Workshop Report to the IASC Secretariat

Second International Arctic Vegetation Archive Workshop

An IASC Terrestrial Working Group
and CAFF Flora Group Workshop

Czech Academy of Science Building

Národní 1009/3, Praha 1, Room 206
Prague, Czech Republic
30-31 March 2017

By

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Arctic Vegetation
Archive and Classification Workshop

Czech Academy of Science Building

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IASC NASA CAFF Flora Group

Institute of Arctic Biology University of Alaska Fairbanks

Alaska Geobotany Center

www.geobotany.uaf.edu/ava

Agenda

Thursday 30 March: Overview

Morning: Welcome, goals for the workshop, keynote talks, progress in Alaska Facilitator – Skip Walker

08:00 Welcome, introduction of participants: *Skip Walker*
08:10 Logistics: *Jana Peirce*
08:20 Why an Arctic vegetation classification? *Marilyn Walker*
08:40 Review of history and progress on the AVA and AVC, goals for workshop: *Skip Walker*
09:00 The European Vegetation Archive (EVA), EuroVegChecklist, and possibilities for contributing AVA data to the EVA: *Milan Chytrý*
09:30 Turboveg and recent advances: *Stephan Hennekens*
09:50 JUICE v.7: A complex expert system language for vegetation classification: Lubomir Tichý Milan Chytrý, Flavia Landucci
10:10: Coffee Break
10:30 Discussion of EVA, TurboVeg, JUICE
10:50 The Alaska AVA (AVA-AK): *Amy Breen*, *Lisa Druckenmiller, Stephan Hennekens, Skip Walker et al.*
11:10 The Canadian Geobioclimate Ecosystem Classification (BEC) approach: *William MacKenzie*
11:30 Lunch

Afternoon: Progress in Canada, Greenland, Russia and maritime boreal tundra, discussion Facilitator: Amy Breen

12:30 Overview of the AVA in Canada: *Will MacKenzie, Esther Levesque, Greg Henry, Dietbert Thannheiser, Fred Daniëls*
12:50 Overview of the AVA in Greenland: *Fred Daniëls & Helga Bültmann*
13:10 Overview of the the AVA in Russia: *Nadya Matveeva, Natalia Koroleva, Olga Lavrinenko & Igor Lavrinenko*, *Ksenia Ermokhina, Olga Khitun*, *Sergei Kholod & Volodya Razzhivin, Elena Troeva, Gabriella*
13:40 Maritime boreal tundra Overview: *Starri Heiðmarsson, Inga Svala Jónsdóttir, Lennart Nilsen, Dietbert Thannheiser, Stephan Talbot*
14:00 Breakout groups to prepare map of databases in each floristic subprovince
15:00 VegBank and the US National Vegetation Classification: *Bob Peet*
15:30 Discussion (Potential questions)

1. How to exchange data between the Canadian (VPro), USNVC (VegBank)
2. EVA (TurboVeg v.3) and the AVA-AK (TurboVeg v.2)?
3. Should we plan a TurboVeg and JUICE AVA training workshop? How to fund?
4. How to standardize all the databases and bring them into the AVA?
5. How to keep the PAF and species lists updated? (Also on agenda for 31 Mar)

16:00 ADJOURN (need to be out by 16:00)

Friday 31 March: Where to from here?

Morning: "Reflections", "Looking ahead", classification, local floras, biodiversity studies
Facilitator: Jozef Šibík

09:00 Welcome back and logistics, travel reimbursements: Jana Peirce

09:10 Panel Discussion 1: Reflections on the realization of an international pan-Arctic vegetation classification: *Marilyn Walker, Fred Daniëls, & Nadya Matveyeva*

09:50 Panel Discussion 2: Looking ahead to application of the AVA to the Arctic Vegetation Classification: *Marilyn Walker, Fred Daniëls, Nadya Matveyeva, Jozef Šibík, & Will MacKenzie*

10:30 Coffee Break

10:45 Panel Discussion 2: Looking ahead (cont.): Questions to address

Progress on an Alaska Arctic vegetation classification using the AVA-AK: *Jozef Šibík*

Plan toward a circumpolar AVA: *Amy Breen, Lisa Druckenmiller, Nadya Mateveeva, Will MacKenzie, Ksenia Ermokhina, Skip Walker & Jozef Šibík*

What are the big problems with bringing other datasets into the AVA? Where should we start? Can we proceed without dedicated funding? *Skip Walker*

The concept of Arctic local floras and can we apply it more widely? *Olga Khitun*

12:00 Lunch & view posters and further discussion of classifications (wine & beer)

Afternoon: Advancing the AVA and AVC in the IASC Science Plan, Publications, Proposals – Facilitator: Skip Walker

14:00: Discussion of how to elevate the AVA and AVC in the IASC Science Plan: *Skip Walker, Kristine Westergaard, Inga Svala Jónsdóttir, Inger Alsos, other CAFF FG participants,*

1. Closer coordination and some shared research items between the CAFF FG floristics and vegetation folks.
2. Coordination between CAFF FG and IASC TWG.
3. Advance the priority FG research items in the IASC Science Plan.
4. Advance IASC Science plan in national Arctic research plans.

14:30: Publications:

1. CAFF Workshop Proceedings volume: *Jana Peirce*
2. AVC-AK: *Jozef Šibík*
3. AVC paper for *Vegetation of Russia: Skip Walker & Nadya Matveyeva*
4. Others Arctic classification papers in press or in preparation?

14:50: Ideas and proposals for developing the national Arctic Vegetation Archives:

U.S.: *Skip Walker & Amy Breen*

Canada: *Will MacKenzie,* et al.

Greenland: *Fred Daniëls & Helga Bültmann*

Russia: *Nadya Matveyeva* et al.

Boreal maritime tundra: *Anna Marie Fosaa* et al.

15:20: **Summary of action items, review Krakow resolution, and wrap up:** *Jana Peirce*

15:50: Travel reimbursement logistics: *Jana Peirce*

16:00: ADJOURN (need to be out by 19:00)

Workshop Summary Report

Summary statement

An Arctic Vegetation Archive (AVA) is essential for developing an Arctic Vegetation Classification (AVC) and is needed for a variety of international Arctic initiatives that involve Arctic vegetation information. The AVA will gather vegetation and environmental data from approximately 31 000 legacy vegetation plots into a standardized format for vegetation classification and analysis. The primary goal is to develop a strategy for each country to assemble its own archive with common protocols that will later allow the databases to be united into a single AVA using TurboVeg v3 and then use JUICE software to create a Pan Arctic vegetation classification. Twenty-nine individuals from most of the Arctic countries participated the two-day workshop at the Czech Academy of Science Building in Prague, Czech Republic, 30-31 April 2017Several overview and keynote talks set the stage. We reviewed the datasets and plots that are available for each of the floristic provinces in each circumpolar country. Discussions focused on the exchange of data between different database approaches, reflections on the realization of a pan-Arctic vegetation classification, steps still needed to achieve the AVC, and how to elevate goals of the workshop in the IASC 5-year Science Plan. One related talk and five posters were also presented during Science Session 13.1 "Arctic Data and Information Science meet System Science". At the end of the meeting, the assembled members resolved to accomplish the following within 5 years: (1) Promote the updating, and maintenance of the Panarctic Flora (PAF) and the Arctic lichen, moss, and hepatic checklists as a panarctic standard for plant nomenclature. (2) Develop a checklist of existing described Arctic vegetation habitat and vegetation types according the European Vegetation Classification approach (an Arctic prodromus). (3) Secure funds for completing the AVA and AVC. (4) Develop and use standardized plot-data collection and archiving methods modeled after the European Vegetation Archive and the Alaska Arctic Vegetation Archive. (5) Modify the existing vector-based Circumpolar Arctic Vegetation Map to a raster-based format with 12.5-km resolution, and incorporate modifications based on new knowledge. (6) Develop a funding strategy to complete the Circumboreal Vegetation Map (CBVM) and link it to the Circumpolar Arctic Vegetation Map (CAVM) with a revised treeline, and a raster format. (7) Work with the Arctic Data Center (ADC) to develop data-sharing methods and rules for Arctic vegetation data. (8) Facilitate and promote the application of AVA, AVC, CAVM, and CBVM to the Arctic research community, land managers, and policy makers. (9) Contribute to training a new generation of young professional Arctic botanists and vegetation scientists through international field courses at the University of the Arctic and the Association of Polar Early Career Scientists (APECS). (10) Finally we resolved to meet again at Arctic Science Summit Week 2019 in Arkhangelsk, Russia.

Introduction

An Arctic Vegetation Archive (AVA) is needed to develop an effective Arctic terrestrial monitoring program and provide a standardized vegetation framework and data for an Arctic Vegetation Classification (AVC), land-cover mapping, ecological experiments, modeling, and biodiversity studies. Insufficient and non-standardized Arctic vegetation plot data are available to accomplish this task. The recently launched AVA and AVC aim to fill this knowledge gap.

The AVA and AVC would cover the entire Arctic tundra biome, the first for any of the world's major biomes. This is achievable because the Arctic is the only biome that has its entire list of known vascular plants, mosses and lichens documented in up-to-date flora checklists developed by taxonomists within the CAFF Flora Group. Also the amount of vegetation plot data from the Arctic is still relatively modest compared to other biomes (approximately 31,000 plots). A large body of international experience and collaboration with database experts in other regions will also help to make the Arctic task feasible.

Goals of the Workshop:

- Development of an international vegetation database useful for addressing a wide variety of pressing science questions that involve vegetation information, including making a panarctic vegetation classification
- Locating and preserving legacy vegetation data sets from all the circumpolar countries that are in danger of being lost
- Creation of an international framework for future studies of vegetation change
- Harmonization of the North American and European approaches for archiving and classifying Arctic vegetation

Relevance to IASC:

- A central resource for vegetation information that could be used in a wide variety circumpolar biodiversity, habitat, and vegetation-change modeling studies
- A standardized vegetation data set necessary for developing a Circumpolar Arctic Vegetation Classification and a wide variety of biodiversity and modeling studies involving vegetation data
- A baseline resource for examining Arctic vegetation change
- An archive of vegetation and environmental data that could be retrieved through a web-based data portal

Participants and talks

Twenty-nine people from most of the Arctic countries participated in the two-day workshop at the Czech Academy of Science Building in Prague, Czech Republic, 30-31 April 2017 (See Appendix A).

Marilyn Walker, who initiated the Arctic vegetation classification initiative (Walker et al. 1994), provided an historical overview and rationale for making an Arctic vegetation classification. The AVA and AVC are being modeled after the approach used in Europe. Milan Chytrý (Czech Republic) provided an update on the European vegetation archive and classification; Stephan Hennekens (the Netherlands) — an update on the Turboveg database management software; Lubomir Tichý (Czech Republic) — an update on the JUICE vegetation analysis software. Bob Peet (US) described the VegBank database and EcoVeg classification approach used in the United States (Peet et al. 2012). William MacKenzie (Canada) described the Biogeoclimate Ecosystem Classification (BEC: Pojar et al. 2011) approach used in British Columbia. Will MacKenzie (Canada), Fred Daniëls (Greenland), Nadya Matveeva (Russia), and Amy Breen (Alaska) provided overviews of recent AVA progress. Jozef Šibík (Slovak Republic) presented the approach and early results of the database analysis of the Alaska Arctic Vegetation Archive. And Olga Khitun (Russia) presented the Russian method of developing local floras. Abstracts by Amy Breen, Milan Chytrý, Ksenia Ermokhina, Starri Heiðmarsson, Stephan Hennekens, Olga Khitun, Will MacKenzie, Robert Peet, Jozef Šibík, Lubomir Tichý, Marilyn Walker, and Skip Walker are in Appendix B.

Major points emerging from the panel and group discussions

- An Arctic Vegetation Archive is an essential first step for developing an Arctic Vegetation Classification, monitoring change in terrestrial ecosystems, and developing a circumpolar framework for studying and modeling changes to the Arctic.
- Major progress on the AVA was achieved since the first AVA workshop in Krakow (Walker et al. 2013), including completion of the Alaska Arctic Vegetation Archive (AVA-AK; Walker et al. 2016), and recent efforts toward using this in developing an Arctic Vegetation Classification (Walker et al. 2016b, 2017 in review, Šibík et al. 2017 in prep.).
- Many of the legacy data in the AVA were collected using non-standardized protocols. Going forward, new datasets should incorporate standardized methodologies for surveys, archiving, and analysis of Arctic plot data; workshops to develop these protocols should probably be proposed as part of the Arctic Observing Network activities.
- The European Vegetation Archive (EVA: Chytry et al. 2012) and European Vegetation Classification (EVC: Mucina et al. 2016) are models for creating the AVA and AVC. The tools used in creating the EVA and EVC (Turboveg: Hennekens & Schaminée 2002; and JUICE: Tichy et al. 2017) are also being used for the AVA and AVC.

Considerable help from the European community of vegetation scientists is gratefully acknowledged.

- The AVA and AVC have been endorsed by IASC and the CAFF and remain high-priority international projects that are in need international funding to complete. Important issues include:
  - Periodically updated and maintained Pan-Arctic species lists are critical for both the AVA and AVC. An important question is should the PAF include the boreal species that occur in the maritime boreal tundra regions, which have been identified for inclusion in the AVA?
  - Standardized methods are needed for making local-floras and plot surveys for vegetation classification and monitoring, and should be part of the Arctic Observing Networks efforts for monitoring terrestrial ecosystems.
  - Special attention is also needed for collecting standardized, soil, and spectral data, biomass, and other forms of ancillary data from the same plots for other applications including mapping, modeling, biodiversity, and remote sensing studies.
  - Bringing the datasets from each Arctic country into a common database is a non-trivial task. Tools for exchanging information between different database approaches are under development (e.g., Veg-X, Wiser et al. 2011) but need to be applied to the Arctic situation.
- Other high-priority Arctic vegetation activities that are endorsed by both IASC and CAFF, but which are in need of international funding to complete, include:
  - Finishing the Circum-Boreal Vegetation Map (CBVM: Talbot and Meades 2011), and harmonizing it with the CAVM.
  - Updating the Circumpolar Arctic Vegetation Map to a raster format, including new information on tree-line boundaries, and otherwise improving the map from its original publication (CAVM Team 2003, Walker et al. 2005).
  - Vegetation classification, mapping and monitoring need to be highlighted as part of the IASC Terrestrial Working Group's input to the IASC 5-year science plan, and for the CAFF Flora Group's input into the Circumpolar Biodiversity Monitoring Program.
- The countries with the most plots nearly ready for inclusion in a panarctic AVA are Alaska, Canada, and Greenland. The next step should be to combine these in a North America Arctic Vegetation Archive and Classification.
- The leaders of the AVA and AVC are aging and leadership needs to be passed to a new generation of Arctic vegetation scientists. Therefore, there is a critical need to identify new leaders, and to train a new generation of Arctic vegetation scientists in the techniques of Arctic field botany and the new analytical tools of vegetation science.
  - A workshop is needed to train AVA participants in use of key software, including Turboveg v2 and v3 (Hennekens and Schaminée 2002) and JUICE v7, and for developing applications of the AVA.
  - Field and classroom courses in Arctic vegetation science need to be developed and promoted through IASC, the University of the Arctic, and the

Association of Polar Early Career Scientists (APECS), and other national Arctic education forums.
  - Exchange programs with European universities that have strong vegetation science programs would be most helpful.

Prague Arctic Vegetation Synthesis Resolution

A common Arctic vegetation language and data framework are needed to achieve several key aspects of the International Arctic Science Committee's (IASC's) five-year Science Plan, including:

- Assessing the diverse impacts of climate change and human activities on Arctic biodiversity and its consequences for ecosystem services and societal impacts.
- Linking studies across all spheres: biosphere, social sphere and the physical spheres of the Arctic;
- Supporting international efforts to make Arctic data and metadata easily accessible, such as the Sustainable Arctic Observing Network (SAON) and the Arctic Data Committee (ADC).
- Developing an international agreement for standards and maintenance of key observing systems.

Furthermore, such a vegetation framework is necessary to accomplish goals of the IASC Terrestrial Working Group (TWG), the Arctic Council's Conservation of Arctic Flora and Fauna's Flora Working Group (CFG), and the Circumpolar Biodiversity Monitoring Program (CBMP). These include such specific products as the Arctic Vegetation Archive (AVA), Arctic Vegetation Classification (AVC), Circumpolar Arctic Vegetation Map (CAVM), Circumboreal Vegetation Map (CBVM) and a hierarchical series of maps and data products that are needed for Arctic terrestrial land-surface characterization, climate- and land-cover change models, government land-use policy makers, and educators.

Therefore, the members of the community of Arctic Vegetation Scientists assembled at the ASSW 2017, resolve to accomplish the following within 5 years:

- Promote the updating, and maintenance of the Panarctic Flora (PAF) and the Arctic lichen, moss, and hepatic checklists as a panarctic standard for plant nomenclature;
- Secure funds for completing the Arctic Vegetation Archive (AVA) and developing an Arctic Vegetation Classification (AVC);
- Develop and use standardized plot-data collection and archiving methods modeled after the European Vegetation Archive and the Alaska Arctic Vegetation Archive;

- Develop a checklist of existing described Arctic vegetation habitat and vegetation types according the European Vegetation Classification approach (an Arctic prodromus);
- Modify the existing vector-based Circumpolar Arctic Vegetation Map to a raster-based format with 12.5-km resolution, and incorporate modifications based on new knowledge;
- Develop a funding strategy to complete the Circumboreal Vegetation Map and link it to the Arctic map with a revised treeline, and a raster format;
- Work with the Arctic Data Center (ADC) to develop data sharing methods and rules for Arctic vegetation data;
- Facilitate and promote the application of AVA, AVC, CAVM, and CBVM to the Arctic research community, land managers, and policy makers;
- Contribute to training a new generation of young professional Arctic botanists and vegetation scientists through international field courses at the University of the Arctic, and the Association of Polar Early Career Scientists (APECS);
- And finally we resolve to meet again at Arctic Science Summit Week 2019 in Arkhangelsk, Russia.

Signed by participants of the AVA and AVC workshop at ASSW, March 31 2017, Prague, CZ

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Appendix A. Participant List

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Appendix B: Abstracts of Talks

Introduction to the Circumpolar Arctic Vegetation Archive and Classification Workshop

Skip Walker
University of Alaska Fairbanks, Fairbanks, AK, USA

A uniform Arctic Vegetation Classification (AVC) is needed as a framework for a wide variety of international Arctic initiatives that involve vegetation information. An Arctic Vegetation Archive (AVA) is first needed to gather the information in a standardized format for analysis. Arctic Science Summit Week is an appropriate venue for this international AVA meeting. The AVA is a supported initiative of the International Arctic Science Committee (IASC), the primary organizers of the conference. The AVA is also a priority initiative of the Conservation of Arctic Flora and Fauna (CAFF), the biodiversity working group of the Arctic Council.

The idea for an Arctic vegetation classification began in 1992 at the first Arctic vegetation classification workshop in Boulder, Colorado, USA, where a resolution was presented to make a circumpolar vegetation classification and map. The Circumpolar Arctic Vegetation Map, published in 2003, was the first concrete product arising from the Boulder resolution. A consistent plot-level Arctic vegetation classification was much slower to develop because of the lack of a common taxonomy and nomenclature for the Arctic and difficulties in standardizing and archiving the large amount of plot data from all the Arctic countries. The Pan-Arctic Species List now provides a unified checklist of accepted names and synonyms for Arctic vascular plants, bryophytes and lichens, and a standardized set of header data for a Turboveg database provide the basic framework. Two workshops in 2013 at Krakow and Boulder revitalized the effort, and a prototype AVA was recently published for Arctic Alaska. Furthermore, recent rapid advancements in international vegetation databases and the European Vegetation Classification now provide models for creation of the Arctic AVA and AVC. The Braun-Blanquet (Br.-Bl.) classification approach, with zonal and habitat-type based grouping of syntaxa, is proposed as a model for the first AVC, similar to the approach used for the European Vegetation Classification.

The next step is to begin the task building a truly international AVA. This meeting in Prague will focus on progress in Canada, Greenland and Russia. We will review the datasets and plots that are available for each of the floristic provinces in these countries. The primary goal is to develop a strategy for each country to assemble its own archive with common protocols that will later allow the databases to be united into a single AVA using TurboVeg v3. We will then move toward developing the Br.-Bl. classification. Long-term plans are to also use the data in the AVA to develop comparative classifications using North American classifications approaches.

Why an Arctic Vegetation Classification?

Marilyn Walker
HOMER Energy, Boulder, CO, USA

Why should we take the considerable time and expense to develop a unified classification of arctic vegetation? Is it not sufficient to have a repository for vegetation data? It is worth our while to take a moment to answer these questions, which underpin the work that has been ongoing, in some form, for 25 years, but is not yet complete.

I convened a workshop in Boulder, Colorado, in March 1992, with a goal of beginning international cooperation toward a common circumpolar arctic vegetation classification. This was the first time this particular group of vegetation scientists came together, and the workshop, which has come to be a watershed event for arctic science, was inspired by two very different people, both Russian. The first was Boris Yurtsev of the Komarov Botanical Garden in (at that time) Leningrad. Yurtsev had developed a map illustrating his visions of the arctic flora as a single region, divided into provinces and subprovinces that reflected the geologic history of the region as well as current climate. Yurtsev's map and theory were published in the special edition of the *Journal of Vegetation Science* that prepared as a key outcome of the workshop (Yurtsev 1994). Yurtsev's work had strongly influenced my thinking and analysis of the vegetation and floristics of pingos (Walker 1990), as I analyzed how the flora of a particular microsite was a reflection of the species' larger distribution. This finding is not particularly surprising, but it made me think about the plants I was studying as a part of larger flora that spread around the entire globe. The second Russian who influenced the meeting was, ironically, Mikhail Gorbachev. Although current popular of opinion of him is low in Russia, he was instrumental in opening Russia and the Soviet Union. Because of Gorbachev's policies, I was able to bring the right Soviets to the Boulder meeting, launching a multi-decadal international cooperative effort toward understanding the integrated ecology of this important region.

I presented the Indian story of "The Blind Men and the Elephant" as an allegory for how the world's vegetation scientists viewed the Arctic in the 1980's. In this folktale, a group of blind men all approach an elephant, and then describe what an elephant is "like." Since the animal is so much larger than them, each describes it according to the piece upon which they happened to land – a spear for the tusk, a snake for the trunk, a tree for the leg, etc. There were publications available on the vegetation of various arctic regions available in the 1980's, many with a synthetic approach to a broad region – such as Canada, Russia, Europe, etc. But each of them seemed to me to be strongly influenced by the unique climate or geology of the geographic area, and therefore not truly extrapolatable to the entire region. This was before we had a globally connected information system that made communication and information sharing trivial, and at a time when travel into the USSR was difficult, and out of the USSR was nearly impossible. So my goal was to get everyone together and move from the allegory of the blind men into a unified view of a region.

One of the clear goals that came out of the 1992 meeting was a desire to create a database of arctic vegetation plots that could be the basis for a classification (Walker et al. 1994), but the most important goal was to create the classification. There should be no need to justify why a classification is required. Classifications are languages. Just as biologists have agreed upon a way of defining and describing a species, which represents a degree of evolutionary isolation, vegetation units describe the synthesis of the local flora with climate and geology. They are the most fundamental and profound description of the ecological functioning of a region. If two different areas have the same fundamental plant community on them, then you can know a great deal about the commonality of their climate, soils, and geology. Without this classification system, there is nothing but a volume of data concerning the presence and abundance of the species. Classifications allow regions to be mapped, and allow those maps to be used as a basis for management, modeling, and other activities (CAVM Team 2003).

One of the important goals for a classification is to serve as a baseline for ecosystems and landscapes in the process of change. Although we spoke of climate change in 1992, we had no idea what the earth would look here in the “future” of 2017. We already recognized the Arctic as a sensitive and important region for climate, for two primary reasons: (1) changes of only a few degrees represent very large effective changes in systems where the growing season temperatures are only just above zero C, and (2) the stores of carbon in arctic soils and permafrost are vulnerable and have the potential to magnify climate change through adding more carbon to the atmosphere. Climate change is now recognized as an international emergency threatening all species, and changes to arctic regions are even more rapid than anticipated (SEI 2016).

Beyond all the compelling scientific and political reasons for an arctic vegetation classification, however, is what I believe is the primary driver for those of us who do the work. We love nature, and we adore the delicate and beautiful arctic plants and their landscapes. More than anything, this is a labor of love.

The development of an arctic (or any) vegetation classification proceeds in a series of steps, beginning with collection of data in the field. Every species, including the smallest bryophytes, and its relative abundance are accounted for. There is often a very long secondary step of verifying that the identifications are correct, which can sometimes take months or even years in some cases, if samples must be sent to experts for taxonomic verification. Then the data are digitized. They may be submitted to various databases or stored locally. For regional or very large classifications, such as the European Vegetation Classification (Mucina et al. 2016), data are pulled from a common database and manipulated with specialized software for classification. Although the addition of data to a secure, agreed upon database is an important step, the synthetic step of the classification gets the highest value out of the data, and makes it useful to the greatest number of people and applications. Classification moves data into information. It protects a valuable legacy.

I share a slide of Vera Komárková, a remarkable vegetation scientist, particularly poignant as she was Czech. Vera completed a detailed and complete classification of the Front Range Colorado alpine vegetation (Komárková 1979), but her very detailed work in the Atqasuq region of Alaska was lost after her death from breast cancer in 2005, at age 62. The data that Vera collected is lost forever, and a legacy is gone.

It is somewhat ironic that a political leader was part of my inspiration for beginning this work in early 1990's, given that we are now seeing active moves on the part of United States Executive Branch to destroy science data and information. Gorbachev, for all his current disrepute in Russia, seemed to understand the peril facing the world in the late 1980's. His intention, I believe, was to save the human race and the planet from annihilation, and he continues to speak of these challenges in our current political environment (Gorbachev 2017). Regardless of our own political views or our opinions of any particular leader, as scientists and ecologists, we all agree that our planet and all the life within it are precious.

As a young woman who spent many years bent over plots, collecting, measuring, and analyzing vegetation data, I used to daydream that one day someone would come up with a mechanism to scan a piece of ground and instantly identify all the species present there through their DNA. And perhaps that day will come. It seems even very likely to me, still, even though I am also waiting for flying cars. But until that day, there is a great deal of work and love involved in measuring and classifying arctic vegetation data. I hope that the valuable legacy represented by that data, and those decades of work, can one day soon become a part of synthetic, integrated classification of the circumarctic region, while we still have time.

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The European Vegetation Archive (EVA), EuroVegChecklist, and possibilities for contributing AVA data to the EVA

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The European Vegetation Archive (EVA, http://euroveg.org/eva-database) is a centralized data repository of vegetation-plot observations (phytosociological relevés) from Europe and adjacent areas, which is maintained by the IAVS Working Group European Vegetation Survey. Its aim is to facilitate the use of these data for non-commercial purposes, mainly academic research and applications in nature conservation and ecological restoration. Currently it includes more than 1.2 million plot observations from 70 databases. Since its establishment in 2014, EVA provided data for 51 projects of basic and applied research, some of which have already resulted in published papers. However, the data from the Arctic and Boreal zones are strongly under-represented in EVA and it would be highly desirable to include more databases covering these zones. Therefore, a close cooperation between EVA and AVA is most welcome.

Another initiative of the IAVS Working Group European Vegetation Survey is so-called EuroVegChecklist (EVC), a compilation of a critically revised hierarchical classification system of European vegetation at the level of phytosociological classes, orders and alliances. After almost 15 years of work of a team of 32 experts from 16 countries, this system was published at the end of last year (Mucina et al. 2016, Applied Vegetation Science). It is divided into a classification system for communities dominated by vascular plants (EVC1), which includes 109 classes, 300 orders and 1108 alliances, a system for communities dominated by bryophytes and lichens (EVC2; 27 classes, 53 orders and 137 alliances) and a system for communities dominated by algae (EVC3; 13 classes, 24 orders and 53 alliances). In total 13 448 taxa were assigned as indicator species of individual classes and a computer expert system was developed to identify the classes based on these taxa. The names of all syntaxa were checked following the International Code of Phytosociological Nomenclature and extensive lists of synonyms were provided. Each syntaxon was characterized by a brief description.

Turboveg v.3 – A gateway to vegetation databases

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Although Turboveg v.2 is acceptable for many users, the call for a better database model has been growing over the last few years to overcome the current version's shortcomings. Since the Dutch National Vegetation Database provides information on the distribution and range of Natura 2000 habitats to report every 6 years to the EU, a 'quality status A' is nowadays required. Therefore a proper database model had to be set up. Because v.2 normally deals with multiple databases, and potentially different databases structures and different taxonomies, it was the challenge to deal with all these differences in a single SQL-based database (SQLite for locally stored databases).

A new Turboveg v.3 is now underway. The prototype not only is able to import Turboveg v.2 databases, but also already contains functions to select data and to export selected plot observations to various formats for further processing with other programs. For example, plots observations can already be exported for use in JUICE, GIS and Excel. Moreover, editing of plot data is already build in, including sophisticated localisation by means of an integrated Google Maps. Storage of metadata is also included for almost every level in the database. Information on data providers (custodians), and the accessibility of data can be stored on the level of plot observation. A clear distinction between plots and plot observations is also supported in the database model and the software.

The European Vegetation Archive (EVA) currently comprises almost 1,5 million plot observations and much different taxonomy. By integrating a crosswalk between the many different taxonomies (already more than 40), an analysis of such large heterogeneous data sets has now become feasible. For the dissemination of the data the EVA Data Property and Governance Rules will be followed (http://euroveg.org/download/eva-rules.pdf).

JUICE v.7: A complex expert system language for vegetation classification

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Major steps have been made recently towards the development of a common vegetation classification system for Europe. The existence of new, huge resources of ecological information, coupled with the lack of comprehensive classification system applicable on the continental scale calls for the development of expert system language for the formal description of vegetation classification. We have introduced complex, but visually understandable structure and syntax of expert system for vegetation classification based on logical formulas for automatic identification of vegetation types. With this approach, we can simplify and clearly describe general definitions of vegetation units, which are able to match the units of the traditional expert-based classification, or to define new vegetation types. The expert system is now so flexible that it can be used for definitions of all hierarchical levels of vegetation classification system. We got a scientific tool, which is highly efficient, fast and flexible and can be also automatically improved. The whole tool is included in the Expert System function of the JUICE program (www.sci.muni.cz\botany\juice.htm).

The Alaska AVA (AVA-AK)

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The Alaska Arctic Vegetation Archive (AVA-AK, GIVD-ID: NA-US-014) is a free, publically available database archive of vegetation-plot data from the Arctic tundra region of northern Alaska. The archive currently contains 24 datasets with 3,026 non-overlapping plots, and we anticipate adding another 1,000 plots over the next year. Of these, 74% have geolocation data with 25-m or better precision. Species cover data and header data are stored in a TURBOVEG database. A standardized Pan-Arctic Species List provides a consistent nomenclature for vascular plants, bryophytes, and lichens in the archive. A web-based online Alaska Arctic Geoecological Atlas (AGA-AK) allows viewing and downloading the species data in a variety of formats, and provides access to a wide variety of ancillary data. We present the contents of the archive, assess its strengths and weaknesses, and provide a brief overview of the database data dictionary and individual datasets.

The Canadian Biogeoclimate Ecosystem Classification (BEC) approach

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BEC is best described as an ecological framework that uses Braun-Blanquet associations of mature vegetation as phytometers to identify and delineate ecologically equivalent regional climatic regions and local stand-level environmental conditions. Developed by phytosociologist Vladamir Krajina to describe forest ecosystems and their distribution within a climatically and topographically complex region of Canada, the BEC approach could also provide an ecological framework for aligning existing Arctic Braun-Blanquet associations. Central concepts in BEC are the Russian concept of the biogeocoenose, the identification of the zonal association to delineate areas of biologically uniform climate, the linkage between associations and site condition through the concept of ecological equivalence, and a structured process of correlation to align and harmonize regional classification concepts. Developed to be an applied tool for resource management, the terminology of the system uses common language to facilitate its application with non-academic users. The central role of vegetation classification in delimiting consistent climatic regions and site conditions facilitates application of ecosystem-based management, modelling the spatial distribution of ecosystems and to assess and predict the impacts of changing climate and environmental condition on terrestrial ecosystems. A consistent ecosystem classification is an important tool for experimental design, ensuring representation in monitoring networks, and the appropriate extrapolation of research findings.

Overview of the AVA in Canada

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International Polar Year funds were used to compile an initial arctic vegetation archive for the Canadian Arctic and sub-Arctic in 2010-2011. Approximately 4800 Arctic reléves were acquired from 82 published and unpublished theses, papers and other reports as part of this effort. Since 2013, additional datasets from previously published and unpublished sources as well as contemporary collections have added 3500 reléves to the Canadian Arctic Vegetation Archive (CAVA). 900 Alaska reléves originally included in the CAVA are now omitted. Major additions to the archive include an extensive unpublished data set of ~1900 reléves collected by Thannheiser between 1971 to 1998, ~750 plots from Parks Canada collections in Aulavik, Ivvavvik, Torngat Mountains, and Ukkusiksalik national parks and ~500 plots from the Yukon territorial government archives. Contemporary field collections in the eastern Yukon (~190 reléves in 2015) and in the Canadian High Arctic Research Station study area (~150 reléves in 2014) has been incorporated. Additional datasets have been identified for possible inclusion in the CAVA: including a large body of work from the eastern arctic in Quebec (currently 425 reléves), an unknown and unreviewed dataset from the Northwest Territories government, and several known historical datasets from published papers and reports (~500 reléves). The 7450 reléves in the 2017 CAVA are housed in VPRO, a programmed ACCESS database designed for management of vegetation and environmental reléves and classification hierarchies. Initial trials to convert CAVA data from VPRO to TurboVeg format indicate that the most common issue will be alignment of taxonomic standards and coding between datasets.

Overview of the AVA in Greenland

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The status of the Greenland vegetation sample plot-datasets stored in Münster, Germany, is almost the same as three years ago. The digital data are still in different formats such as Turboveg-database, Excel files and Word files. We will concentrate to harmonize those digitized data, which stem from several Master and PhD theses of the former Utrecht (Netherlands) and Münster (Germany) working groups. Material published earlier and non- digitized, is considered being safe and is not considered for now.The first step will be to harmonize the header data, the species lists and cover values with the Alaska-AVA and Turboveg. Parts of datasets are published, but rarely as a full dataset. We will try to identify and tag the published relevés within the datasets. Additionally, relevés, which bear nomenclatorical types, should be marked. We present screenshots of the datasets for discussion and propose that the finalized Turboveg datasets should be kept safe within the Alaska-AVA in Fairbanks.

Overview Progress on the AVA in Russia

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The study of plant cover within the Russian Arctic started in the 1930s and was intensified gradually reaching its peak in the 1970s and 1980s. Initially the very few phytocoenologists sampled vegetation using a relevé approach. Even less who published these with enough repetition. However, the famous tundra ecologists B. N. Gorodkov, V. N. Andreev, A. A. Dedov and V. D. Aleksandrova were among those who did.

The formal methods of the Braun-Blanquet approach were used by some Russian phytosociologists who worked in southerner biomes in the late 1970s, but only at the beginning of 1990s did the approach begin to be applied in the Russian Arctic.

Presently the pool of data published validly according to the Codex of Phytosociological nomenclature (Weber et al. 2000) in total contains close to 5000 relevés that belong to about 130 associations within the 35 alliances of 21 orders and 19 classes while about 40 new associations have not been placed into higher units. The main information is from the most important classes: three zonal — *Loiseleurio-Vaccinietea, Carici arctisibiricae–Hylocomietea alaskani* (prov.), *Drabo corymbosae-Papaveretea dahliani,* and four intazonal **—** *Scheuchzerio-Caricetea nigrae, Oxycocco-Sphagnetea, Carici rupestris–Kobresietea, Salicetea, herbaceae*.

The number of unpublished data still exceeds that of published. And a lot of data are still in field notebooks and boxes with incompletely identified cryptogam specimens. There are also phytosociologists who have data but so far did not classify and published these. The perspectives for such very valuable data are vague.

The published relevés are not only the best but also the only one source that is ready to be incorporated into the AVA, at least at the initial stage. Most of these in Russia are stored in Excel tables by their owners in botanical institutions in six cities (Saint-Petersburg, Syktyvkar, Kirovsk, Novosibirsk, Yakutsk, Magadan).

AVA project is the basis for a more ambitious task of creating a classification of circumpolar Arctic vegetation.

Yamal and Gydan peninsulas

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Tundra zone of the West Siberia was visited by many geobotanists since early 30s of the previous century. Although Gydan peninsula still stays almost a “blank list”, other regions are known much better. The purpose of studies during the first part of the century was mainly researching of reindeers’ grazing source (B. Gorodkov, V. Andreev).

Last 20 years this work along with studying of lichen cover dynamics is carried out by Yekaterinburg group (M. Magomedova, S. Ektova, M. Morozova, S. Abdulmanova). The second part of the previous century was dedicated to many aspects of vegetation study. The key geobotanists that worked there are N. Andreyashkina (mainly vascular plants; research on phytomass), M. Boch (wetlands; mainly vascular plants and bryophytes), S. Gribova (mainly vascular plants and bryophytes) and L. Meltser (mainly vascular plants). All scientists mentioned above worked using Russian dominant classification system and didn't make relevés with full list of species. 3 datasets of relevés made in this region not long ago (table 1) meet the requirements of AVA format of data storing and are either already imported into archive or are in process of importing. Also it is known that there is a relevant dataset of O. Sumina (Biological department of Saint Petersburg University) that is mainly focused on vegetation of anthropogenic environments (670 relevés).

Vegetation of the East European tundra: Classification and Database

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More than 40 sites on East European tundra plains were visited within 1996–2016 when 1500 relevés in the Braun-Blanquet school were made along the latitudinal gradient from typical tundra to forest-tundra. A Prodromus of this works contains 17 classes, 20 orders, 27 alliances and 53 associations (20 new ones). Vegetation of *Juncetea maritimi* marshes, *Oxycocco–Sphagnetea* and *Scheuchzerio–Caricetea nigrae* bogs and mires, *Carici rupestris–Kobresietea bellardii* on calcareous rocky grounds and *Thlaspietea rotundifolii* on unstable substrates fell-fields was studied rather well. The new *Rubo chamaemori–Dicranion elongati* alliance within *Oxycocco–Sphagnetea* is proposed for dwarf-shrub–moss (*Dicranum elongatum, Polytrichum strictum*)–lichen communities of oligotrophic palsa bogs and peatlands of the Subarctic, in contrast to boreal *Oxycocco–Empetrion hermaphroditi* with dwarf-shrub–*Sphagnum* communities of ridges and hummocks in ombrotrophic raised bogs. The necessity of new class for zonal tundra vegetation on placor (interfluve habitats with loamy soils), which unites the diverse sedge–dwarf-shrub–moss communities, is obvious. Their structure and composition are characterized by: continuous or discontinuous plant cover with regular frost boils with bare ground; high (more than 200) species richness; well-developed (up to 8 cm) moss layer dominated by common tundra bryophytes (*Aulacomnium turgidum, Hylocomium alaskanum, Ptilidium ciliare, Tomentypnum nitens*); dominance by *Carex arctisibirica* / *C. lugens* in grass layer; high dwarf-shrub willows (*Salix reticulata, S. polaris*) abundance; non constants presence of *Dryas octopetala* / *D. punctata* and shrub willows (*Salix glauca, S. lanata*). We reserve the name *Carici arctisibiricae–Hylocomietea alaskani* for coming new class. The practice to put zonal tundra communities into *Carici rupestris-Kobresietea bellardii*, *Loiseleurio-Vaccinietea* or *Juncetea trifidi* blurs their ecological affinity and brings disbalance in Arctic syntaxonomy. There are plans to continue classification with long-term perspectives to use results in making vegetation maps as well as in zonation with updating the between/inside boundaries and geobotanical subdivision schemes.

Large-scale geobotanical mapping of the East European tundra

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Since 1996, we are doing large-scale geobotanical mapping of the East European tundra, based on the ArcGIS, relevés (more than 1500) and remote sensing. The following works were performed:

1) Vegetation maps projects (scale 25 000 – 100 000) for the 10 regional nature reserves and protected areas.

2) GIS Project "The Red Book of the Nenets Autonomous Okrug", which contains 1300 location 102 rare plant species and the layers with the key areas for the conservation of rare and endemic species.

3) 132 geobotanical districts with homogeneous composition and distribution of vegetation cover have been allocated to East European tundra territory. Distribution of the maximum NDVI correspond to this scheme geobotanical zoning. Maps of geobotanical districts conservation values are prepared on the basis of analysis of the diversity and density of rare vascular plant species, as the most well-known group.

4) Maps of long-term dynamics of the vegetation cover for the key areas on the Vaigach and Kolguev Islands were prepared using remote sensing techniques and field relevés. The maximum NDVI values increased over the last 25 years by 30% and 15% on Vaigach and Koguev islands respectively. A high correlation there was between growth of phytomass and an increase of the average summer temperatures, lengthening the growing season (at the beginning and end) and the amount of accumulated heat over this period.

5) With the use of satellite images were shows that between 1973 and 2010 area of marshes with vegetation in the Kolokolkovoy bay (Barents Sea coast) was not constant and varied from 357 to 636 ha and after a severe storm on July 24—25, 2010, accompanied by a surge of water was reduced to 43—50 ha. A comparative analysis of species composition and vegetation structure in the relevés made in 2002 and again in 2011, allowed to evaluate syntaxa changes on the various levels of marshes.

6) Draft of the typological scheme of vegetation territorial units, based on the Braun-Blanquet classification was prepared for Kolguev Island as model. 4 ranks of typological units were offered: department, class, type and subtype, which correspond to the basic levels of the hierarchical organization of vegetation. This typology is consistent with the EUNIS habitat classification.

Update on the AVA in Iceland

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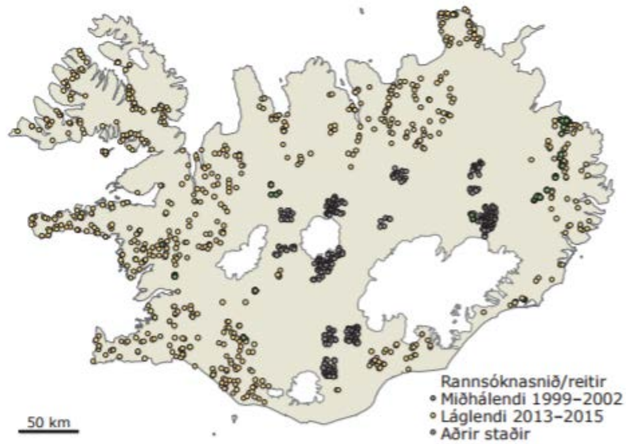
As presented at the AVA workshop in Krakow in 2013 there are substantial plot based vegetation data available in Iceland (Fosaa et al. 2013). Since then there has not been much progess in synchronising the data nor accumulate it. The amount of suitable data has, on the other hand, increased significantly in Iceland mainly thanks to the mapping of habitat types in Iceland (Ottósson et al. 2016), a project which has been ongoing since 1999 when the work started at the central highlands of Iceland (Magnússon et al. 2009).



Since 2013 several hundred transects have been studied on the lowland part of Iceland more than doubling the number of plots included in the analysis. Furthermore has all data been added to a common database. All transects included in the habitat type mapping can be seen on the following map from Magnusson et al. 2016: 20. The different colour of the points refers to work on the central highlands (1999-2002), the lowlands (2013-2015) and other plots.

Analyses of available data resulted in the delimitation of 64 different terrestrial habitat types which follow the EUNIS classification system as possible (http://www.eea.europa.eu/themes/biodiversity/eunis/eunis-habitat-classification). A map showing the habitat types of Iceland can be assessed at http://vistgerdakort.ni.is.

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The US National Vegetation Classification and the VegBank plot archive

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Rapid progress is being made in the development of the US National Vegetation Classification. Use of the system is mandated by the federal government to assure a common language for the effective inventory, management, and conservation of plant communities in the U.S. The classification includes of an 8-level hierarchy with the potential for implementation globally at the upper levels. The lowest levels, Alliance and Association, contain units similar to the alliances and associations of the Braun-Blanquet system, with around 9000 associations currently recognized within the US. Proposals for changes are peer-reviewed as coordinated by the Vegetation Panel of the Ecological Society of America in collaboration with Federal agencies and NatureServe. A critical component of the peer review is to assure that accepted types are based on data from across the range of the type and are clearly differentiated from other accepted types. All proposals are expected to be based on plot data that is publicly available, typically through deposit in VegBank. VegBank is a stand-alone, Internet-accessible, vegetation plot archive designed to allow users to easily submit, search, view, annotate, cite, and download diverse types of vegetation data. The archive also contains embedded databases that contain classifications of vegetation and individual organisms, designed and implemented to track the many-to-many relationship between names and plant or community concepts, as well as alternative party perspectives on accepted taxa. The VegBank data model is also implemented in VegBranch, a desktop tool for data management and for uploading to and downloading from VegBank.

Progress on an Alaska Arctic vegetation classification using the AVA-AK

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Vegetation classification has recently become the most important tool of vegetation scientists, ecologists and nature conservationists all over the world. Following Braun-Blanquet approach, botanists in Europe created sophisticated hierarchical system of units representing plant communities based on their floristic, ecological and structural criteria. The advantages of simple language of this classification system is mainly in its simplicity – beyond each name created following certain prescripts there is whole information that is comparable with other similar or vicariant units in various regions. Up to now, arctic parts of North America were missing this kind of overview of vegetation units that can be comparable with rest of the world. Contemporary activities leaded by Alaska Geobotany Centre of University of Alaska Fairbanks and other institutions resulted into establishment of Arctic Vegetation Archive that has had ambitions to put together all relevant vegetation data with available axillary data from whole arctic biome.

The data stored in Alaska Arctic Vegetation Archive – 3026 relevés, were analyzed based on floristic criteria and their abundance using cluster analyzes. Using the methods of crispness of classification, the best interpretable number of clusters were identified that lead to exploring the structure of stored data. On the highest level of dissimilarity we can identified the four main divisions represented i) initial, aquatic and azonal communities; ii) moist to dry acidic dwarf shrubs; iii) zonal alpine communities and iv) graminoid tundra and dwarf-shrub heath vegetation, respectively.

The main idea of our next progress should be the creating of useful classification system of arctic vegetation based on formal language which will be understandable and easy to use. Based on our preliminary results obtained by above mentioned methods together with finding the main gradients and drivers of vegetation variability in our dataset, we will be able to create logical expert system comparable and combinable with recently used units (e.g. the US National Vegetation Classification) not only in the US, but also in other parts of the world.

Toward a circumpolar AVA

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The goal of a circumpolar AVA is to unite and harmonize vegetation data from the Arctic tundra biome for use in developing a pan-Arctic vegetation classification and to facilitate research on vegetation and biodiversity change. The Arctic Vegetation Archive (AVA) working group of the Conservation of Arctic Flora and Fauna (CAFF) has begun gathering a baseline record of vegetation plot-data in archive modeled after the European Vegetation Archive and the Alaska Arctic Vegetation Archive. The AVA working group launched three prototype databases for Greenland (AVA-GL), Arctic Alaska (AVA-AK) and Yamal (AVA-YL) since the Krakow AVA Workshop at Arctic Science Summit Week in April 2013. These databases utilize the TURBOVEG database program and follow protocols developed for the European Vegetation Archive (EVA) and the Global Index of Vegetation Databases (GIVD). Within TURBOVEG, a common header data format was prepared that includes minimal required environmental data and a suite of recommended data to collect in the field. A suggested common AVA field protocol was published and datasheets for use in the field will be made available. Vegetation-plot data from the AVA-AK are also being deposited in the US vegetation archive, VegBank, and data from AVA-GL is included in the EVA. A Pan-Arctic Species List (PASL, v2.0) provides a standard list of accepted vascular plant, bryophyte, and lichen species names for the Arctic biome for the three databases. The Pan-Arctic Species List (PASL v 2.0) was created from lists of accepted taxa for different groups in the Arctic: vascular plants, mosses, liverworts, lichens and lichenicolous fungi, compiled by members of the Conservation of Flora and Fauna (CAFF) Flora Working Group. We present an overview of steps undertaken to construct the prototypes, lessons learned, and make suggestions of issues to consider as other regions step up their efforts to construct their database contributions to the AVA.

The concept of Arctic local floras and can we apply it more widely?

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The local flora method is widely used by Russian botanists. The method strives to achieve the complete floral list for the studied area, which is normally about 100 km^2 in lowlands and 300 km^2 in mountainous regions. Detailed information about the method is given in *Khitun et al*. 2016. The authors have created a database on Russian Arctic local floras, which by now includes 287 localities. Initially database included only local floras from the Asian Arctic, but it has been expanded to the European part of the Arctic due to recently published surveys (Sergienko 2013, Matveeva & Zanokha, 2015; Lavrinenko et al., 2016).

Although a great number of relevés were made during the local flora studies in the past, absolute majority of them is not suitable for AVA (poor records on cryptogam component, lack of coordinates and/or permanent marking, many authors died and even if diaries and cryptogam collections exist, it is not realistic to organize these data). Less than ca 1/3 of relevés made by O.V. Khitun and O.V. Rebristaya during the local flora studies in Gydan and Yamal meet the requirements for AVA. They are not processed yet but can be used for AVA in future.

The local flora method provides very detailed information about the species distributions within the area. The method demands thorough search in all habitat types and allows find many rare species which can be missed otherwise. Information gathered by this method contributed to PAF and CAFF initiatives. Old local flora data can be used for studying the gradients of various taxonomical parameters, zonal and provincial changes in geographical and biomorphological structure of flora, for clarifying the boundaries of phytogeographic regions and sets of differential species. Numerical approach to floristic subdivision of the Russian Arctic was tested. The units obtained in cluster analysis of species composition similarity partly resembled subprovinces suggested by Yurtsev (1994), but there was a principal difference also. Our attempt of analysis of results of monitoring at local flora level (Khitun et al. 2016), showed the same tendencies as found in other research (Callaghan et al. 2013) but lack of accurate documentation from the initial surveys did not allow definitive conclusions.

Taking into account the difficulties in reaching remote locations throughout the Arctic and also shortage of qualified personnel, incorporating the local floras approach to existing network of Arctic observatories seems advantageous. Complementary studies of local floras in the surroundings of existing stations can provide additional material for monitoring and modeling. However we want to stress the necessity of accurate documentation. It should include such information as coordinates of the base camp, GPS tracking of daily routes, coordinates (and willingly permanent marking) of all relevé plots and their photographs, GPS coordinates of all rare species found in the area. And this information should be published! Even today there are publications of local floras where sites are shown on the map (of very small scale) and no coordinates are given. A roadmap towards uniform approaches of vegetation sampling is given in *Walker et al.* 2016. Evaluation of general species occurrence within the local flora remains rather subjective, its combination with data from permanent plots can provide more reliable data.

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