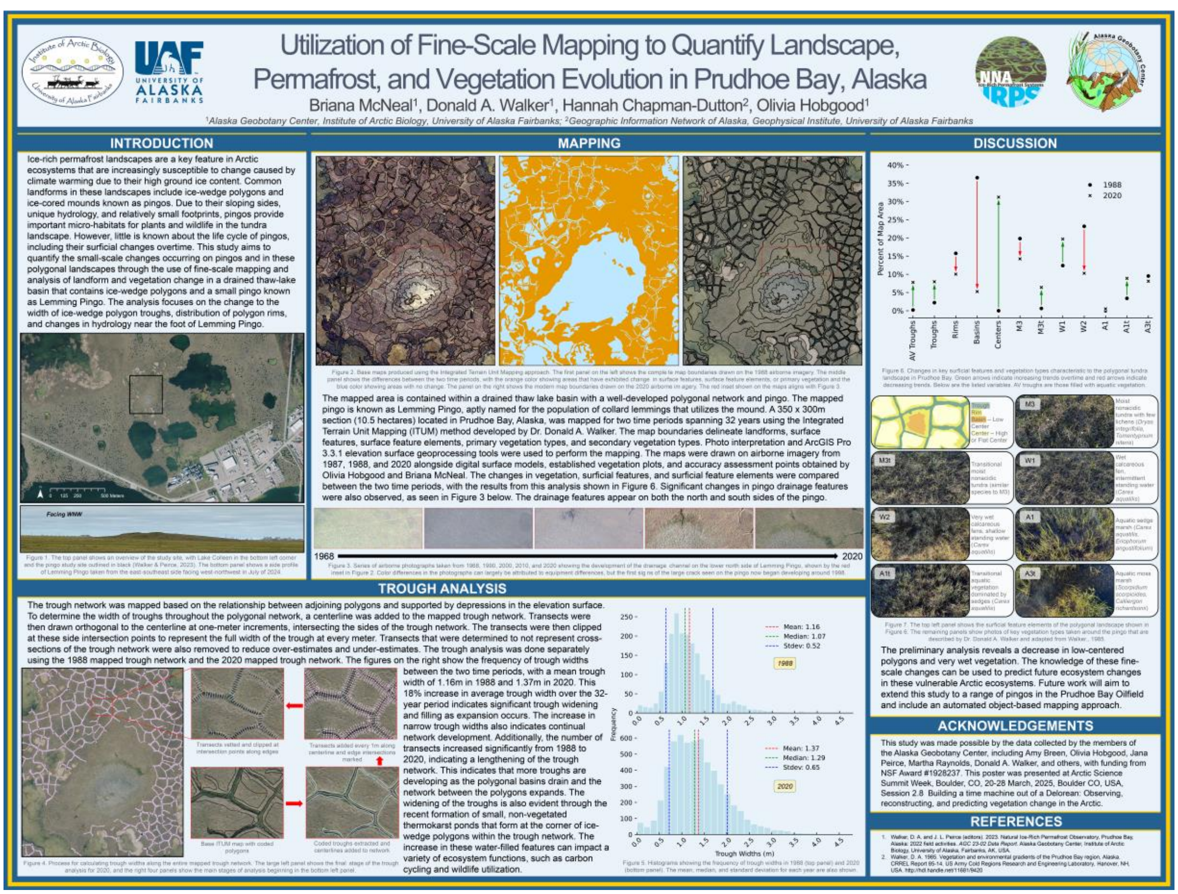
Discrepancies between carbon budgets at different spatial resolutions representing sub-grid wetland coverage by region. These results highlight the importance for TBMs to represent sub-grid landscape distribution to produce accurate regional carbon budgets.

UTILIZATION OF FINE-SCALE MAPPING TO QUANTIFY LANDSCAPE, PERMAFROST AND VEGETATION EVOLUTION IN PRUDHOE BAY, ALASKA — BRIANA MCNEAL

University of Alaska Fairbanks, USA

COAUTHORS: Donald Walker, Hannah Chapman-Dutton, Olivia Hobgood | **FORMAT:** Poster in-person

ABSTRACT: Ice-rich permafrost landscapes are a key feature in Arctic ecosystems that are increasingly susceptible to change with climate warming due to their ice content. In coastal tundra regions, these ice-rich systems often appear as polygonal matrices formed through ice wedge development. These landscapes also give rise to ice-cored mounds known as pingos. This study aims to quantify the small-scale changes occurring in these polygonal landscapes and on pingos using fine-scale mapping. Change was analyzed over a period of 32 years using orthomosaic and aerial imagery from 1987, 1988, and 2020 alongside digital surface models and accuracy assessment points obtained in the field. A 350 x 300 m section located in Prudhoe Bay, Alaska, was mapped for the two time periods using photo interpretation and ArcGIS Pro 3.3.1 elevation surface geoprocessing tools. The area of interest is contained within a drained thaw lake basin with a well-developed polygonal network and steep-sided pingo. The changes in vegetation, surficial features, and surficial feature elements were compared between the two time periods. The preliminary analysis reveals a decrease in low-centered polygons and very wet vegetation of 86% and 56%, respectively, from 1988 along with an 18% increase in trough width. Significant changes in pingo drainage features were also observed. The knowledge of these fine-scale changes can be used to predict future ecosystem changes in these vulnerable Arctic ecosystems. This study can also help to inform future work that aims to utilize remote sensing to map Arctic landscapes in greater detail.

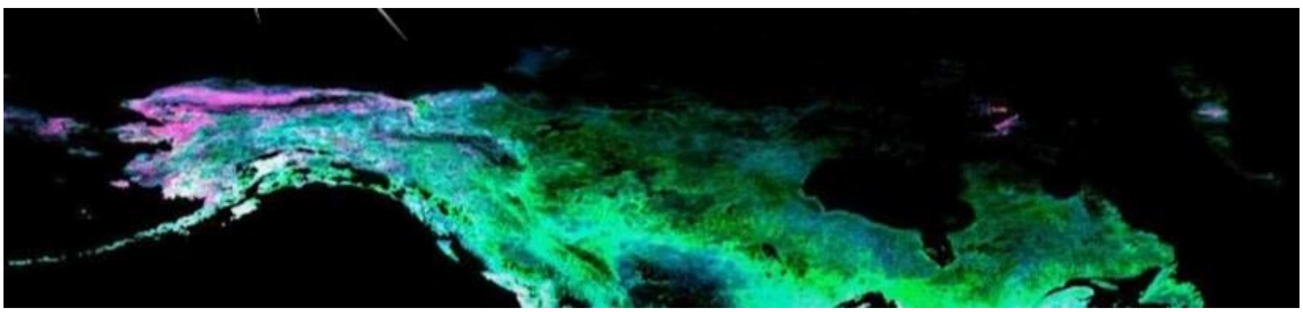


TRANSFORMATIVE SPACE BASED MAPPING, CLASSIFICATION, AND MONITORING OF ARCTIC VEGETATION — CHARLES MILLER

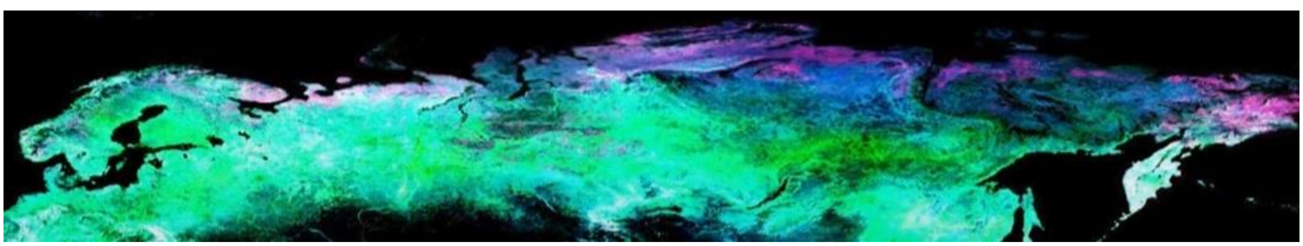
Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA

COAUTHORS: Peter Griffith, Elizabeth Hoy, Scott Goetz, Laura Duncanson, Phil Townsend, Laura Bourgeau-Chavez, Daryl Yang | **FORMAT:** Oral in-person

ABSTRACT: New space-based remote sensing technologies will transform our ability to map, classify, and monitor vegetation and its changes in the rapidly evolving Arctic. Here, we present results from airborne imaging spectroscopy, L-band synthetic aperture radar (SAR), Ka-band water surface elevation, and full waveform lidar surveys acquired over Alaska and northwestern Canada from 2017 to 2024 during NASA's Arctic Boreal Vulnerability Experiment (ABoVE). These surveys helped pioneer the application of these techniques to Arctic vegetation and give us initial insights into how they can help us monitor interannual to decadal scale change. Additionally, they pave the way for pan-Arctic vegetation remote sensing by current and upcoming missions including IceSAT-2, SWOT, NISAR, ROSE-L, PACE, EnMAP, PRISMA, PRISMA-SG, SBG-VSWIR, and CHIME.



NASA's PACE mission provides daily, 1-km resolution spectral imaging of the Arctic-boreal region. This data will revolutionize the study of vegetation cover and dynamics in the northern high latitudes.



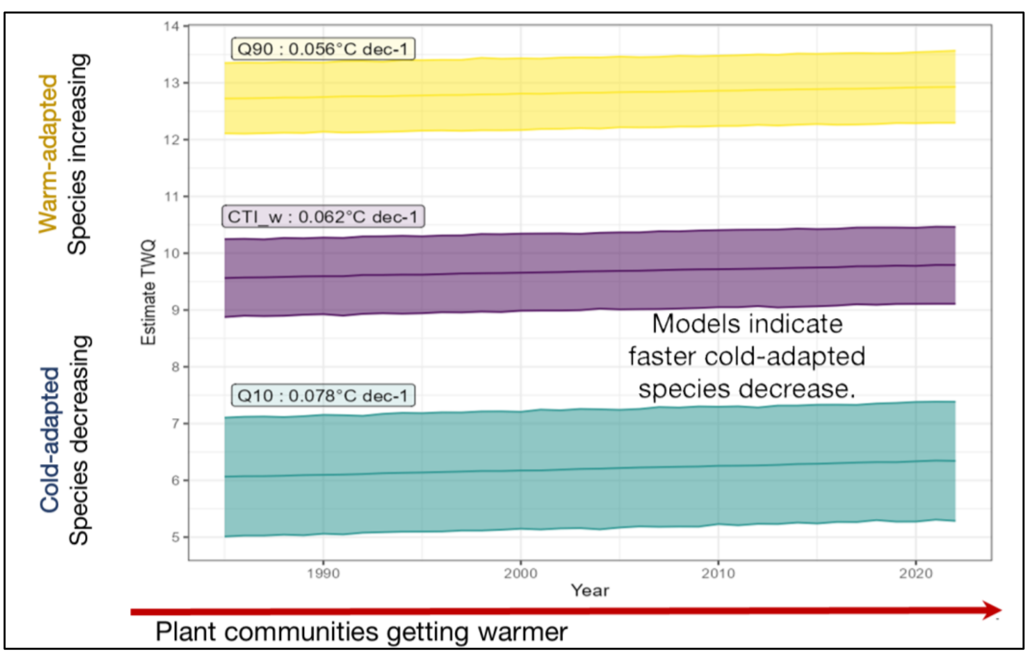
PACE spectral imaging of pan-Arctic vegetation

LONG-TERM TUNDRA MONITORING REVEALS HOTSPOTS OF TUNDRA VEGETATION CHANGE WITH WARMING AND BIOTIC INTERACTIONS — ISLA H. MYERS-SMITH

Department of Forest & Conservation Sciences, University of British Columbia, Canada

COAUTHORS: Jeremy Borderieux, Sarah Elmendorf, Mariana García Criado, Joseph Everest, Anne Bjorkman, Robert Hollister, ITEX Consortium | **FORMAT:** Oral in-person

ABSTRACT: Coordinated distributed experiments and long-term monitoring networks provide unique opportunities for documenting decadal scale ecological change. Longitudinal data from such networks are particularly valuable for understanding change in the tundra, where dramatic changes in climate are already underway. Here, we present recent synthetic work from the ITEX+ network, a grassroots effort consisting of permanent vegetation plots, often paired with experimental warming treatments, distributed throughout Arctic and alpine tundra worldwide. Ongoing efforts to expand the network together with dedicated data harmonization efforts have yielded a pan-Arctic dataset of vegetation composition and abundance, with over 10,000 plots, in 271 study areas distributed across 5 continents, surveyed between 1980 and 2023. Recent syntheses highlight instances of both vegetation change and stability across monitoring locations and inform our understanding of the processes likely to alter plant species diversity under a warming climate. Over the network as a whole, we find that plant species richness is greater in lower latitude and warmer sites. Despite substantial warming, average species richness was not increasing over time in recent decades. In contrast, species composition changed over time 59% for most plots. Species turnover was highest in rapidly warming sites, whereas species loss was highest where shrubs - particularly tall shrubs - increased in dominance. These tundra plant communities have undergone thermophilization, with both warm-loving species increasing and cold-adapted species decreasing. Changes in functional diversity largely mirrored those in species diversity, with decreased functional diversity in colder, high latitude sites or those with increasing shrub dominance. Together, these results indicate climate and biotic interactions jointly influence the taxonomic and functional diversity of a warming tundra.



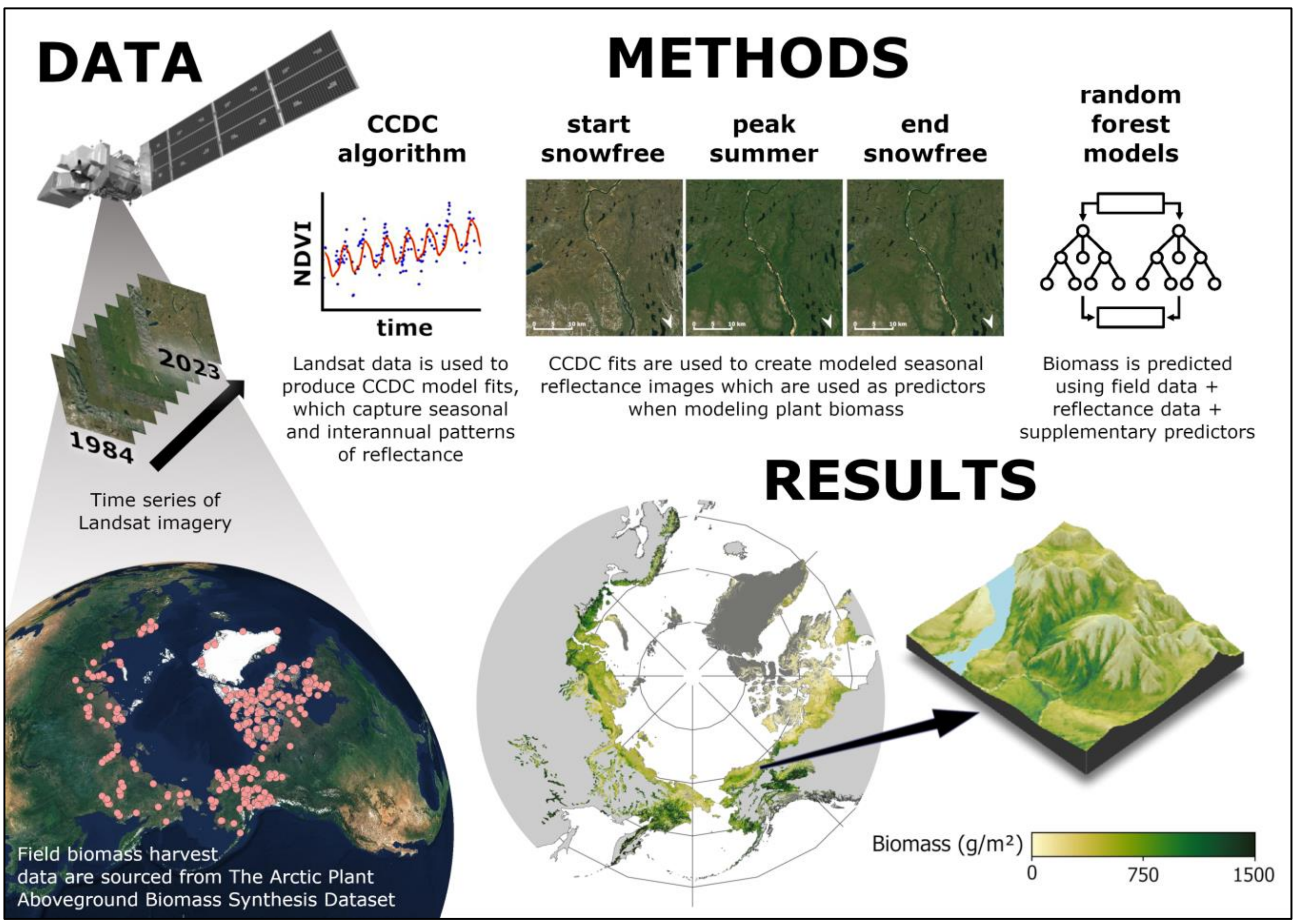
Trends in warm- and cold-adapted species richness from 1980 to 2023.

NEXT GENERATION MAPS OF PLANT ABOVEGROUND BIOMASS FOR THE ARCTIC TUNDRA BIOME — KATHLEEN ORNDAHL

Northern Arizona University, Flagstaff, Arizona, USA

COAUTHORS: Logan Berner, Matthew Macander, Scott Goetz, The Arctic Tundra Plant Biomass Synthesis Network | **FORMAT:** Oral in-person

ABSTRACT: The Arctic is warming faster than anywhere else on Earth, placing tundra ecosystems at the forefront of global climate change. Plant biomass is a fundamental ecosystem attribute that is sensitive to changes in climate, closely tied with ecological function and crucial for determining ecosystem carbon storage. However, the amount, composition, and distribution of plant biomass remains poorly understood across the Arctic. We developed the first moderate resolution (30m) maps of plant and woody plant aboveground biomass (gm^2) and woody dominance (%) for the Arctic tundra biome. We modeled biomass for the year 2020 using a new synthesis dataset of field measurements, Landsat satellite seasonal synthetic composites, and machine learning models. Moreover, we quantified pixel-wise uncertainty in biomass predictions using Monte Carlo simulations and validated predictions using a robust cross-validation procedure. Validation showed prediction root-mean-squared-error (RMSE)≈400 gm^2, relative RMSE.

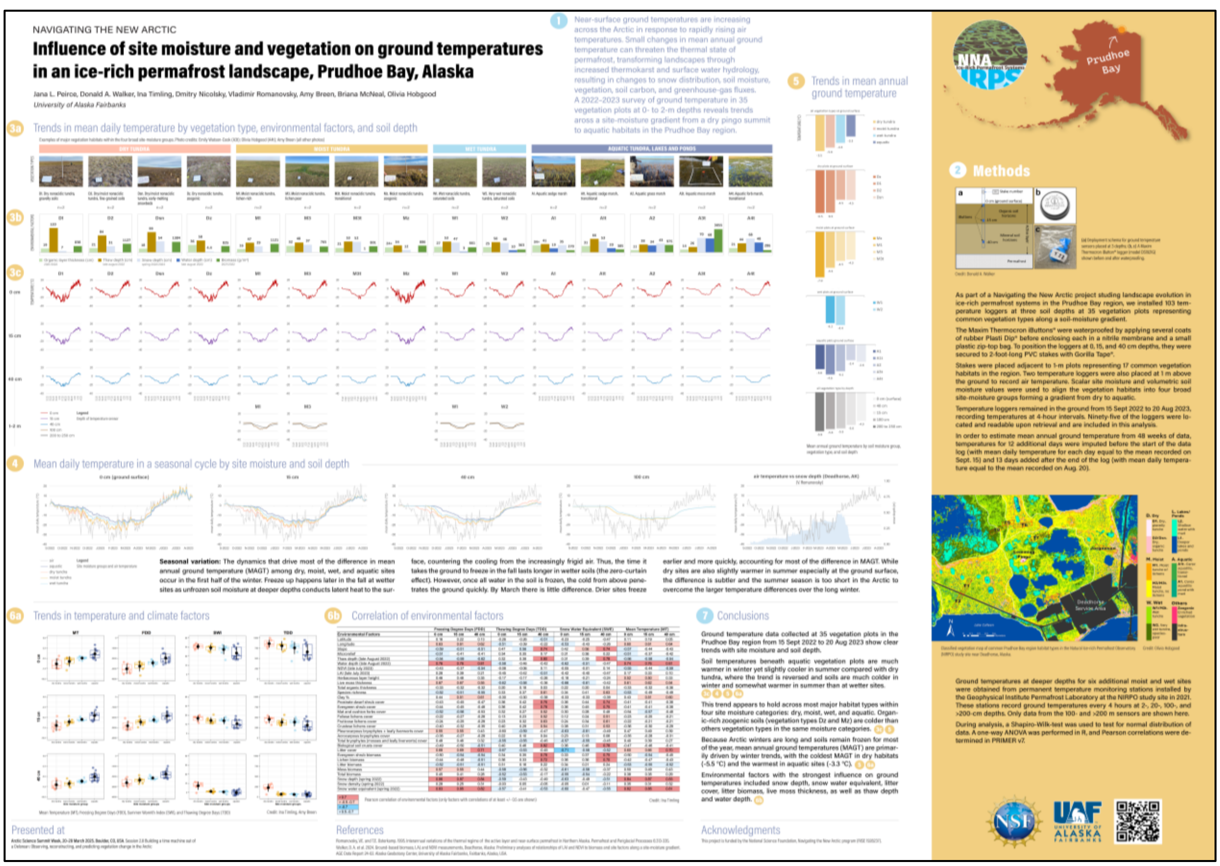


INFLUENCE OF SITE MOISTURE AND VEGETATION ON GROUND TEMPERATURES IN AN ICE-RICH PERMAFROST LANDSCAPE, PRUDHOE BAY, ALASKA — JANA PEIRCE

University of Alaska Fairbanks, USA

COAUTHORS: Donald Walker, Ina Timling, Dmitry Nicolsky, Vladimir Romanovsky, Amy Breen, Briana McNeal, Olivia Hobgood | **FORMAT:** Poster in-person

ABSTRACT: Near-surface ground temperatures are increasing across the Arctic in response to rapidly rising air temperatures. Small changes in mean annual ground temperature (MAGT) can threaten the thermal state of permafrost, transforming landscapes through increased thermokarst and surface water hydrology, resulting in changes to snow distribution, soil moisture, vegetation, soil carbon, and greenhouse-gas fluxes. Here we share findings from a 2022–2023 survey of ground temperature trends at 0, -15, and -40 cm depths in 35 vegetation plots located along a site-moisture/vegetation gradient from a dry pingo summit to aquatic habitats. Preliminary analysis indicates a strong positive trend of ground temperatures along the site moisture gradient. Mean annual ground surface temperatures varied from: -7.39˚C on a windblown pingo summit with dry zoogenic tundra (habitat type Dz) to -2.86 ˚C in aquatic thermokarst-pond habitats with approximately 50–100 cm of water and thick aquatic moss (*Scorpidium scorpiodes* and *Calliergon richardsonii*) (habitat type A3t) — a +4.53 ˚C difference. Mean annual ground temperatures at -40 cm in the same habitats varied from -8.04 ˚C in type Dz to -4.28 ˚C in type A3t) — a +3.76 ˚C difference. Other factors affecting the ground temperatures included the depth of snow, and the thickness of organic soil layers. Other factors affecting the ground temperatures included snow depth, snow water equivalent, litter cover, litter biomass, live moss thickness, as well as late August thaw and water depths.

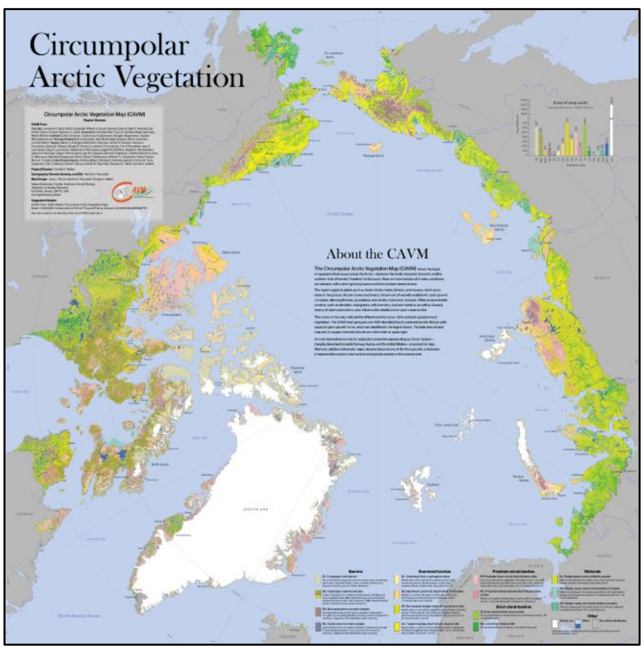


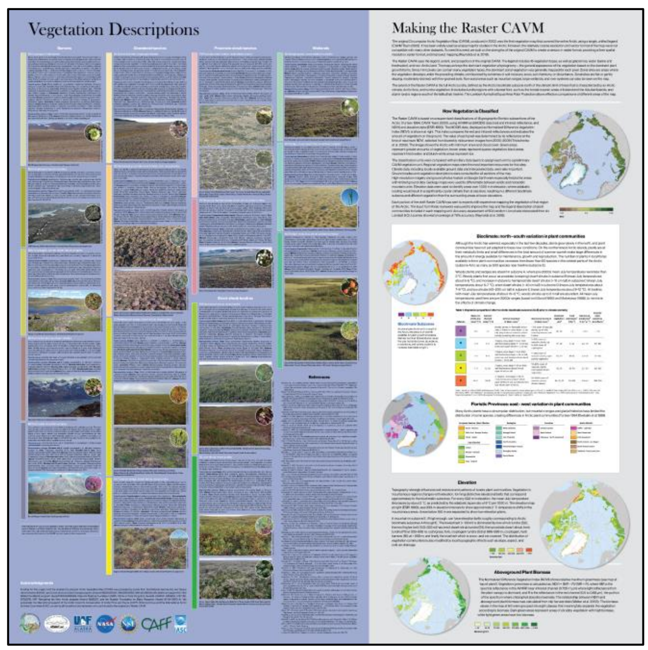
THE RASTER CAVM — HARD-COPY AND DIGITAL VERSIONS TO SUPPORT CURRENT AND FUTURE RESEARCH APPLICATIONS — MARTHA RAYNOLDS

University of Alaska Fairbanks, USA

COAUTHORS: CAVM Team | **FORMAT:** Poster in-person

ABSTRACT: A raster version of the Circumpolar Arctic Vegetation Map (CAVM) was created in 2019, building on the success of the 2003 vector CAVM. The raster version uses the same Arctic extent as originally defined by the CAVM and the same circumpolar legend based on plant physiognomy. The raster format, based on analysis of 1-km AVHRR data, is compatible with remote sensing data, making it easier to use for analysis and modeling. The CAVM provides a base map for many studies, and its boundaries are the most common delineation used to define the Arctic. The Raster version has been used for mapping studies, modeling, and for extrapolating local or regional findings to larger areas. There are aspects of the CAVM that could be improved on. The treeline boundaries and the ice boundaries could be updated using recent mapping. The 1-km resolution makes a very manageable dataset size, but many studies are now working at finer resolutions. We expect the CAVM will continue to be useful at the circumpolar scale. We also expect that the legend, with its easily understood units and its hierarchical nature, will continue to provide a framework for other arctic vegetation maps. A new hard-copy version of the Raster CAVM displays the map on the front and details about the map and the legend units on the back. Photographs illustrate landscape views and characteristic plants of the units. We hope this beautiful map will inspire new avenues of Arctic research.



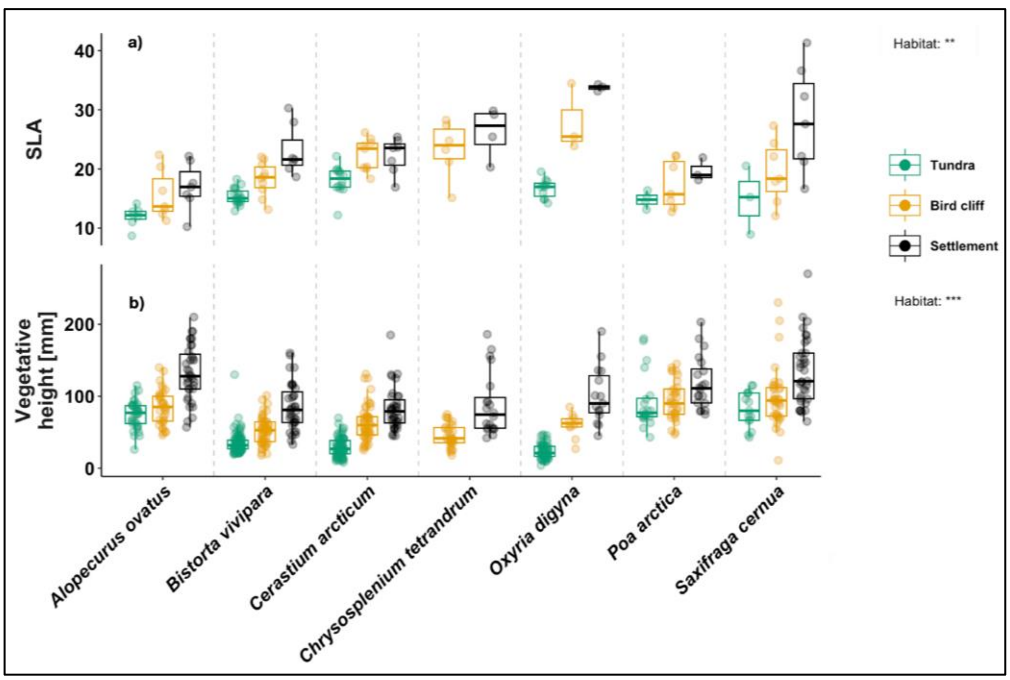


WHAT ELSE MATTERS? INFLUENCE OF LOCAL SOIL PROPERTIES ON PLANT RESPONSES IN A GREENING ARCTIC — JANA RÜTHERS

Department of Environmental Systems Science, ETH Zurich, Switzerland

COAUTHORS: Lena Bakker, Sebastian Doetterl, Simone Fior, Marco Griepentrog, Annina Maier, Moritz Mainka, Kristine Bakke Westergaard, Jake Alexander | **FORMAT:** Oral in-person

ABSTRACT: Arctic Greening has been observed in recent years, with an increase in plant biomass and productivity. However, the patterns of greening are heterogenous, and the reasons for this are not fully understood. One reason for this heterogeneity might be variation in soil properties and weathering processes, which could accelerate and affect vegetation responses as climate warms. In this interdisciplinary project we try to gain insight into how changing soil properties might be linked to future vegetation development. We conducted vegetation surveys, trait measurements and soil analyses on Svalbard in distinct habitat types, representing a difference in soil properties and fertility. Initial results indicate a decrease in dwarf-shrub cover and an increase in graminoid cover on nutrient enriched soils. Species also differ in their growth, trait values and possibly in their resource allocation strategies between habitats, with many species improving their performance on nutrient enriched soils. Those species were not only found on the nutrient enriched soils, but also in the natural tundra just with a lower abundance and cover. This implies that as soon as soil conditions might change with warming or disturbance, those communities could quickly change and also increase greening values. These first results hint that changing plant communities and increasing greening may be more strongly linked to local soil properties than to warming alone. Together with the increasing risk of the establishment of non-native species, especially highly specialized tundra species could be at risk of suppression. This information is also highly relevant for conservation purposes.



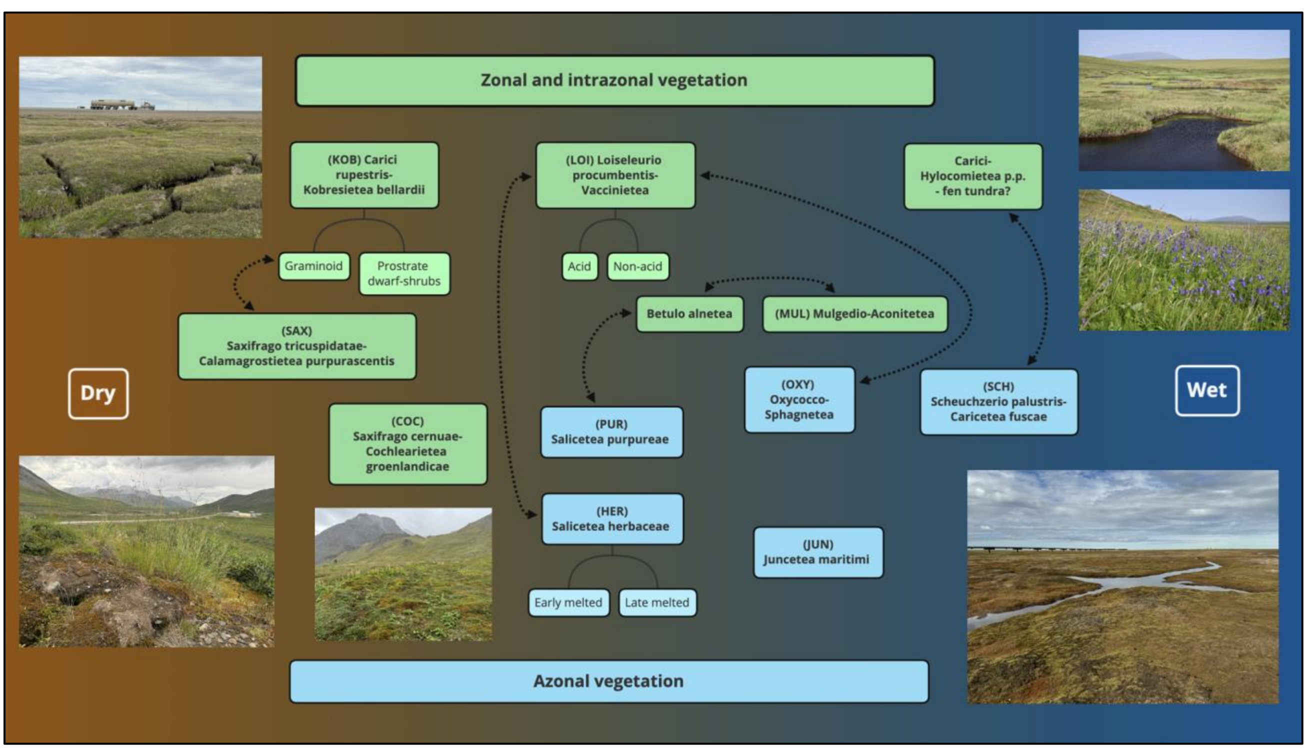
Specific leaf area (SLA) (a) and vegetation height (b) of selected tundra species across different habitats: tundra (green), bird cliff (yellow), settlement (black). Those generalist species that were able to respond to the variation in soil properties and fertility were also present in the tundra habitat, not only in the nutrient enriched bird cliffs and settlements. This implies that a further greening and change in vegetation patterns can occur quickly – as soon as tundra soil properties are altered due to warming or disturbance.

VARIABILITY OF MAJOR VEGETATION TYPES IN ARCTIC ALASKA: KEY GRADIENTS, VEGETATION UNITS, AND SYNTAXONOMY — JOZEF ŠIBÍK

Plant Science and Biodiversity Center of Slovak Academy of Sciences, Bratislava, Slovakia

COAUTHORS: Skip Walker, Amy Breen, Helga Bültmann, Olivia Hobgood, Bryana McNeal, Jana Peirce, Maria Šibíková, Martha Raynolds, David Cooper, Marilyn Walker | **FORMAT:** Oral in-person

ABSTRACT: The Arctic is experiencing rapid changes driven by climate fluctuations, enhanced nutrient cycling, and increasing disturbances like wildfires and resource extraction. These changes significantly impact vegetation patterns, serving as indicators of broader landscape shifts, including alterations in topography, hydrology, and permafrost dynamics. In response, the Arctic Vegetation Classification (AVC) is essential to the Circumpolar Arctic Vegetation Science Initiative (CAVSI) under ICARP IV, which aims to create a comprehensive framework for classifying, mapping, and monitoring Arctic vegetation. Since 1992, the Arctic Vegetation Archive (AVA) and AVC were developed through collaborative workshops, recently using the Turboveg system for data management and the Braun-Blanquet classification method, which has proven effective across the Arctic. With around 31,000 documented vegetation plots, the AVA enhances understanding of diverse Arctic habitats and builds on monitoring efforts in northern Alaska, potentially integrating into broader Arctic observation networks or creating a dedicated Arctic Vegetation Observatory Network (AVON).Our research emphasizes the diversity of major vegetation types, both zonal and azonal, reflecting a range of environmental conditions, disturbances, and changes over time. We advocate for the Braun-Blanquet units as a universal system for vegetation classification that can be applied globally while also considering the structural and textural characteristics of plant communities. This approach is crucial for understanding microclimatic properties, the ecological roles of species, and mapping vegetation effectively. It indicates that vegetation structure should be a key component in developing a universal phytosociological system alongside floristic criterion.

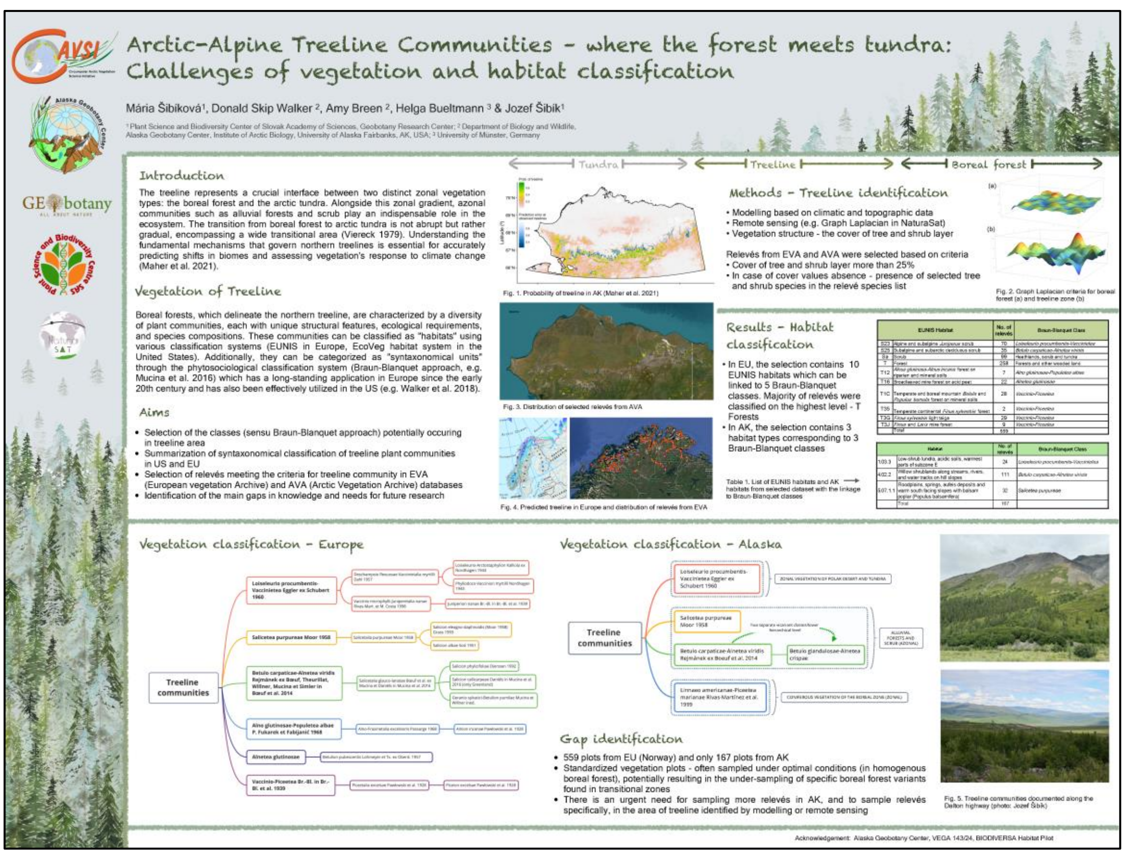


ARCTIC-ALPINE TREELINE COMMUNITIES — WHERE THE FOREST MEETS TUNDRA: CHALLENGES OF VEGETATION AND HABITAT CLASSIFICATION — MARIA ŠIBÍKOVÁ

Plant Science and Biodiversity Center of Slovak Academy of Sciences, Bratislava, Slovakia

COAUTHORS: Skip Walker, Amy Breen, Helga Bueltmann, Jozef Sibik | **FORMAT:** Poster in-person

ABSTRACT: The treeline represents a crucial interface between two distinct zonal vegetation types: the boreal forest and the arctic tundra. Alongside this zonal gradient, azonal communities such as alluvial forests and scrub play an indispensable role in the ecosystem. The transition from boreal forest to arctic tundra is not abrupt but rather gradual, encompassing a wide transitional area. Understanding the fundamental mechanisms that govern northern treelines is essential for accurately predicting shifts in biomes and assessing vegetation's response to climate change. Boreal forests, which delineate the northern treeline, are characterized by a diversity of plant communities, each with unique structural features, ecological requirements, and species compositions. These communities can be classified as "habitats" using various classification systems (EUNIS in Europe, EcoVeg habitat system in the United States). Additionally, they can be categorized as "syntaxonomical units" through the phytosociological classification system (Braun-Blanquet approach) which has a long-standing application in Europe since the early 20th century and has also been effectively utilized in the US. This syntaxonomical classification relies on standardized vegetation plots, facilitating comparative analyses across continents. However, it is noteworthy that vegetation scientists often sample under optimal conditions, potentially resulting in the under-sampling of specific boreal forest variants found in transitional zones. This study aims to consolidate current knowledge on the habitats and syntaxonomical classification of treeline forest communities in both Europe and the US, while also identifying gaps and research needs for future exploration.

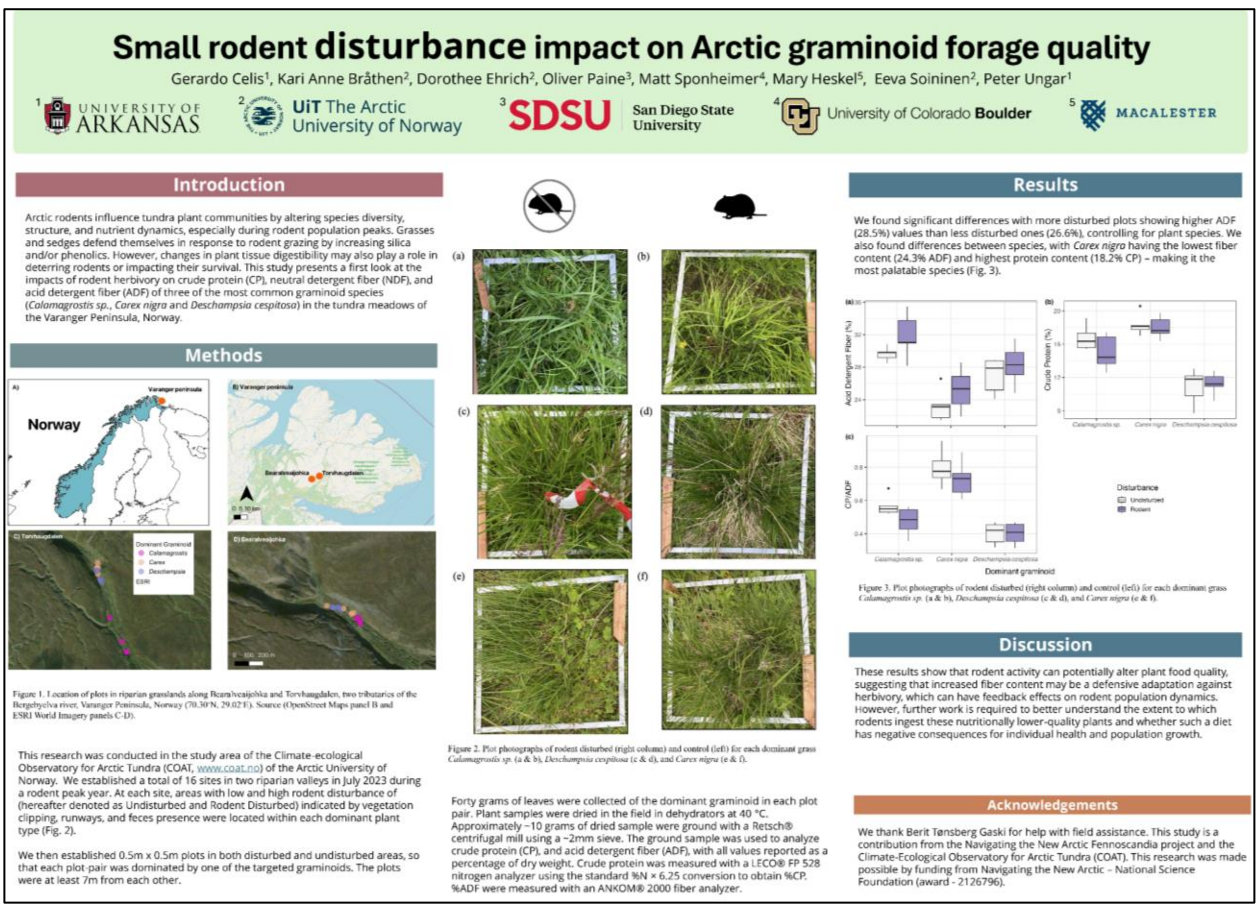


SMALL RODENT DISTURBANCE IMPACT ON ARCTIC GRAMINOID FORAGE QUALITY — MATT SPONHEIMER

University of Colorado at Boulder, USA

COAUTHORS: Gerardo Celis, Kari Anne Bråthen, Dorothee Ehrich, Oliver Paine, Mary Heskel, Peter Ungar | **FORMAT:** Poster in-person

ABSTRACT: Arctic rodents influence tundra plant communities by altering species diversity, structure, and nutrient dynamics. These dynamics are intensified during rodent population peaks. Grasses and sedges are well known to defend themselves in response to rodent grazing by increasing silica and/or phenolics. However, changes in plant tissue digestibility may also play a role in deterring rodents or impacting their survival. This study presents a first look at the impacts of rodent herbivory on crude protein (CP), neutral detergent fiber (NDF), and acid detergent fiber (ADF) of three of the most common graminoid species (*Calamagrostis* sp., *Carex nigra* and *Deschampsia cespitosa*) in the tundra meadows of the Varanger Peninsula, Norway. We created 32 experimental plots representing both rodent-disturbed and adjacent, undisturbed graminoid patches. During a rodent population peak, we found significant differences due to intensified rodent activity, with more disturbed plots showing higher ADF (28.5%) values than less disturbed ones (26.6%), controlling for plant species. We also found differences between species, with *Carex nigra* having the lowest fiber content (24.3% ADF) and highest protein content (18.2% CP) – making it the most palatable species. These results show that rodent activity can potentially alter plant food quality, suggesting that increased fiber content may be a defensive adaptation against herbivory.



INTERNATIONAL TUNDRA EXPERIMENT (ITEX) PHENOCAM SYNTHESIS: IMAGE PROCESSING AND DATA ANALYSIS WORKFLOW — CRAIG E. TWEEDIE

University of Texas El Paso, USA

CO-AUTHORS: Katherine I. Young, Sergio A. Vargas, Victoria Villagomez, Daniel Cruz, Tabatha Fuson, Santiago Hoyos Echeverri | **FORMAT:** Poster in-person

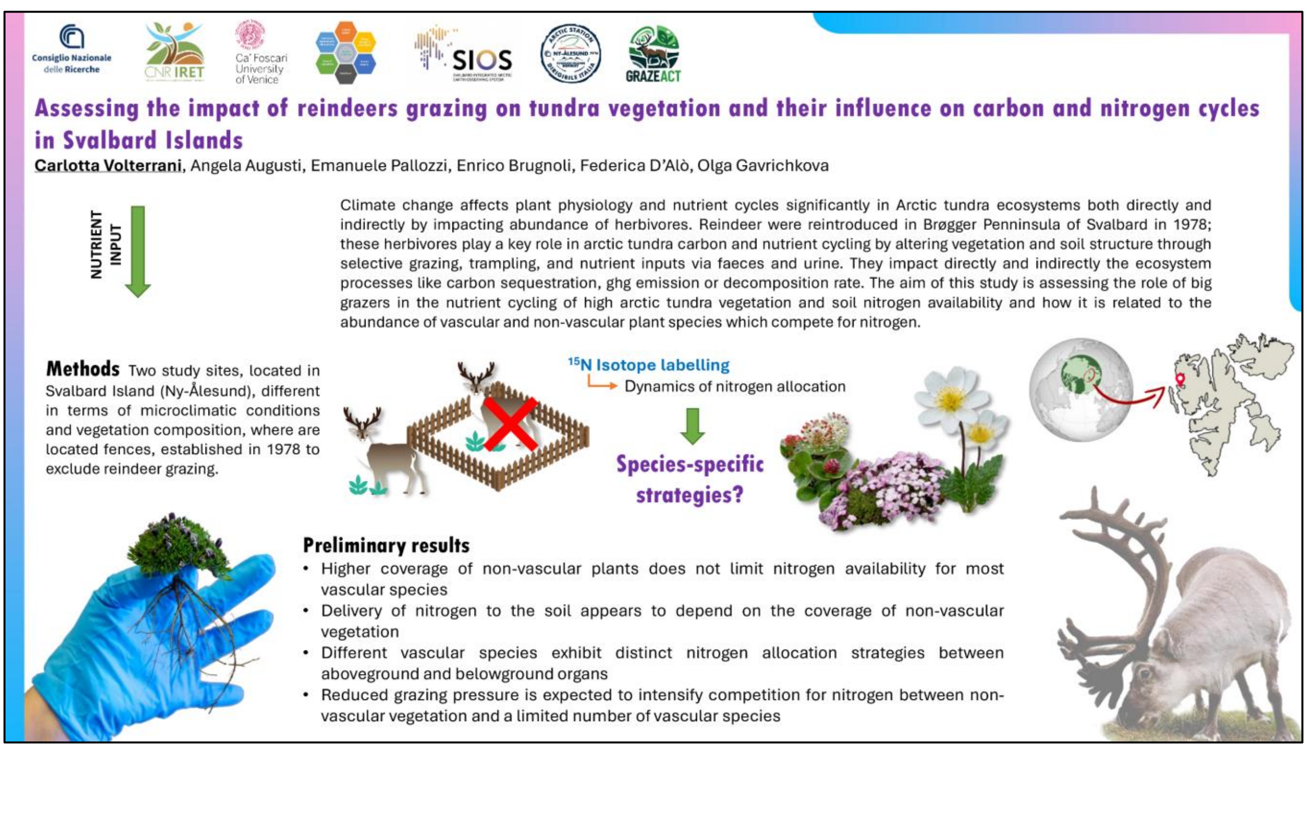
ABSTRACT: Arctic tundra is undergoing changes in satellite-derived “greening” and “browning” trends, reflecting a complex landscape-scale vegetation response to Arctic Change. Plant phenology is sensitive to climate variability and is recognized as an important indicator of ecosystem change. Repeat photography using affordable digital cameras (Phenocams) has emerged as an effective, low-cost tool for monitoring phenological changes in arctic tundra ecosystems. Here we present our workflow for acquiring and synthesizing phenocam data from over 200 arctic tundra sites to address broad research questions focused on 1) variation in the onset and peak of the growing season, 2) shifts in tundra seasonality due to climate change and extreme events, 3) differences in phenological seasonality across plant communities and vegetation types, and 4) correlation between near surface and remotely sensed phenological measurements. Our workflow integrates streamlined data sharing, storage, processing, and analysis using high performance computing (HPC) and local workstations. We utilize multiple software resources (Python, R, Futura, Phenocamanalyzer—an in-house analytical software—and custom image classification code) for image processing, automated quality control, and time-series analysis. This flexible procedure accommodates diverse research questions and scales, from landscape to plot-level and vegetation community analyses. Images, metadata, and analytical deliverables will be shared and managed through our University of Texas El Paso team. This effort is being coordinated through the International Tundra Experiment.

ASSESSING THE IMPACT OF REINDEERS GRAZING ON TUNDRA VEGETATION AND THEIR INFLUENCE ON CARBON AND NITROGEN CYCLES IN SVALBARD ISLANDS — CARLOTTA VOLTERRANI

Cà Foscari University of Venice, Mestre, Italy

COAUTHORS: Angela Augusti, Emanuele Pallozzi, Enrico Brugnoli, Federica D'Alò, Olga Gavrichkova | **FORMAT:** Oral in-person

ABSTRACT: Climate change impacts plant physiology and the carbon (C) and nitrogen (N) cycles in Arctic ecosystems, which contain about 50% of the world's underground organic carbon. The Arctic tundra is experiencing significant changes due to global warming and permafrost thaw, leading to increased CO_2 and CH_4 emissions. Herbivores, like reindeers, play an important role in these dynamics by influencing vegetation structure and composition, thereby altering the C and N cycles through grazing and soil modification. Because reindeer populations experience considerable fluctuations with changing climate, understanding the role of grazing in Arctic tundra dynamics is essential for predicting the ecological responses to climate change in the Arctic. This study investigates the effects of reindeer grazing on the tundra by comparing areas with and without big grazers (through fences) on Svalbard Islands. It focuses on the interaction between grazing, plant composition, microbial activity, and C and N cycles. A multifaceted methodological approach includes alongside vegetation monitoring, its functional performance with CO_2 flux measurements, elemental and isotopic analysis under natural abundance to characterize water use efficiency and nutrients cycling ($\delta^{13}C$, $\delta^{15}N$) and isotope labeling to track N allocation dynamics. The aim is to clarify how grazing influences the Arctic carbon balance and its long-term consequences for climate and land management. By understanding the complex interactions between vegetation, soil, and herbivores, the findings will improve climate models and support efforts to mitigate climate change impacts through better land management practices.

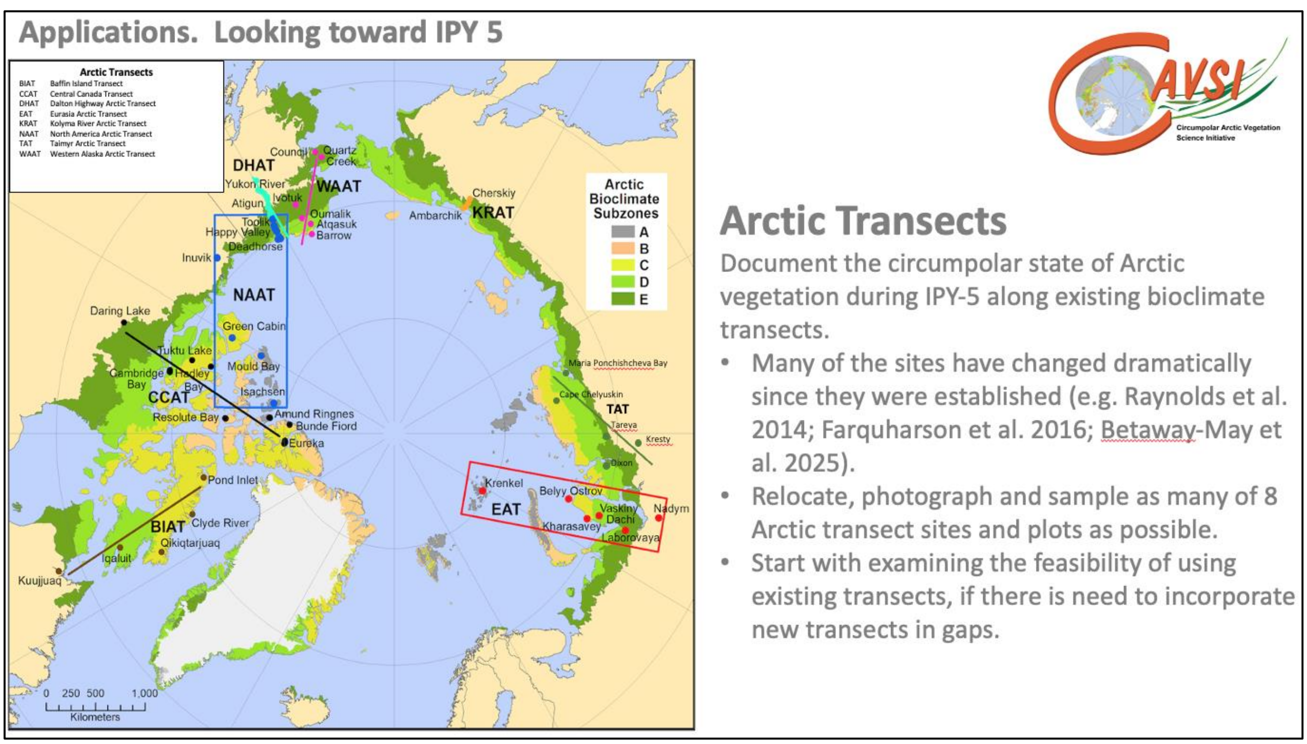


CIRCUMPOLAR ARCTIC VEGETATION SCIENCE INITIATIVE (CAVSI) — DONALD A. WALKER

University of Alaska Fairbanks, USA

COAUTHORS: Martha Raynolds, Amy Breen, Helga Bültmann, Jozef Šibík, Howard Epstein, Gerald Frost, Ksenia Ermokhina, William MacKenzie, Nadezhda Matveyeva, Jana Peirce, Gabriela Schaepman-Strub, Craig Tweedie, Vitalii Zemlianskii, Marilyn Walker | **FORMAT:** Oral in-person

ABSTRACT: The goal of the Circumpolar Arctic Vegetation Science Initiative (CAVSI) is to organize the international community of Arctic vegetation researchers to address the critical vegetation-related priorities during the next decade, including the Fifth International Polar Year (IPY-5). CAVSI is a response to the needs of ICARP IV Research Priority Team 2: Observing, reconstructing, and predicting future climate dynamics and ecosystem responses. RPT 2 research topics will require ground-based Arctic vegetation data and maps to monitor, model, and predict the impacts of Arctic climate change and anthropogenic disturbances in a hierarchy of spatial scales. A primary task of the workshop was to draw on the interdisciplinary expertise of over 80 participants to develop a CAVSI White Paper that will include plans and tasks for: (1) a CAVSI Organizing Group; (2) an Early Career Arctic Vegetation Scientist (ECAVS) group; (3) an Arctic Vegetation Observing Network (AVON); (4) protocol manuals for species lists and local floras; vegetation sampling; archiving and classifying vegetation and environmental data; and mapping vegetation. Future frontiers of Arctic vegetation science include applications of drone-based images, hyperspectral data, LiDAR, and AI-assisted methods of pattern recognition for mapping; and bar-coding and e-genomic methods for species identification in present-day and paleo ecosystems. Possible CAVSI projects for IPY-5 include: (1) more detailed mapping of regional Arctic Biomes defined by climate, substrate, and regional topography, (2) mapping important boreal areas adjacent to the Arctic, including boreal-alpine connections, and oceanic-boreal tundra areas, and (3) revisiting legacy long Arctic transects.

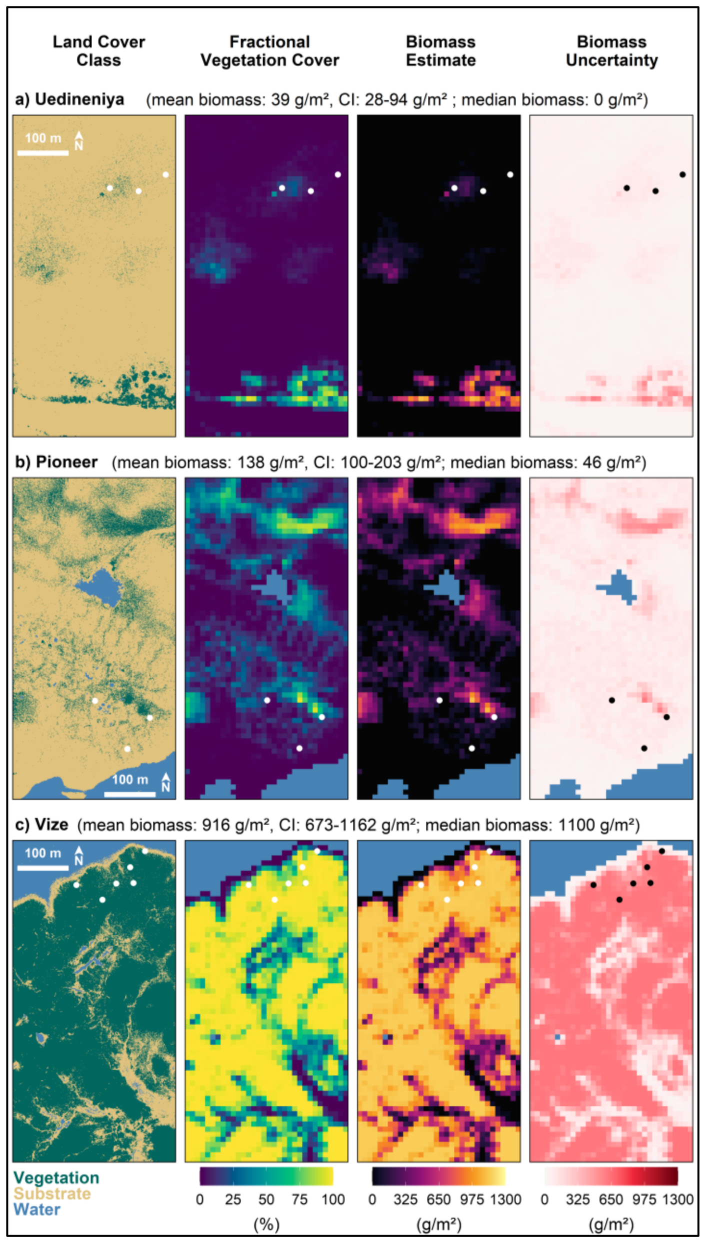


ARCTIC POLAR DESERTS: BASELINES TO STUDY CHANGE AT THE NORTHERN EDGE OF PLANT LIFE — VITALII ZEMLIANSKII

University of Zürich, Switzerland

COAUTHORS: Ksenia Ermokhina, Nils Rietze, Ramona Heim, Jakob Assmann, Gabriela Schaepman-Strub | **FORMAT:** Oral in-person

ABSTRACT: Arctic polar deserts make up the northernmost terrestrial biome located mainly on Arctic islands. They are characterized by near-zero summer temperature, patchy vegetation primarily consisting of cryptogams, and low diversity. Due to ongoing Arctic amplification, polar deserts are expected to shrink, giving place to continuous tundra vegetation and leading to changes in permafrost insulation, carbon storage and biodiversity. The study of polar desert biomass is important due to its high sensitivity to climate driven changes, yet we lack baselines as monitoring in these environments is challenging. Lack of ground truth data, high landscape heterogeneity, and vegetation patchiness create methodological difficulties for biomass quantification. We show that vegetation cover but not NDVI is a useful predictor for plant and lichen biomass and emphasize the need to combine in-situ data with drone imagery to accurately estimate biomass of polar deserts. The cover-based approach helps establish baselines for biomass, but gaps in monitoring of plant diversity remain. In contrast to most other terrestrial ecosystems, vascular plants play a relatively minor role in polar deserts, while cryptogams make up most of their diversity. Despite the importance of polar islands as potential future climate refugia for climate-threatened Arctic species, differences in diversity and their underlying factors are not fully understood as the islands vary in size, relief, and history. We estimate the diversity of the polar islands and its drivers, providing ground-truth geobotanical data for some of the most understudied parts of the Russian Arctic such as Vize, Uedineniya Islands and Severnaya Zemlya.



Vegetation cover is a better predictor for plant and lichen biomass than NDVI across our 3 study sites.

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APPENDIX
CAVSI WORKSHOP CONTRIBUTIONS BY RUSSIAN VEGETATION SCIENTISTS

RUSSIAN ARCTIC GEOBOTANY: DATA, CLASSIFICATION, AND MAPPING — KSENIA ERMOKHINA

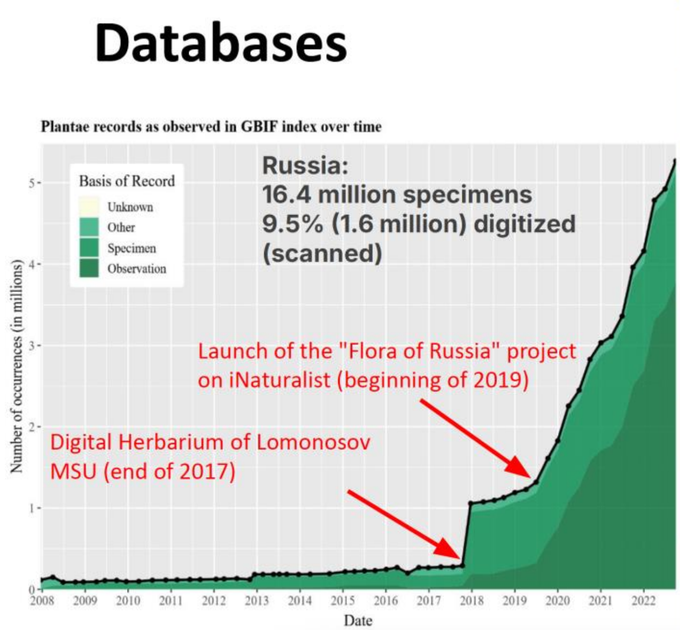
Institute of Ecology and Evolution, Russian Academy of Sciences, Moscow, Russia

COAUTHOR: A.N. Severtsov | **FORMAT:** Oral virtual during Panel 5: Sampling and archiving protocols for Arctic plot data

ABSTRACT: This presentation outlines the recent advances and current challenges in Russian Arctic geobotanical research, emphasizing data compilation, vegetation classification, and mapping efforts. A significant milestone is the digitization of over 1.6 million herbarium specimens in Russia, led primarily by Moscow State University (MSU) and the Komarov Botanical Institute (MSU 2025). National-scale efforts like the AVA-Russia (AVA-RU) database now host over 2,800 open-access geobotanical plots and nearly 2,000 restricted-access plots, spanning observations from 1927 to 2022 (Zemlianskii et al. 2023).

The development of a common species list (PASL) highlights ongoing difficulties in unifying Russian, boreal, and plant functional type (PFT) classifications. For Arctic vegetation classification, the use of Braun–Blanquet approaches paired with machine learning techniques such as t-SNE (T-distributed Stochastic Neighbor Embedding) provides new ways to visualize ecological gradients and groupings of vegetation classes.

These advances support the broader goals of pan-Arctic vegetation monitoring and the integration of Russian data into international frameworks. Continued efforts in digitization, taxonomy harmonization, and ecological modeling are crucial for improving vegetation classification and understanding ecological responses to environmental change across the Arctic biome.



Organization	Code	Number	%
Moscow, Moscow State University (MSU)	MW	1 015 242	94%
St. Petersburg, Komarov Botanical Institute RAS (BIN RAS)	LE	141 253	2%
Moscow, Main Botanical Garden of the RAS (GBS RAS)	MHA	106 627	17%
Novosibirsk, Central Siberian Botanical Garden of the SB of the RAS (CSBG SB RAS)	NS+NSK	80 232	11%
Vladivostok, Botanical Garden-Institute of the FEB of the RAS (BSI FEB RAS)	VBGI	46 022	35%
Irkutsk, Irkutsk State University (IGU)	IRKU	42 154	32%
Barnaul, Altai State University (ASU)	ALTB	39 905	13%
Yekaterinburg, RAS (RAS)	SVER	38 873	30%
Kemerovo, Kuzbass Botanical Garden of the RAS (KuzBS RAS)	KUZ	19 014	34%

Status of records in Global Biodiversity Information Facility (GBIF 2025) and digital specimen collections of the major herbaria in Russia.

LOCAL FLORA STUDIES AND SELECTED BIBLIOGRAPHY OF RECENT RESEARCH ON FLORA AND VEGETATION IN THE RUSSIAN ARCTIC — OLGA KHITUN

Komarov Botanical Institute of the Russian Academy of Sciences, St. Petersburg, Russia

COAUTHORS: Ksenia Ermokhina, Tatiana Koroleva, Michael Telyatnikov, Andrej Zverev, Svetlana Chinenko, Irina Czernyadjeva, Vladislav Petrovsky | **FORMAT:** Oral in-person during Panel 4: Pan-Arctic Species List and local floras

ABSTRACT: This presentation introduces the local flora (LF) method and highlights the extensive body of research conducted on LFs across the Russian Arctic. We emphasize the utility of LFs for floristic subdivision, biodiversity monitoring, and vegetation regionalization. Originally developed by A.I. Tolmatchev in the 1930s, the LF approach involves comprehensive floristic surveys within defined landscape units. These surveys allow detailed assessments of species richness, phytogeographic composition, and spatial patterns.

The Russian Local Floras Database now includes more than 325 LFs, organized using the Integrated Botanical Information System (IBIS; Zverev 2009, 2012). IBIS, similar in scope to the TURBOVEG program (Hennekens and Schaminée 2001), goes beyond data storage by enabling advanced table processing for comparative floristics, biodiversity and taxonomic indices, indicator values, and ecological contingency analysis. IBIS is also compatible with TURBOVEG and the JUICE software for vegetation classification (Tichý 2002), allowing streamlined data exchange.

We further present a summary of recent research on the flora and vegetation of the Russian Arctic. This includes the digitization status of major herbarium collections, newly published checklists, taxonomic revisions, and moss and lichen floras. To support Arctic vegetation science and initiatives like the Arctic Vegetation Archive (AVA) and Classification (AVC), we provide a partially annotated bibliography of relevant recent publications.

How can we use local flora data in the AVA?

No direct use for classification, but it is valuable for:

- **Estimating regional biodiversity,**
- **Identifying hotspots,**
- **Selecting localities for future research,**
- **Providing general information about vegetation, and**
- **Offering indications for targeted studies of specific vegetation types.**

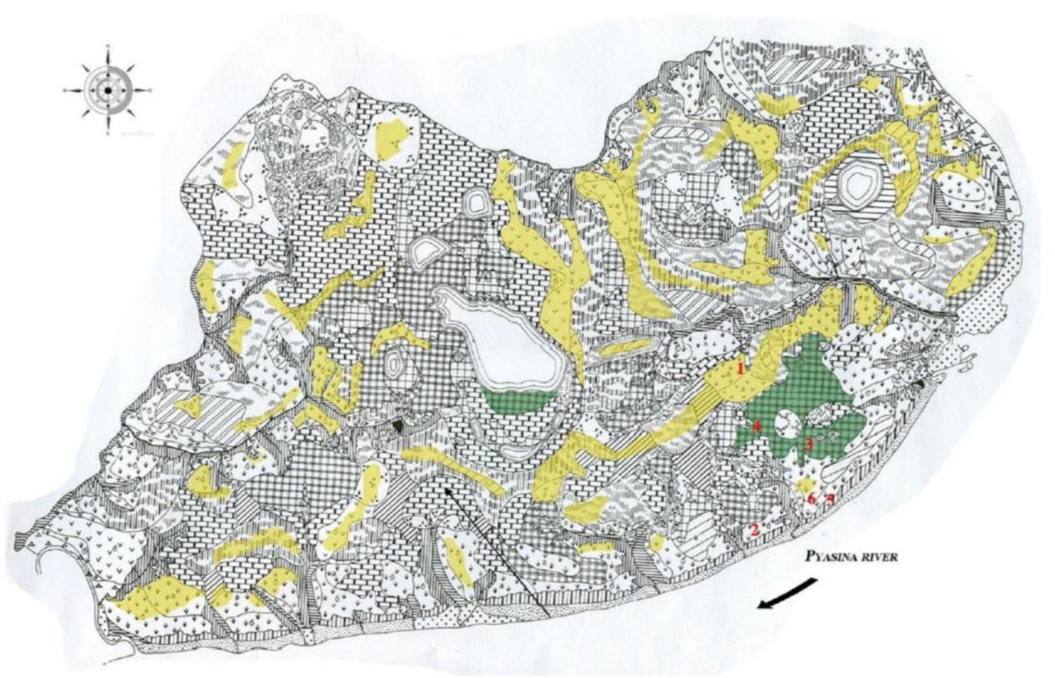
- **Use of old relevés is possible, but it is extremely time-consuming, as all cryptogam vauchers, and even some vascular plants need to be rechecked.**
- **Published LF data is widely used in various datasets and has also served as a source for herbarium collections.**
- **The network of local floras has been extensively used to study various parameters of flora, such as species richness and the representation of different phytogeographical groups. Additionally, this data has been applied for regionalization purposes.**

PLANT COVER STABILITY IN UNSTABLE LANDSCAPE: TAREYA FORTY YEARS LATER — NADEZHDA MATVEYEVA

Komarov Botanical Institute of the Russian Academy of Sciences, St. Petersburg, Russia

FORMAT: Abstract sent to CAVSI workshop

ABSTRACT: A phytosciological re-study in 2010 at the Tareya site (western Taymyr Peninsula), where the Biogeocenological Station operated in 1965-77, leads to the finding that plant cover is stable with the vascular plant species and communities belonging to the same associations to which they were previously assigned (Matveyeva 2024). The striking finding is that only minor changes in flora and vegetation are recorded against the background of spectacular transformation of the important landscape parts, including: (1) the appearance of mound-trench systems (high-center polygons of different height and size and troughs of various width and depth) in new polygonized watersheds in some areas; and (2) in other areas where surface leveling (elimination of polygon rims) occurred in polygonal mires. This third polygonal system is in addition to two previously described polygon systems in concave portions of the landscape (mires in lake depressions and mire-tundra complexes in the upper stream reaches. These new changes formed no earlier than 1994 but before 2003. So far, the plant cover in troughs and on subsiding rims is not changed compared to previously flat surfaces in the first case and concave polygon centers in the second. Potentially, the presence of the trench system may strengthen the hydrological cycle through higher soil water flow; however, the development of drainage network will decrease the amount of moisture in watersheds. Similarly, without rims, previously standing water on polygons, being no longer isolated, became drained, which increased the total flow. The formation of the polygonal system on watersheds, may continue, which will gradually lead to radical transformation of the Arctic landscape and its vegetation on plains.



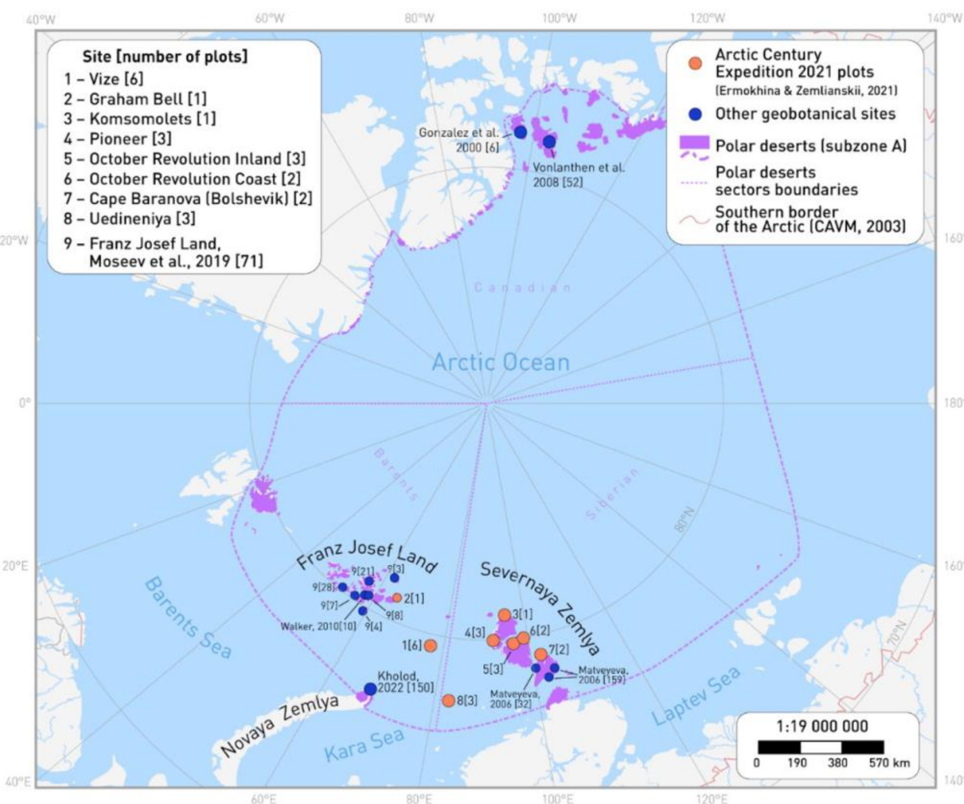
Vegetation map (see Matveeva 1978) of the Tareya study area. Areas with polygonization of watersheds in 2010 are shown in yellow. Former rim-polygonal mires, where the rims are partially or completely gone, are shown in green. The remaining area of the landscape was unchanged in 2010 compared to 1965-77.

RUSSIAN ARCTIC VEGETATION ARCHIVE UPDATE — VITALII ZEMLIANSKII

University of Zürich, Switzerland

COAUTHORS: Ksenia Ermokhina, Gabriela Schaepman-Strub | **FORMAT:** Oral in-person during Panel 5: Sampling and archiving protocols for Arctic plot data

ABSTRACT: The Russian Arctic Vegetation Archive (AVA-RU) represents an essential foundation for understanding patterns of plant diversity and biomass across Arctic ecosystems (Zemlianskii 2023). This presentation provides an update on the AVA-RU, which now includes 4,695 standardized vegetation plots compiled between 2019 and 2023. Recent contributions include 274 newly standardized plots from Polar Desert regions, integrating data from the Arctic Century Expedition (21 plots; Ermokhina & Zemlianskii 2021), Franz Josef Land (71 plots; Moseev et al. 2019), Novaya Zemlya (150 plots; Kholod & Konoreva 2022), and Bolshevik Island (32 plots; Matveyeva 2006). These datasets enable improved modeling of Arctic vegetation structure, diversity, and ecosystem functioning. Plans for further integration include vegetation plots from the Kytalyk reserve, the Western Siberian forest-tundra and boreal zone, and mountain tundra regions across Siberia. The team highlights the need for digitizing legacy datasets, including those from Chukotka (102 plots; Sumina 1994), and exploring the potential use of local floras. Key recommendations include publishing a dedicated paper on Arctic vegetation survey protocols, expanding taxonomic coverage to include bryophytes and lichens, and ensuring international backup of data resources. This effort contributes significantly to the Arctic Vegetation Archive and Classification initiatives.



Recent contributions to the AVA-RU from the Arctic Century Expedition and other sites compiled for the Polar Desert Plant Diversity Project that includes data from AVA-AK and plots previously archived in AVA-RU (Zemlianskii In prep).

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This checklist includes 730 species and 13 additional infraspecific taxa with references on their distribution in eleven floristic regions: Wrangel Island –286 species, Western Chukotka–267 species, Continental Chukotka –272 species, Southern Chukotka –384 species, Beringian Chukotka –434 species, Magadan Region –435 species, N. Koryakia–178 species, Khabarovsk Territory, northern part –219 species, S. Koryakia–152 species, Kamchatka –572 species, Commander Islands –336 species.

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New checklist! The monotypic species concept is consistently followed. Species and interspecific hybrids (notho-species) are distinguished. Very closely related taxa are grouped into species aggregates. The generic concept of the Catalogue of Life (COL) is accepted. Classification is modern as it is based on recent advances in systematics from molecular studies.

Chepinoga, V., A. Seregin, V. Barkalov, A. Ebel, P. Efimov, N. Friesen, A. Gontcharov, (...) and V. Troshkina. 2023. New combinations and new names in vascular plants of Asian Russia. *Botanica Pacifica* 12(2):120–133.

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This is an annotated checklist with 156 species; 18 of which are new for the archipelago. The more interesting records are *Arctoa anderssonii*, *Pohlia beringiensis*, *Schistidium abrupticostatum*, and *Schistidium andreaeopsis*.

Czernyadjeva I. V., A. D. Potemkin, and E. I. Troeva. 2021. Mosses and liverworts of Stolbovoy Island (New Siberian Islands Archipelago, Yakutia). *Novitates Systematicae Plantarum non Vascularium* 55(2):439–467.

This is also an annotated checklist which includes 140 species of mosses and 58 species of liverworts. For the first time, 119 species of mosses and 54 species of liverworts were revealed for Stolbovoy Island.

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This annotated list includes 173 species: including one moss variety and 52 species and nine infraspecific taxa of liverworts. The liverworts include the insufficiently known taxa *Blepharostoma trichophyllum* hybrid 1, *Barbilophozia rubescens*, *Saccobasis polita* var. *arctica*, and *Trilophozia quinquedentata* var. *grandiretis*.

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This is a 6-Volume set; Volume 5 should be published in 2025. The moss flora is based on integrative molecular and morphological studies.

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* *This bibliography is drawn primarily from Olga Khitun's presentation. All annotations are hers.*