PART I

SECOND CIRCUMPOLAR ARCTIC VEGETATION MAPPING WORKSHOP

ARENDAL, NORWAY, 19-24 MAY 1996

I.A. INTRODUCTORY ADDRESS AND KEYNOTE ADDRESS

WELCOME ADDRESS

PROGRESS SINCE THE FIRST CAVM WORKSHOP AND GOALS OF THE SECOND

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I am very pleased that we are able to meet again and take the next step toward the development of a vegetation map of the circumpolar arctic tundra region. Welcome to everyone, and particularly those that were not at the first meeting in St. Petersburg in March of 1994.

I am pleased that GRID (Global Resource Information Database)-Arendal has agreed to host the meeting and provide the logistic support. We are all excited to be here to learn more about this famous facility. Karen Folgen has worked diligently making the arrangements for this workshop; it has all happened smoothly through the internet. In the US, Andrew Lillie has worked very hard at putting together the schedule, compiling the abstracts, and communicating with all of you.

This workshop was funded by the US National Science Foundation through the Arctic System Science Program. There was also a considerable amount of support that came through individual contributions to some of your air fares and the time that you are all devoting to coming here and to writing your papers. This support from you and your home institutions is much appreciated because it increased the number of individuals that I could invite and has enriched the quality of the workshop.

I think the biggest acknowledgment has to go to you participants who recognize the need for a circumpolar vegetation map, who have provided support and encouragement for this endeavor, and who are willing to move forward in the face of the considerable difficulties involved in any international activity of this nature. It is not a minor task.

As an example of the magnitude of the type of endeavor we are seeking to accomplish, we can look to the Map of the Natural Vegetation of Europe. Udo Bohn, who is the principal coordinator of the natural vegetation map of Europe and who will be presenting the keynote talk this morning, recently sent me a reprint (Bohn 1994) describing the conception, the problems, and the coordination required to make the European map. He notes that the original idea for a European map goes back to 1959 at the International Symposium on Vegetation Mapping in Stockholm when the Permanent Commission for the Vegetation Map of Europe was established under the leadership of Reinhold Tüxen. The map gradually evolved through many meetings, and took thirty-six years to complete! The final map is a testimony to Tüxen's original vision and the diligence of all the contributors. The problems involved with developing a unified legend that could be agreed upon by all the European countries seemed almost insurmountable at times. Many problems involving procuring funds,

developing true international cooperation, and achieving a fully integrated map legend with a comparable level of detail across all countries stretched the project over several decades.

We do not have the luxury of several decades with the Circumpolar Arctic Vegetation Map. The current problems facing the arctic regions due to many forces of global change are immediate. There is an urgent need for a new map for many scientific, cultural, educational, conservation, and development purposes. Luckily, the task will be hastened through modern telecommunication systems and automated methods of making and compiling maps. We also have relatively few countries involved. Whereas, the European map demanded the coordination of activities in 28 countries and seven republics within the former USSR, there are only six countries with true arctic tundra. Much of the planning for the European map occurred during the Cold War era when communication and travel to Russia was very difficult; now communication with Russia is relatively simple.

Our task is also easier because we are a relatively tightly-knit scientific group with many common objectives and scientific issues to be addressed. We are working in a system with many close climatic, cultural, and ecological ties. The arctic scientific community also has a voice through the International Arctic Science Committee (IASC), which is becoming a more powerful force in shaping the scope and nature of international arctic science. In the US, our primary sponsor, the Arctic System Science (ARCSS) program, is pushing to develop a truly integrated global program of scientific research that involves the marine, terrestrial, atmospheric, paleoenvironmental, and human aspects of the Arctic as related to global change. And there are numerous parallel efforts in Europe, Russia, and Japan. Many international projects such as the High Latitude Ecosystems portion of Man and the Biosphere (MAB) Programme and the Conservation of Arctic Flora and Fauna (CAFF) Program need maps that portray the nature and diversity of the circumarctic vegetation. Numerous other organizations such as GRID-Arendal are already devoted to developing spatial databases for the circumpolar region. The vegetation of the Arctic is also relatively simple compared to that of all of Europe. We will not have the 650 map units that occur on the European map and hopefully by the end of this meeting, we will have already agreed on the framework for the map legend.

So, in many ways our task is easy compared to that which faced Tüxen in 1959. Our greatest challenge will be to keep the project funded and continuously moving so that we can complete the maps as rapidly as possible so they can be used by scientists and decision-makers. I think that we can do this, but it will require hard work at this workshop to lay the foundation for the legend and develop concrete proposals for funding.

History of the CAVM

In 1991, at the International Workshop on Classification of Circumpolar Arctic Vegetation, in Boulder, Colorado, US, the participants recognized the need for a new vegetation map of the circumpolar tundra regions. One of the resolutions of the workshop was to begin the task of developing the organizational mechanism to accomplish this task. This Boulder workshop created the first synthesis of detailed classification of arctic vegetation, much of it using the Braun-Blanquet approach, and the results of this workshop were published in a special issue of the *Journal of Vegetation Science* (M.D. Walker *et al.* 1994).

Following the Boulder workshop, a proposal was co-funded by the US National Science Foundation and the US Fish and Wildlife Service to hold the first workshop devoted entirely to arctic vegetation mapping. This delightful occasion was hosted in March 1994 by the Komarov Botanical Institute in the small village of Lakta on the outskirts of St. Petersburg, Russia. At this workshop, 51 participants reviewed the status of arctic vegetation mapping in each of the circumpolar countries. We also developed a strategy for making a new series of maps that portray our current knowledge of arctic vegetation. This workshop led to three publications, all of which are contained in the USGS Open File Report 96-251. The first paper (Walker 1995), published in *Arctic and Alpine Research,* gives an overview of the workshop and sets forth a plan for making the maps; the second paper by all the members of the CAVM Executive Committee (Walker *et al.* 1995) reviews the current status of vegetation mapping in each of the circumpolar countries. The most recent publication (Walker and Markon 1996) is a

compilation of all the abstracts and papers presented at the first workshop, and it also contains reprints of the other two publications. The volume summarizes the various approaches to vegetation mapping currently being used for the Arctic, and I hope that you have all had time to read this and review what transpired at the first workshop.

At the St. Petersburg workshop, we proposed to make several types of map products. First, we saw the need for an accurate base map of the circumpolar region that is derived from a mosaic of satellite images at a scale of 1:5,000,000. This is being worked on by the US Geological Survey, and we will see a preliminary version at this workshop. Secondly, we agreed to make a variety of products derived from the AVHRR Normalized Difference Vegetation Index (NDVI). These maps will include a variety of products such as maximum NDVI, which is a measure of vegetation greenness and hence biomass, and other maps portraying the dates of initiation of green-up, start of senescence, etc. Mike Fleming from the USGS EROS (Earth Resources Observation Systems) Alaska Field Office will present a summary of much of this activity.

Following the St. Petersburg workshop, the project received the endorsement of the International Arctic Science Committee (IASC) and the US Polar Research Board (PRB) and has been recognized as a priority task of the Conservation of Arctic Flora and Fauna (CAFF) project.

Goals of the 2nd CAVM workshop

At this workshop we have three primary goals. First, we need to develop a sound legend framework on which to build the synthesis map. Second, we need to establish the methods for international cooperation that will be needed to integrate the efforts of all the circumpolar countries. Third, we need to outline a funding strategy. Finally, we need to begin work on a set of proposals to make the maps.

To start this process, the first day-and-a-half of the workshop will be devoted to papers summarizing the progress in the each of the circumpolar countries. Today, we will hear reports from representatives of each of the countries regarding progress on the mapping legend and various approaches. Tomorrow we will focus on some of the circumpolar databases, remote-sensing products and GIS activities.

After lunch tomorrow, we will break into two working groups. One working group will address the legend of the synthesis maps, and the other will focus on the GIS and remote-sensing activities. As currently scheduled, these groups will meet once tomorrow and in four 1.5 hour sessions on the third day with intervening plenary sessions and breaks for coffee and lunch. At the plenary sessions, the working group chairs will report progress. On the fourth day, we will reconfigure the working groups and focus on the topics of international cooperation and mapping strategy, and developing proposals to fund the mapping.

Toward a legend framework

Our biggest challenge here is to develop a legend framework with terminology that is acceptable to all of the circumpolar countries. Over the past century, vegetation science has evolved very differently in North America, Scandinavia, and Russia. There have been numerous isolating forces including language barriers, difficulties in travel, different geographic, scientific and societal forces, and the isolation imposed by the Cold War. Now these forces are beginning to break down, and we are seeing increased impetus for a more detailed circumpolar map. We are realizing, though, that some of the differences in language cause major barriers for an international synthesis. These differences are not trivial and must be addressed before we can move forward.

In the US, vegetation science has focused largely on ecophysiology and modeling vegetation processes. There has been relatively little interest or funding for developing a national vegetation mapping program or pursuing a coherent classification system for the nation. The result has been that each federal and state agency developed its own mapping system to satisfy its own mission requirements. This has led to some innovative methods, but for the most part, it has left the US with little to show the world in the way of useful classification methods or vegetation maps. The view of the earth from space and the US Global Change Program have awakened some US vegetation scientists to the need for a coherent international vegetation classification and maps.

The very existence of the UNEP (United Nations Environment Programme)-GRID network of GIS centers is testimony to the international need for accurate maps. We cannot possibly model the global ecosystem and examine interactions between the land, oceans, and atmosphere unless we have useful global vegetation maps based on sound scientific principals.

In Europe and Russia, centers of vegetation mapping formed in nearly every country, and great traditions developed in Toulouse, Montpellier, Zurich, Bonn, and St. Petersburg under the leadership of personalities such as Gaussen, Tüxen, Lavrenko, and Sochava. At the St. Petersburg workshop in 1994, we saw the results of Sochava's leadership in the many vegetation maps that cover the entire arctic portion of Russia. And Dr. Bohn has brought with him the result of the European effort. These results are very impressive. When we look to North America, a great challenge faces us in making maps at a comparable level of detail for all of arctic Canada and Alaska. We do have relatively good knowledge of the structure and composition of vegetation in relation to climate and other environmental gradients. We also have good information on arctic plant species distributions. And we know, with a fair degree of predictive power, how plant communities are organized in typical arctic landscapes. But we have to look to Europe and Russia for guidance and methodological leadership in making new vegetation maps that will reflect an international perspective.

The work of Gorodkov, Andreev, Tolmachev, Alexandrova, and Yurtsev has given us a framework from which to view the gross zonal and floristic-sectoral patterns of Russian arctic vegetation. Comparable frameworks have been developed in North America by Bliss, Polunin, Edlund, and Young. And in Scandinavia, Dahl, Elvebakk, Ahti, and Tuhkanen have described the major zonal patterns. The problem is that the terminology used by the above authors is far from consistent.

For example and perhaps most obviously, the term "High Arctic" is used to describe the region of discontinuous plant cover and landscapes that are dominated by cushion plants, prostrate shrubs, and rosette forbs (Bliss and Matveyeva 1992); whereas in Russia this term is currently used to describe the coldest extremes of the Arctic, where plant cover is exceedingly sparse with only a few occasional forbs (Yurtsev 1994). Also, in North America the term "Low Arctic" is used to describe the same tundra types that the Russians have called "subarctic" or "hypoarctic". Within North America, there are also different approaches to describing zonal patterns. For example, the terminology used by Edlund (1996) is quite different from that of Bliss and Mayveyeva (1992). In Scandinavia, we see many similarities between the climatic-phytogeographical zonal map and the Russian zonal approach (Elvebakk 1996), but again with differences in terminology. The approach proposed for Greenland (Daniëls 1994, 1996) incorporates close connections to the Braun-Blanquet terminology and offers intriguing possibilities for a global synthesis.

Perhaps, the most interesting aspect of all this is that we are not even in agreement on a name for the object which we are attempting to map, i.e. the region north of the latitudinal treeline. Some authors call this the Arctic region and some call it the Arctic Tundra region. The term "tundra" which is at the root of the whole matter is not understood by all of us to be the same thing. Aleksandrova (1980) and Bliss and Matveyeva (1992) seem to agree that tundra is associated with landscapes that have more or less continuous cover of vegetation that has a large component of low and dwarf shrubs. Whereas, in Alaska the term tundra is more of a landscape term applied to the totality of all arctic and alpine landscapes above and north of treeline including the polar desert regions (Gabriel and Talbot 1984).

Developing a consistent nomenclature system will be a difficult task. I would like to promote a spirit of compromise about the terminology we will adopt. This will be necessary because many of the words crucial to our science have very different meanings in different countries, but I think we all recognize the underlying kernels of similarity in all the approaches. Our only option is to develop hybrids of our terminologies that take the best characteristics of each. During this workshop, we must strive to reach consensus on some of these basic terms. Dave Murray and I will present one possible solution to get around the terminology problem with respect to the zonation of the Arctic. Also, I see by glancing through the abstracts that there are other hybrids that will appear at this workshop. These terms are at the root of our disagreements regarding vegetation

legends, and we must reach consensus on them and define them in a mutually acceptable way for the international community.

At the St. Petersburg workshop, we made an initial step. I would like to draw your attention to the Recommendations of the Russian Working Group at the First Workshop (Russian CAVM Working Group, this volume). These were summarized after the St. Petersburg meeting and many of you may not have seen these. They are not in any of the publications from the last meeting, so I encourage everyone to read these and consider the ideas in your deliberations.

Developing a mapping strategy

I think that the problems faced by the remote-sensing and GIS group are somewhat less formidable because the major tasks involve assembling remotely-sensed imagery and using existing algorithms to produce some of the NDVI-derived maps. This is not to say that it will not be a big job, but it seems that the task will be relatively straight-forward if we can clearly define the scope of the task we wish to accomplish and move quickly to develop the base maps and the NDVI-derived maps.

With regard to collaboration on assembling the synthesized regional maps into a single vegetation map of the Arctic, the task is much more challenging, and I am hoping that we can learn from Dr. Bohn's experience with the European collaborative effort.

Developing a funding strategy

Finally, we must be prepared to write the proposals to obtain the necessary funding. We have to get the word out to all relevant national and international bodies that this project has international endorsement by IASC and that it is essential to all of our arctic national and international political, cultural, educational, and scientific interests. We have to identify who can accomplish the work that is needed and how we can take advantage of the key experts in each of the participating institutions and then boldly move forward, again with a spirit of cooperation.

In the US we are learning that large integrated projects can be successful only if there is an underlying desire to collaborate. The US National Science Foundation (NSF) is interested in promoting international projects of this nature, and I am confident that we can write a proposal that will be successful. But NSF and the US funding agencies cannot pick-up the tab for the entire map. We have to demonstrate that there is major cost sharing by the international community. Steve Talbot will be presenting some of plans that we are developing in the US, and I hope that others of you have come with similar concrete funding ideas.

So, again I would like to welcome everyone. I want this to be a relaxed atmosphere, but with enough structure to keep things moving along.

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KEYNOTE ADDRESS

HIERARCHIC CLASSIFICATION OF THE LEGEND AND MAPPING UNITS OF THE MAP OF NATURAL VEGETATION OF EUROPE, SCALE 1:2.5 M

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Introduction

As present principal coordinator of the international mapping project of the Map of Natural Vegetation of Europe (MNVE), I want to thank Skip Walker for the invitation to this decisive workshop of the Circumpolar Arctic Vegetation Map (CAVM) working group. Our long-lasting mapping project has now reached the final stage: digitizing of the map sheets is in progress, and printing of the vegetation map should take place next year. The draft of the explanatory textbook should be finished at the end of this year.

There are two good reasons for my participation in this workshop:

1. As the two mapping areas (CAVM; MNVE) are overlapping in the north of Europe, we should try to harmonize the classification and content of their mapping units.

Also, I think the working group can profit from the experiences and results of our work. Some of our co-workers are also involved in the CAVM project.

2. I want to take the opportunity to fill in some gaps in our legend and explanatory text concerning the natural vegetation of Svalbard and Iceland. I think that there are also some weak points in our classification of the arctic vegetation which should be improved.

Aims, Content, and Basic Principles of the European Vegetation Map

The aim was to construct a map of the potential natural vegetation because of the small scale and because of the importance of this information for different purposes of application: nature protection, environmental protection, bio-