PROCEEDINGS OF THE FIRST INTERNATIONAL CONSERVATION OF THE ARCTIC FLORA AND FAUNA (CAFF) FLORA GROUP WORKSHOP

CAFF Technical Report No. 10
About CAFF

The program for the Conservation of Arctic Flora and Fauna (CAFF) of the Arctic Council was established to address the special needs of Arctic ecosystems, species and their habitats in the rapidly developing Arctic region. It was initiated as one of four programs of the Arctic Environmental Protection Strategy (AEPS) which was adopted by Canada, Denmark/Greenland, Finland, Iceland, Norway, Russia, Sweden and the United States through a Ministerial Declaration at Rovaniemi, Finland in 1991. Other programs initiated under the AEPS and overtaken by the Arctic Council are the Arctic Monitoring and Assessment Programme (AMAP), the program for Emergency Prevention, Preparedness and Response (EPPR) and the program for Protection of the Arctic Marine Environment (PAME).

Since its inaugural meeting in Ottawa, Canada in 1992, the CAFF program has provided scientists, conservation managers and groups, and indigenous people of the north with a distinct forum in which to tackle a wide range of Arctic conservation issues at the circumpolar level.

CAFF’s main goals, which are achieved in keeping with the concepts of sustainable development and utilisation, are:

- to conserve Arctic flora and fauna, their diversity and their habitats;
- to protect the Arctic ecosystems from threats;
- to improve conservation management laws, regulations and practices for the Arctic;
- to integrate Arctic interests into global conservation fora.

CAFF operates through a system of Designated Agencies and National Representatives responsible for CAFF in their respective countries. CAFF also has an International Working Group which meets regularly to assess progress. CAFF is headed up by a chair and vice-chair which rotate among the Arctic countries and is supported by an International Secretariat.

The majority of CAFF’s activities are directed at conserving Arctic biodiversity—the abundance and diversity of Arctic flora, fauna, and habitats—and at integrating indigenous people and their knowledge into CAFF. In recognition of this, the Arctic Ministers in 1998 endorsed CAFF’s Strategic Plan for Conservation of Arctic Biological Diversity as a framework for future program activities. The Strategic Plan is built around five objectives addressing biodiversity monitoring, conservation of genetic resources, species and habitats, establishment of protected areas, conservation outside protected areas, and integration of biodiversity conservation objectives into economic plans and policies. Examples of major projects CAFF is currently working on are: a status report on Arctic biodiversity; development of a program to monitor Arctic biodiversity; assessment of climate change impacts on Arctic ecosystems in collaboration with AMAP and other Arctic organisations; assistance with implementation of circumpolar conservation strategies for murres (guillenots) and eiders and for a Circumpolar Protected Areas Network (CPAN); preparing a Circumpolar Arctic Vegetation Map and listing and mapping rare Arctic vascular plants.

Whenever possible, CAFF works in co-operation with other international organisations and associations to achieve common conservation goals in the Arctic.
CAFF PUBLICATIONS:

CAFF Habitat Conservation Reports (HCR):
No.1 The State of the Protected Areas in the Circumpolar Arctic (1994)
No.2 Proposed Protected Areas in the Circumpolar Arctic (1996)
No.3 National Principles and Mechanisms for Protected Areas in the Arctic Countries (1996)
No.4 Circumpolar Protected Areas Network (CPAN) Principles and Guidelines (1996)
No.5 Gaps in Habitat Protection in the Circumpolar Arctic (1996)
No.6 Circumpolar Protected Areas Network (CPAN) Strategy and Action Plan (1996)
No.7 Circumpolar Protected Areas Network (CPAN) Progress Report 1997 (1997)
No.8 Summary of Legal Instruments and National Frameworks for Arctic Marine Conservation (2000)
No.9 Gap analysis on the Russia Arctic (2000)

CAFF Technical Reports:
No.1 Incidental Take of Seabirds in Commercial Fisheries in the Arctic Countries (1998)
No.2 Human Disturbance at Arctic Seabird Colonies (1998)
No.3 Atlas of Rare Endemic Vascular Plants of the Arctic (1999)
No.4 Global Overview of the Conservation of Arctic Migratory Breeding Birds Outside the Arctic
No.6 CAFF/AMAP Workshop on a Circumpolar Biodiversity Monitoring Program, Reykjavik 7-9 Feb, 2000; Summary Report
No.7 Workshop on Seabird Incidental Catch In the Waters of Arctic Countries, Dartmouth, Nova Scotia 26-28 April 2000; Report and Recommendations
No.8 CAFF Workshop on Conservation of Migratory Arctic Birds, Songli, Norway, 10-11 September 2000; Summary Report
No.9 Seabird Harvest Regimes in the Circumpolar Nations

CAFF Strategies
Circumpolar Protected Areas Network (CPAN) Strategy and Action Plan (1996)
The Co-operative Strategy for Conservation of Biological Diversity in the Arctic Region (1997)
Strategic Plan for the Conservation of Arctic Biological Diversity (1998)

Program Management and Meetings
CAFF Report to Ministers 1996 (March 1996)
CAFF Report to SAAOs 1997 (June 1997)
EXECUTIVE SUMMARY

During the next few decades the Arctic will be strongly affected by many forces from within and outside the region, including global climate change, cumulative impacts of resource development, population increases, and tourism. The relatively simple and fragile ecosystems could be dramatically altered through changes to the vegetation, wetland destruction, and thawing of ice-rich permafrost. This could have important consequences to wildlife resources and to Native people within the Arctic, as well as feedbacks to the global hydrologic and atmospheric systems. In the words of Reinhold Tüxen, it should not be forgotten that plant cover is and will stay the basis for all other life on earth. Circumpolar cooperation of arctic botanists is essential to achieve a unified approach to conservation, protection, and sustainable use of arctic ecosystems and its resources. Cooperation from all eight arctic countries avoids replication of effort and permits realistic assessment of the conservation requirements for arctic vegetation and flora. Toward this end, representatives of arctic countries met at the First International Conservation of Arctic Flora and Fauna (CAFF) Flora Group Workshop from 27 – 29 March 2001 in Uppsala, Sweden where a dialogue on issues important to their shared arctic environments was begun.

The CAFF Flora Group (CFG) recognizes and supports CAFF's main goals: (1) conserve arctic flora and fauna, their diversity and their habitats; (2) protect arctic ecosystems from threats; (3) develop conservation management, laws, regulations, and practices for the Arctic; (4) collaborate for more effective research in support of sustainable utilization and conservation; and (5) integrate Arctic interests into global conservation efforts. The group objectives were (1) establish the CAFF Flora Group to support CAFF priorities including the Arctic Climate Impact Assessment, the Circumpolar Protected Areas Network, and circumpolar monitoring; (2) finalize a CAFF Flora Group Charter; (3) review issues identified in the Ad hoc CAFF Flora Group discussion paper tabled at CAFF VIII in Trondheim, Norway, and make recommendations to CAFF IX on priority action items; (4) support completion of a unified checklist of arctic vascular plants by the Panarctic Flora Project (PAF); (5) revise the list of rare non-endemic plants of circumpolar conservation submitted by Russia; and (6) support progress of the Circumpolar Arctic Vegetation Map Project (CAVM).

Workshop objectives were addressed in separate papers by assigning topics to participants who provided the initial statement and led the discussion. Recommendations for projects and further action were developed, which are summarized here:

**Adopt the CAFF Flora Group Charter** with minor revisions offered by the CAFF Flora Group.

**Use of the Term “Flora”:** The term flora in the title “CAFF Flora Group” is broadly interpreted to include flora and vegetation. CFG distinguishes between the term flora, an enumeration and separate description of each of the various kinds of plants that grow in the Arctic, and vegetation, the mosaic of plant communities over the landscape.

**Arctic Defined:** CFG uses the polar tree line to delimit the Arctic against the neighboring boreal zone, and it is only in the amphi-Beringian sector where additional criteria are necessary to determine the status of some areas. The PAF map is used as
the cartographic reference for defining the Arctic. However, the CFG recognizes the importance of adjacent areas. To be able to treat conservation issues broadly, CFG recognizes the importance of adjacent areas and extends its geographical consideration, when necessary, to include boreal mountains neighbouring the Arctic.

**CAFF Flora Group (CFG):** Financial support is central to work on arctic plants. It is understood that CAFF is not a granting agency, but to the extent its endorsement of projects is desirable, the CFG wants to see that sort of influence applied. The CFG can assume the role of brokers on behalf of projects and use CAFF to gain support. For the CFG to function, there must be sufficient funding dedicated by each national representative to support travel for him/her or his/her designee to CFG meetings. This minimum of support must be met.

**Panarctic Flora (PAF):** Complete the checklist and revise the rare plant surveys. Inasmuch as the physical documentation for the occurrence of plants is by means of specimens, collections of specimens in herbaria deserve and require protection and financial support. Work on the conservation of rare plants is not scientifically grounded unless such evidence is maintained, thus the activities of herbaria have our full support.

**Monitoring of “Local Floras”:** An approach for monitoring of local floras used in Russia is of interest to the CFG. Russia will initiate a pilot study to test the method of monitoring local floras; Boris Yurtsev is to write a primer on methods.

**Lichen and Bryophyte Checklist:** CFG will commence work on checklist of lichens and bryophytes of the Arctic prior to assessment of rare taxa with Iceland as the lead country.

**Circumpolar Protected Areas Network (CPAN):** In planning areas for CPAN, the flora and vegetation should be considered in selecting areas for protection, more so than has been done to date. Areas for special consideration should include (1) special habitats such as hot springs and sand dune areas (western Victoria Island, Canada); (2) areas where significant disjuncts or extrazonal species occur; (3) areas with rare or endemic plants; and (4) areas with good examples of common plant communities as well as rare plant communities.

**Revised Atlas of Rare Vascular Plants of the Arctic:** As the Panarctic Flora Project (PAF) nears completion, new information is becoming available on the distribution and identification of rare vascular plants in the Arctic. A second edition of CAFF Technical Report No. 3 should be prepared that enlarges and revises the original. As well as rare arctic plants it will include certain rare boreal and alpine species that exist in the Arctic. This effort would be led by PAF and the Chairman, CAFF Flora Group.

**Monitoring of Rare Species:** Long-term monitoring of rare species was endorsed with PAF as lead group.

**Proposal for the Second International Workshop on the Classification of Arctic Vegetation:** A workshop is proposed for July 2003 in Kangerlussuak, Greenland, with formal papers and a field practicum (as a course for credit to encourage student participation). Funding will be sought to support students. There is a mechanism for U.S. students to sign up for credit at University of Oslo or University of Tromsø.

**Education of Next Generation of Botanists:** There is a growing lack of competence in arctic botany as senior scientists age and leave the field. It is essential that a way be found to get young people involved in arctic botany. Encourage Greenland (indigenous Greenland) to select and train their best and brightest to become the next generation of
arctic scientists. CFG will seek ways to facilitate student exchange among participating countries.

**Greenlandic Involvement in Botany:** Despite the importance of botany in Greenland, the representatives noted the absence of a research botanist for Greenland. In addition, the Panarctic Flora Project is without an arctic plant taxonomist for Greenland. Engagement of the Greenlandic community in the study of Greenland’s plants, from both research botanists and policy makers, is essential.

**International Tundra Experiment (ITEX):** The representatives recognize the importance of the ITEX studies in monitoring global change. Protected areas could be of great value as potential ITEX sites, particularly because many are undisturbed and possess the infrastructure to assist researchers or provide local interested individuals or groups.

**Cooperation Between the CAFF Flora Group and Other Conservation Groups:** Although CFG brings a unique perspective by specializing on the botanical aspects of the circumpolar Arctic, there are other groups that share some of the CFG’s interests. With the help of WWF and IMCG, and other organizations and parties, establish more effective communication by setting up a CFG web site within the CAFF web site and submit articles to journals such as *Plant Talk* to disseminate information about the goals and objectives of the CFG.

**Circumpolar Arctic Vegetation Map (CAVM):** Support the development by CAVM of a common language for vegetation types and habitats.

**Arctic Climate Assessment (ACIA):** The relationship between the CFG and ACIA should avoid parallel processes within CAFF; communication and coordination between the various sub-activities should be the goal.
Figure 1. The CAFF Flora Group Workshop was held at the “Naturicum”, home of the Swedish Species Information Centre. The Centre is a shared body of the Swedish University of Agricultural Sciences and the Swedish Environmental Protection Agency.

Figure 2. CAFF Flora Group members Hörður Kristinsson, Iceland (left), and Fred J.A. Daniels, Germany for Greenland (right).
Figure 3. CAFF Flora Group members from Norway, Reidar Elven (left) and Arve Elvebak (right).

Figure 4. CAFF Flora Group members Bengt Jonsell, Sweden (left), and David F. Murray, United States of America (right).
Figure 5. CAFF Flora Group members Susan Aiken, Canada (left), and Henry Väre, Finland (right).
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PREFACE

At the first meeting of the CAFF Working Group (CAFF I) in 1992, Canadian botanists proposed that CAFF prepare a circumpolar list of rare vascular plants. At CAFF II in 1993, an informal flora group was established to continue this work, which culminated in the publication of the *Atlas of Rare Endemic Vascular Plants of the Arctic* in 1999.

CAFF VIII, in Trondheim, September 2000, established a formal CAFF Flora Group, which met for the first time in March 2001 at the Swedish Threatened Species Unit, Uppsala. This formal recognition gave important legitimacy to an activity already being carried on an *ad hoc* basis by a group of botanists from several Arctic countries.

The proceedings of the first CAFF Flora Group meeting are now available in this publication. They make the results of the meeting available to all interested in Arctic flora and vegetation. As a Chair of CAFF, I want to thank all the excellent Arctic botanists of the CAFF Flora Group and its Chair, Stephen Talbot, for preparing this valuable work.

The work of the Flora Group has expanded and is now ever more important for CAFF. I congratulate the Flora Group for what it has achieved so far and look forward to their future contributions to the CAFF program.

Sune Sohlberg
Chair of CAFF
Stockholm, Sweden
I. INTRODUCTION

The three-day CAFF Flora Group (CFG) Workshop convened botanical experts from all Arctic Countries (Canada, Finland, Denmark/Greenland, Iceland, Norway, Russia, Sweden, and the United States (Appendix I and II). The purpose of the workshop was to address action items from the Flora CAFF Work Plan 2000 - 2002 items. These items were:

2.1. Establish the CAFF Flora Group to address flora and vegetation issues in support of CAFF priorities including the Arctic Climate Impact Assessment, the Circumpolar Protected Areas Network and circumpolar monitoring. A charter will be prepared for the April 2001 CAFF management meeting.

2.2. Review issues identified in the Ad hoc CAFF Flora Group discussion paper tabled at CAFF VIII at a workshop to be held in Fennoscandia in 2001, and make recommendations to CAFF IX on priority action items.

2.3. Support completion of a taxonomically unified checklist of vascular plants by the Panarctic Flora (PAF) and evaluate the list of rare non-endemic plants of circumpolar conservation. Provide a status report at CAFF IX. (Russia/CAFF countries as appropriate)

2.4. Support completion of the Circumpolar Arctic Vegetation Map in 2002, and present the map at CAFF IX.

The workshop was held at the Artdatabanken / Swedish Species Information Centre (formerly the Swedish Threatened Species Unit), Swedish University of Agricultural Sciences, Uppsala, Sweden, 27 – 29 March 2001.

This Report addresses the issues of the Ad hoc CAFF Flora Discussion Paper (Appendix III) presented at CAFF VIII in Trondheim, Norway, 6 – 9 September 2000. The Report provides a summary of the presentations in the form of extended abstracts as well as general conclusions and recommendations from the workshop.
II. WELCOME, HISTORY, AND PROGRESS OF THE CAFF FLORA GROUP (CFG)

Stephen S. Talbot
U.S. Fish and Wildlife Service
1011 East Tudor Road
Anchorage, Alaska 99503 USA

E-mail: stephen_talbot@fws.gov

The Program for the Conservation of Arctic Flora and Fauna (CAFF) was established to address the special needs of Arctic species and their habitats in the rapidly developing Arctic. CAFF forms a program of the Arctic Environmental Protection Strategy (AEPS) which was formally adopted by Canada, Denmark/Greenland, Finland, Iceland, Norway, Russia, Sweden and the United States through Ministerial Declaration at Rovaniemi, Finland in 1991. In 1996, AEPS was taken over by the Arctic Council. Other programs of the Arctic Council include (1) the Arctic Monitoring and Assessment Program (AMAP), (2) the Program for Emergency Prevention, Preparedness and Response (EPPR), and (3) the Program for the Protection of the Arctic Marine Environment (PAME). CAFF cooperates with several observers such as the World Wildlife Fund (WWF), World Conservation Union (IUCN), and United Nations Educational Program (UNEP).

Since its inaugural meeting in Ottawa, Canada in 1992, the CAFF Program has provided scientists, conservation managers and conservation groups, and indigenous peoples of the North with a forum through which to tackle a wide range of arctic conservation issues at the circumpolar level.

CAFF’s main goals, in keeping with the concepts of sustainable development and utilization, are:

1. Conserve arctic flora and fauna, their diversity and their habitats.

2. Protect the arctic ecosystem from threats; seek to develop improved conservation management, laws, regulations and practices for the Arctic.

3. Collaborate for more effective research, sustainable utilization, and conservation.

4. Integrate Arctic interests into global conservation fora.

The majority of CAFF’s activities are grouped under several main themes including habitat conservation, species conservation, biodiversity conservation in the Arctic, integrating indigenous people and their knowledge, and program management. The Program is implemented through annual CAFF Work Plans and through specialist and Ad hoc groups and task forces. CAFF works in cooperation with other international organizations and associations to achieve common conservation goals in the Arctic. CAFF’s goals, mandate, functions, operating principles, management implementation, and structure are laid out in its Framework Document, approved by Ministers in 1996.
Nearly ten years after CAFF I, the CAFF Flora Group (CFG) is meeting now for the first time as an officially sanctioned CAFF unit. At CAFF VIII in Trondheim, the CAFF National Representatives supported the formation of the CAFF Flora Group. This action paved the way for a draft CAFF Flora Group Charter. The success we have experienced is due in large measure to the suggestions CFG members have made. Your thoughtful suggestions demonstrated a seriousness of purpose that impressed the CAFF National Representatives. In addition we published an *Atlas of Rare Vascular Plants of the Arctic* and made significant progress with the *Circumpolar Arctic Vegetation Map*, which will be published in July 2002. Your efforts are greatly appreciated.

I gratefully express my thanks to Mora Aronsson, Swedish Species Information Centre, for all his helpful work in organizing the meeting, and to Sune Sohlberg, Chair of CAFF, for moral support of the CFG and for providing financial support for the meeting.

From a practical standpoint, we are here for at least two major purposes. The first is to provide assistance to the CAFF National Representatives to respond to botanical issues and support them in their leadership roles. The second is to chart a course for the CAFF Flora Group and establish priorities among the important botanical issues in the Arctic. How we can best serve the arctic flora, its diversity, and environment without duplicating the work of other organizations.
III. MAIN TASKS OF ARTDATABANKEN – THE SWEDISH SPECIES INFORMATION CENTRE
(Formerly the Swedish Threatened Species Unit)

Mora Aronsson
ArtDatabanken / Swedish Species Information Centre
SLU / Swedish University of Agricultural Sciences
Box 7007
75007 Uppsala, Sweden

E-mail: mora.aronsson@dha.slu.se

Establishment of Red Lists

The most important task of the Swedish Species Information Centre is to evaluate the threat status of Swedish organisms and to compile and update Red Lists. The work will result in an updated Red List every five years.

Last year’s edition was the first Swedish Red List that was based on the new and improved IUCN-category system. This Red List (together with the new Finnish Red List) was one of the first to apply the new system to all kinds of organisms such as marine invertebrates, insects, birds, fungi, mosses and vascular plants. Of the 58,000 species in Sweden, 20,000 were evaluated for the Red List, and 4,120 were subsequently assigned to one of the following categories: (1) RE – Regionally extinct, (2) CR – Critically Endangered, (3) EN – Endangered, (4) VU – Vulnerable, (5) NT – Near Threatened, and (6) DD – Data Deficient.

One big difference compared to the “old” IUCN-system is that all species under consideration are tested against a set of five very strictly defined criteria, all with well-defined threshold values for the respective categories: (1) the size of the population is declining rapidly; (2) the population has a limited distribution area and is declining, fragmented or extremely fluctuating; (3) the population is small and declining, (4) the population is very small; and (5) a quantitative analysis (e.g. a population viability analysis) indicates an evident risk of extinction.

Collection of Information

The production of a Red List urgently requires large amounts of information. A very important and never-ending task is the accumulation of information on the Swedish species, especially those that are rare and/or declining. This information is stored in a species-database, and used for many purposes apart from red-listing such as conservation measures and prediction.

Distribution of Information

There are several ways to distribute the information concerning threatened species to the people who need it. One important method is the production of species fact sheets that are published both as books – Red Data Books – and on the web. Every year several other books on various topics concerning threatened species are also issued by the
Centre. Once a year the Centre arranges a national conference on conservation of flora and fauna. Information is also spread through lectures, radio-programs, etc.

Analysis

To an increasing extent the Centre works with analyses of threat factors, habitat preferences, and needs for conservation measures in order to enhance the efficiency of the efforts to protect the threatened species.

Monitoring

The Centre is involved, at least to some extent, in all monitoring of Swedish species, but only the project “Flora Guardians” is explicitly organized by the Centre. The Flora Guardian Project is a monitoring scheme for threatened vascular plants. It is financed by Word Wildlife Fund (WWF) Sweden, and monitoring is conducted by the Swedish botanical non-governmental agencies. At the moment about 500 people yearly monitor more than 300 species at 3,500 sites.

Species Conservation Action Programs

The Swedish Environment Agency is responsible for the production of species conservation action programs, but the Centre has an important task in supplying the underpinning data and otherwise supporting the production of these programs.

Initiation of Inventories and Research Projects

The information accumulated by the Centre creates the overview necessary to suggest areas where the knowledge is particularly scarce and the need for inventories and/or research especially great.

International Cooperation

The Centre takes part in several international projects (bilateral, European and global) concerning threatened species.
IV. CHARTER OF THE CONSERVATION OF ARCTIC FLORA AND FAUNA (CAFF) FLORA GROUP

Introduction

During the next few decades the Arctic will be strongly affected by forces within and from outside the region, including the impacts of global climate change, resource development, changes in numbers of wildlife species, increases in permanent residents, and burgeoning tourism. The relatively simple and often fragile arctic ecosystems are dramatically altered through changes to the species composition of the vegetation, destruction of wetlands, and thawing of ice-rich permafrost, as well as through feedbacks of these effects to global hydrologic and atmospheric systems. To preserve plant diversity, conservation programs must be guided by the biological requirements of species and ecosystem components as biological diversity ensures a healthy biosphere.

Traditionally, conservation and research activities for arctic plants have not been well coordinated in terms of common direction, concerns, reporting, and information exchange. Except for two CAFF action items, Panarctic Flora Project (PAF) and Circumpolar Arctic Vegetation Mapping Project (CAVM), governmental and non-governmental groups are often organized bilaterally. Therefore, plant conservation and research activities have not had a fully circumpolar perspective. Creating the CAFF Flora Group (CFG) within the Conservation of Arctic Flora and Fauna (CAFF) of the Arctic Council, will ensure that scientists, conservationists, and managers interested in arctic flora and vegetation will have a forum to promote, facilitate, and coordinate conservation, management, and research activities of mutual concern. To these ends, the CFG is created.

Goals

With botanical expertise drawn from CAFF member countries, to promote, encourage, and co-coordinate internationally the conservation of biodiversity of arctic flora and vegetation, habitats, and research activities in these fields; and to enhance the exchange of information relating to arctic flora and vegetation and factors affecting them.

Objectives

1. Seek international opportunities to support the conservation needs of the biodiversity of arctic flora and vegetation.
2. Create conservation partnerships within the Arctic.
3. Support research and education for conservation partnerships.
4. Exchange published information and unpublished data concerning arctic flora and vegetation.
5. Develop cooperative botanical activities for the Conservation of Arctic Flora and Fauna annual work plan.

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The CFG complements global and other regional botanical committees of governmental and non-governmental organizations. The CFG is comprised of up to 16 representatives, i.e., up to two representatives from each of the eight Arctic Council member states and permanent participants. The representatives come from the range of organizations and geographical. The CFG meetings, however, are open to botanical specialists of all governmental and non-governmental organizations with proven interest and expertise in the Arctic.

A chairperson administers the CFG. The chairperson facilitates and coordinates the work of the CFG between annual meetings and facilitates the annual meeting. The meeting agenda is developed by the chairperson in consultation with the other representatives.

The CFG conducts meetings as necessary to fulfill its goals and objectives. The meetings will be conducted in Europe whenever possible for maximum efficiency and to minimize costs; otherwise the meetings will be conducted in each country on a rotational basis.

Materials and records of each CFG meeting are provided to each CAFF National Representative, CFG representative, and other attendees as soon as possible following a meeting. The chairperson is responsible for preparing and distributing the materials unless other arrangements are concluded during the meeting.

Unless there is prior agreement for logistics, the host country is responsible for all in-country meeting expenses and arrangements for the CFG representatives. Expenses for lodging, meals, and transportation are the responsibility of each representative, unless prior arrangements are concluded.

**Contact Person:** Stephen S. Talbot, Chairman, CAFF Flora Group, U.S. Fish and Wildlife Service, 1011 East Tudor Road, Anchorage, AK 99503 USA; E-mail: Stephen_Talbot@fws.gov; Tel: +1 907 786 3381; Fax: +1 907 786 3905.
V. DEFINITION OF THE ARCTIC FOR THE CAFF FLORA GROUP

Arve Elvebakk
Department of Biology
University of Tromsø
N-9037 Tromsø, Norway

E-mail: arve@ibg.uit.no

Introduction
The definition of the Arctic is an issue that has caused much confusion, due to several factors: 1) application of different criteria, 2) insufficient knowledge on a circumpolar scale, 3) prevalent traditions, and 4) political considerations. The latter aspect was clearly reflected in the map presented by Conservation of Arctic Flora and Fauna (1994). The eight countries involved chose their own definitions of the Arctic for the Conservation of Arctic Flora and Fauna (CAFF) program. It was stated that Canada and the United States followed the polar tree line, a criterion valid also for Greenland, except that its small forested area in the south was also included within the CAFF definition of Arctic. However, a glimpse at the map shows that very large forested areas of Canada were also included within their concept of "Arctic".
The three Fennoscandian countries and Russia basically used the Arctic Circle as their criterion. Sweden included mountain areas south of the Arctic Circle and Norway made a extended the boundary southwards to include a national park and a municipality. Russia also included large areas south of the Arctic Circle including forested and sparsely forested areas. Iceland, which is situated south of the Arctic Circle, used their low July temperatures and small forested areas as criteria for including all of Iceland within the CAFF definition of Arctic, although a map in the same report (Conservation of Arctic Flora and Fauna 1994) shows that about half of Iceland is situated south of the 10° C July isotherm.

The newly established CAFF Flora Group needs to select a definition for their activity that both has a sensible relationship with the flora and vegetation, which is the very object of our activity, and also a clear relevance to the starting point of CAFF and its eight participating countries. A strict exclusion of all areas south of the polar tree line would, for instance, exclude Iceland, Sweden and Finland from the territory covered by the Group! From this point of view, the present contribution deals with the problems related to the different criteria.

Evaluation of criteria

The Arctic Circle
The Arctic Circle criterion gives an indication of "arctic" light conditions, with the southern limit of the occurrence of midnight sun in summer and a dark period in winter; this is essentially a criterion based on the irradiation pattern from the sun before it is modified by processes in the atmosphere/biosphere/geosphere. Can this be defended as a primary criterion for defining the Arctic?
The major modifications on incoming radiation is caused by the uneven distribution of land and sea, and the ocean currents and climate patterns this unevenness creates. All major biological and human activities are based on the consequences of these modifications. The most striking example is the difference between the polar areas of both hemispheres. A more regional difference is shown by comparing the coastal areas of North Norway and East Greenland at similar latitudes.

Nobody would dream of using the Antarctic Polar Circle as a criterion for defining the antarctic polar area. A part of the antarctic continent as well as many extremely cold islands are situated north of the Antarctic Circle. The Arctic Circle, similarly, is as inadequate in the Arctic, as nearly one third of Greenland and an even larger treeless area in Canada are situated south of the Arctic Circle. All inhabitants and visitors to these areas would probably consider these areas as Arctic, although they do not have midnight sun and winter darkness. Neither the Arctic nor the Antarctic circles can be used for defining arctic or antarctic areas.

Not a single biological species has a distribution pattern coinciding with the Arctic Circle. However, there are probably widespread light adaptations within single species along a latitudinal light gradient, although they are generally poorly known. Such adaptations are of strong scientific interest, and also important economically, with respect to species for agriculture. But the possible occurrence of a high latitude light adaptation in, for instance, all tree species at 70° N in North Norway, is irrelevant for a comparison with Canada and Greenland, where climate prevents the establishment of any tree species at similar high latitudes. Thus, climatic dependance is strongly dominant over light adaptation.

The 10° C July Isotherm
This is another classical criterion defining the Arctic. Elvebakk (unpubl.) selected 188 meteorological stations of northernmost Europe, including Norway, Sweden, Finland, and Russia north of the Arctic Circle, in addition to meteorological stations situated in a belt around the White Sea in Russia. Positive mean monthly temperatures from these stations were compared with their zonal positions in bioclimatic maps, basically following boundaries shown by Tuhkanen (1984), Dahl et al. (1986) and Elvebakk et al. (1999). Two parameters were compared, the sum for all months with positive values ("temperature sums") and mean July values.

When only the 78 arctic stations are included, the correlation involving temperature sums had an $r^2$ value of 0.96 and the one with mean July temperatures, 0.91. For the remaining 110 boreal stations the corresponding values were 0.86 and 0.25, respectively. Mean July temperatures are almost useless in this northern part of the boreal zone, and good in the Arctic, but inferior to temperature sums there. The situation along the polar tree line should be about intermediate, and a comparison of meteorological stations near this transition shows that the value in coastal northeast Norway (Finnmark) is near 9.5° C, near the mouth of the White Sea 10.5 and in the continental parts of European Russia in the range 12.0-12.5° C.

This shows that the 10° C July isotherm is not well correlated with the polar tree line and other zonal boundaries, due to its variation from oceanic to continental areas. Tuhkanen (1984) treated the entire boreal zone on a circumpolar scale and delimited
and subdivided the boreal zone, primarily based on analyses of data from about 2000 meteorological stations. The lowlands of an oceanic area such as Iceland with relative low mean July temperatures were treated by him as partly northern and partly middle boreal, and certainly not arctic.

Occurrence of permafrost
This is another response to climate, which is so strongly associated with the continentality gradient that it is not very useful as a general criterion.

Areas inhabited by northern indigenous peoples
This is an important aspect of political activity for most of the CAFF countries. Some of these Native people live north of the polar tree line others to the south, and some have traditionally followed reindeer which seasonally have migrated from tundra to forests. The Saami people are mostly based in the northern boreal zone following the classification of Dahl et al. (1986), but their reindeer also exploit treeless areas. The question whether the Saami should be called an arctic people has many dimensions, including cultural identity, and should primarily be decided by themselves. But such decisions should, in my opinion, not influence the classification of the whole territory they inhabit or use.

The polar tree line
The polar tree line has the advantage that it is clearly visible, although there is a forest-tundra ecotone. It is not only a botanical criterion, but it is a growth form that is only maintained in areas above a certain temperature threshold and thus is a good indicator of climate. It is the only botanical criterion among the five criteria evaluated here, and as a group of botanists we would be suspected to favor this criterion over others. A more thorough evaluation of the polar tree line as a primary criterion for defining the Arctic follows.

The polar tree line as a major criterion
Tuhkanen (1984) defined the boundary between the boreal and the arctic zones based on covariation between the extent of forests and temperature sums (biotemperature of Holdridge), but his boundary lines were primarily drawn on the basis of the temperature sums. The southern line of the Arctic drawn by Elvebakk et al. (1999) for the delimitation of the Arctic for the Panarctic Flora Project (PAF), is based on the occurrence of the polar tree line and is quite similar, except in the Bering Sea area (see Box 1 "Zonal Division of the Arctic" at the conclusion of this article). The PAF map is also found at <http://www.tøyen.uio.no/panarctflora/>. On this map continental areas have a well-defined tree-line, although the ecotone between the forest and the tundra have been considered very broad by some authors and narrow by others. So the real problematic areas are the oceanic ones, those in the North Atlantic and the Beringian sectors.

Let us start with the North Atlantic area. The study by Yurtsev (1994) was very influential in the CAFF process. In Yurtsev (1994) and Conservation of Arctic Flora and Fauna (1994) a 'floristic arctic boundary line' was drawn almost as far north as the middle part of Greenland, and continuinued north of Bjørnøya before coinciding with the polar tree line east of the White Sea. These areas were excluded as Arctic because of
the dominance of boreal-oceanic species 'alien to the circumpolar areas' (Yurtsev 1994). In this context the total distribution patterns of single species were considered.

However, following a general approach of considering the Arctic a 'northern polar cold treeless region', a much wider area in the North Atlantic sector was included in 'the arctic phytogeographic region' by Yurtsev (1994). This larger area comprises all of Greenland, Iceland, the Faroe Islands and a broad part of North Norway north of the Lofoten Islands. However, later in his paper, Yurtsev (1994) did not include this area (and a corresponding amphi-Beringian area) in the Arctic, but as 'a zonal equivalent of IV and V (the southernmost arctic subzones) outside the tundra zone'. These boundary lines were called 'phytogeographic', although the 'floristic' map is based on a phytogeographical evaluation of the components of the flora of the area. I think these lines and the nomenclature associated with them have caused confusion.

It is true that the lowlands of these areas, including the isolated islands of Jan Mayen and Bjornoya, have widely distributed arctic-alpine and/or boreal species and a few exclusively arctic species. This area is also characterized by the lack of dense coniferous forests as is true for most of the remaining circumboreal area. However, birch forests could be used for defining a polar tree line.

In North Norway, a narrow strip of the coast of Finnmark east of North Cape is devoid of forests. These northernmost forests are isolated in valley bottoms some distance away from the coast and separated by mountains and hills with a less favorable climate. These areas were mapped by Dahl et al. (1986), and the line between them portrays arctic lowland areas and mountains to the north and boreal lowland areas and mountains to the south. Elsewhere along the North Norwegian coast there are forested areas, but generally these are in a mosaic with treeless areas. These areas can be treeless because of sea spray, strong winds, lack of soil on acidic convex landforms, and human influence. Traditional agriculture eliminated the establishment of forests along the whole coast, but as the agricultural land is now largely being abandoned, a massive recruitment of small birch plants indicates that there will be re-establishment of the forests.

Some distance away from the coastal, dense tall birch (Betula pubescens) forests dominate the landscape, and the alpine tree line near Tromso lies at an altitude of about 400 m. A total of 20 tree species are known from North Norway, but only eight of these are known from the southern part (Elven 1983). Species like Ulmus glabra and Corylus avellana have isolated occurrences within the area considered as Arctic by Conservation of Arctic Flora and Fauna (1994). In the Tana-Deatnu area north of 70º N in northeast Finnmark, a large area lacks mountains, and here large continuous forests are developed not far from the arctic tree line.

The lowlands of Iceland were largely forested by birch before the Viking colonization a little more than 1,000 years ago. Through the centuries grazing by domesticated animals became more and more intense, and the coarse and sandy volcanic substrate proved to be much more sensitive to overgrazing than other substrates. Consequently, several meter-thick sediments have been blown away in the most serious cases. However, Betula pubescens is still widespread in Iceland up to an altitude of 400-450 m (Kristinsson 1987), although real forests are found in scattered and remote valleys in the interior, where they have been exposed to a lower grazing pressure.
These data show that forests are the climatic climax vegetation of most of Iceland, except in the mountains and in the northernmost peninsulas. Thus, a polar tree line can be mapped in Iceland in a similar way as it was in northernmost Norway by including only a narrow coastal strip (cf. Elvebakk et al. 1999).

In the continental parts of southernmost Greenland, an area with *Betula pubescens* forests was mapped as an enclave in the tundra landscape by Elvebakk et al. (1999), and treated as a boreal area.

In conclusion, the polar tree line can easily be drawn across Fennoscandia, Iceland and Greenland following the birch forests, and this criterion was used to delimit the Arctic in the PAF map.

**The Beringian sector**

This area will be treated briefly here. In continental Alaska the tree line can be followed, but in the Aleutians forests are lacking. However, lowland areas of the Aleutians have a clearly boreal vegetation and were placed outside the Arctic in the PAF map. This is the only area where northern parts of the boreal zone, as defined by the PAF map, lack forests.

In Beringian Russia a peculiar aspect is represented by the *stlanik*, the tall shrubs of *Pinus pumila*. The interior stlanik area of Chukotka was not included within the Arctic in the PAF map, because *Pinus pumila* can attain the height of trees, although it generally maintains a tall shrub growth form. So this is the second case of uncertainty when adopting the tree line criterion. For more details of the Northeast Asian peculiarities refer to Razzhivin (1999). It should be mentioned that the large rivers bring warm water from the large continental areas of the south into the Arctic. This helps to explain the establishment of azonal gallery forests along such rivers in the southern parts of the Arctic, where the landscape otherwise is tundra.

**Neighboring mountains**

Mountains adjoining the Arctic represent a particular problem. In areas close to the Arctic their vegetation is obviously very similar to vegetation of the Arctic, and then the differences increase gradually southwards. Northern mountains have been called 'orarctic', which is a useful term to denote similarity with arctic vegetation. However, there are no established criteria to distinguish the northern orarctic vegetation from more distinct alpine vegetation further to the south. Conservation of Arctic Flora and Fauna (1994) showed a boundary between the 'arctic-alpine zone' and the 'alpine zone' in Fennoscandia, with the boundary line roughly running between the cities of Narvik and Kiruna. But the criteria for such a boundary remain unknown, and I do not know of any reason to justify this boundary.

Even greater problems are associated with the large and longitudinally oriented mountains in Russia and North America; each of these has separate floristic characteristics. PAF discussions concluded that we do not have any criteria to select
parts of the adjoining alpine areas into the 'Arctic'. The southern limit of the Arctic was therefore drawn as the shortest connection line between the northernmost areas of lowland forests. Large alpine areas form enclaves within the boreal zone. These will require separate attention and international cooperation between botanists to resolve, equivalent to those efforts which now have included the Arctic.

Subdivision of the Arctic

For the CAFF Flora Group, subdivision of the Arctic has not been an important topic to discuss. It appears that the subdivision shown on the PAF map can be referred to until it is felt that this should be discussed also in our group. The present author presented unpublished data on the correlation between temperature sums and zonal positions of 90 meteorological stations being situated in the three northernmost zonal units of the PAF map, corresponding to the most common concept of the High Arctic. These data showed a very strong positive correlation with an \( r^2 \) value of 0.92. The three northernmost zones also represented almost equal temperature ranges, and the data presented support the present subdivision of the High Arctic in the PAF map.

Conclusions

1. The CAFF Flora Group concluded that the polar tree line is a well-defined criterion that can be used to delimit the Arctic against the neighbouring boreal zone, and it is only in the amphi-Beringian sector where additional criteria are necessary to determine the status of some areas.

2. The CAFF Flora Group did not define any alpine areas south of lines connecting the northernmost forests as Arctic. There is a gradual transition from arctic to alpine vegetation, and criteria for distinguishing one from the other have not been established. This means that the CAFF Flora Group accepts the PAF map (Elvebakk et al. 1999) as a cartographic reference for what we consider the Arctic our primary area of interest.

3. Nevertheless, it is a fact that numerous species and vegetation types occurring in the Arctic are also found south of the presently drawn southern limit of Arctic, particularly in the adjacent mountains, irrespective of what these areas are called. To be able to treat conservation issues in a broader perspective, the Group therefore can and should extend the geographical reference area of species, vegetation and ecosystems of the Arctic to include also areas where these occur in mountains neighbouring the Arctic as defined by the PAF map.
References


Box 1. Zonal Subdivision of the Arctic


Zone A. Desert-like with widely scattered phanerogams, plant cover is mostly less than 5%.
Zone B. Prostrate shrubs such as Dryas and Salix, especially S. arctica and S. polaris; peat accumulation occurs and mires with Carex and Eriophorum species are present; plant cover is discontinuous.
Zone C. Zonal habitats dominated by the dwarf-shrub Cassiope tetragona and minerotrophic fens cover large areas; plant cover in zonal sites is closed.
Zone D. Zonal habitats dominated by dwarf shrubs of the genera Betula, Empetrum, Salix, and Vaccinium; oligotrophic peat development occurs in mires, which have a hummocky structure.
Zone E. Zonal habitats with shrubs (greater than 0.5 m) with common species of the genera Salix, Alnus, and Betula. In the amphi-Beringian area, tussock tundra dominates and on the Asian side it co-occurs with altic thicket of Pinus pumila.
Zone N. The map shows a small northern boreal birch forest (Betula pubescens) enclave in South Greenland.
VI. LINKAGES BETWEEN CAFF AND ITEX

Philip A. Wookey
Uppsala University
Department of Earth Sciences
Villavägen 16
S-752 36 Uppsala
Sweden

E-mail: Philip_Andrew.Wookey@natgeog.uu.se

The International Tundra Experiment (ITEX, a MAB NSN program) has been working since December 1990 toward an improved understanding of the potential impacts of global warming on tundra vascular plant species. The purpose of ITEX is to monitor the performance of plant species and communities on a circumpolar basis in undisturbed habitats and without environmental manipulations. The approach has been based upon simple, robust but effective passive warming of in situ tundra vegetation at a range of sites within the tundra biome including both arctic and alpine. The geographical spread of sites in ITEX, and the range of physico-chemical environments that they encompass, are considered key elements of the program. At present there are over 20 active ITEX field sites throughout the circumpolar Arctic and in some alpine areas, operated by field parties from 13 countries.

The basic experiment is a temperature enhancement manipulation, where the field mean surface temperature is increased by 2 - 3° C to simulate the climate at the middle of the next century according to the forecast from the General Circulation Models (GCM). Most of the results generated within ITEX so far relate to the response of single species, but from the field season of 1995 the experimentation was scaled up to include community-level responses. There are also ITEX research efforts dealing with plant phenotypic plasticity and quantitative genetics of some of the target species.

Most ITEX field stations now have a standardized climate station in accordance with the ITEX Manual. The Manual also provides standardized methods for permafrost monitoring, (collaboration with IPA, the International Permafrost Association), monitoring of snow cover and lake ice, documentative analysis of permanent plots, assessment of seed rain and seed banks, statistical analysis, and data management.

During the CAFF Flora Group (CFG) meeting in Uppsala in March 2001 an overview of ITEX was presented as a catalyst for a discussion of the design and implementation of monitoring/experimental networks in tundra regions. ITEX and CAFF/AMAP have been working together since March 1998 (Rovaniemi, Finland) to exchange ideas and experience in this area. One of the key issues taken up was the possibility to harness the resources (in terms of infrastructure, personnel and access to undisturbed tundra sites) potentially available in the national parks and protected areas of the Arctic region. At sites where a ranger station is operating, or a settlement nearby, there may be great potential to organize ITEX-style experiments, or monitoring of unmanipulated plots, by personnel or local interested individuals/groups. One example that was discussed (suggested by Dr. Susan Aiken, Canadian Museum of Nature) is at Sack’s Harbour on
Banks Island, Canada. On a related matter, Philip Wookey also raised the issue of the type of measurements that would be suitable for longer-term monitoring (such as date of bud-burst and reproductive phenology, seed output), perhaps by non-experts. This, and other key issues such as the national parks network will be discussed within the ITEX program, and we will report back to CAFF with our conclusions and a suggested implementation plan. ITEX does not meet as a full group again until September 2002 (in Finse, Norway), but a discussion can be initiated by use of the ITEX e-mail list server (ITEX@lists.colorado.edu).
The Panarctic Flora Project began as a biodiversity project with the aim of creating a comprehensive database on arctic plants. The project has undergone changes over the several years of its existence from a bilateral effort between the United States and Russia to a multinational effort by taxonomists with its first goal to produce a unified checklist of the arctic vascular plants. This goal is now being realized. A provisional draft of the checklist has been completed. A final meeting to make the necessary taxonomic and nomenclatural decisions to unify the treatment of taxa is planned for September 2002, and the final version is planned for publication late in 2002 in both hard copy and on the PAF web site. The provisional checklist draft will be made available, for discussion and comments, on a temporary web site. The checklist is further planned as a prodromus for a future real Panarctic Flora.

The unified checklist is made both possible and necessary by the diverse taxonomic philosophies and traditions evident in the many regional floras available to us. Especially among wide ranging species, for which the Arctic is renown, morphology and behavior throughout the circumpolar north can vary significantly from place to place; this variation has led to different taxonomies. The process of unifying these treatments, while not always possible, has presented us with an intellectual challenge that has forced us to make clear our differences and the reasons behind them.

The checklist contains proposals of a standardized taxonomy for all arctic vascular plants, a recommended nomenclature (but with citation of all major synonyms in current use), full comments on alternative taxonomic and nomenclatural solutions and on remaining problems, some information on types and chromosome numbers, and information on distribution, frequency and status (e.g., as native, introduced, stable or not) for all accepted taxa within the six nations involved, within five arctic bioclimatic zones, and within the 21 arctic phytogeographical regions proposed. Appendices IV and V give actual examples using the genus *Juncus* for taxonomy and distribution, respectively.
Providing a checklist is not a purely academic exercise, but one with immediate applications to other projects, particularly those that are circumpolar in scope. For example, the International Tundra Experiment (ITEX) and the Circumpolar Arctic Vegetation Map project (CAVM) need a standardized taxonomy and nomenclature to follow. Inasmuch as the participants in PAF all are curators or associated with active herbaria with major arctic collections, they have the knowledge and documentation of rare plants in the Arctic and thereby through CFG serve CAFF needs. The network of experts and herbaria established by CFG is therefore at least as important as the checklist itself.
VIII. ROLE OF THE CFG IN THE CONSERVATION OF ARCTIC FLORA

Bengt Jonsell
Professor Bergianus
Bergius Foundation, P.O.Box 50017
SE-104 05 Stockholm
Sweden

E-mail: bengtj@bergianska.se

The CAFF Flora Group (CFG) starts, in my opinion, in a favorable situation with respect to the excellent progress made by the Panarctic Flora Project (PAF), whose checklist of arctic vascular plants is within sight of completion. This means a firm basis for one of the main tasks of CFG, the preservation of plant species and areas with species rich floras. Its important for CFG to transmit the critical, scientific mode of thinking expressed in the PAF-list to discussions within CAFF. Also, the progress made in mapping adds essentially to a promising starting point.

A matter of concern is the support for botanical competence necessary for evaluation of the arctic flora and vegetation. It is increasingly difficult to get funding for taxonomic research, and even the training of young people in arctic floristics, taxonomy and phytogeography is diminishing. Ways to secure future competence should be given attention.

Presently there is a lack of taxonomic/floristic interest in the flora of Greenland. The Greenlandic institutions, as well as the Botanical Museum at the University of Copenhagen, should be encouraged to engage themselves in those matters.

The documentation of the Arctic flora with specimens is important and therefore CFG should to obtain an inventory of existing collections of Arctic plants, some of which are located outside the countries represented in CFG. Where are the important collections, and is help needed to protect and preserve them?

I support the view that mosses and lichens should be included within CFG obligations. Their great importance in Arctic vegetation and the reasonably good knowledge we have about them makes the necessity for their inclusion an obvious one.

It is essential that CFG exerts pressure on CAFF to pay much more attention to flora and vegetation. We should aim at a more biologically sound balance among issues taken into consideration. CAFF through CFG, should deal with the plant species, the flora (species composition), and the vegetation at a proper balance and degree of integration.
IX. ROLE OF CAFF FLORA GROUP (CFG) AND INTERNATIONAL SCIENTIFIC INITIATIVES

David F. Murray
Professor Emeritus
University of Alaska Museum
907 Yukon Drive
Fairbanks, AK 99775 USA

E-mail: fidfin@aurora.uaf.edu

Through the activities of CFG representatives, we have had de facto integration of interests with International Tundra Experiment (ITEX), Panarctic Flora Project (PAF), and Circumpolar Arctic Vegetation Map Project (CAVM). Additionally, various members of CFG have associations with representatives of International Arctic Science Committee (IASC) and Man in the Biosphere (MAB) Northern Science Network. Collectively we are very aware of what is going on of a complementary nature and we therefore avoid duplication of efforts. The question is whether there is a need to formalize relationships of CFG with these other activities; this question was left unanswered. But, it is clear that by establishing a Web presence for CFG we can also make links to other web pages and connect our various electronic presentations. More than this may not be needed. Invitations to representatives of these other activities should be tendered for the next meeting of CFG. The value of the presentation on ITEX by Phil Wookey (see above) show how important these interactions can be.

CFG has expressed strong support not just for the international activities mentioned above, but also for:

1) botanical libraries and herbaria and felt the need to express just how central they are to our and other efforts,

2) student involvement in our work and training of the cadre of specialists who will in time replace us, and

3) engagement of the Greenlandic community in the study of Greenland's plants, both research botanists and policy makers.

Financial support is central to work on arctic plants. It is understood that CAFF is not a granting agency, but to the extent its endorsement of projects is desirable, we want to see that sort of influence applied. We can assume the role of brokers on behalf of projects and use CAFF to gain support. But, it has become clear that there are funding issues "closer to home" as it were: for CFG to function there must be sufficient funding dedicated by each national representative to support travel to CFG meetings. That minimum of support must be met.

We touched on examples of cooperation between institutions among member countries and wish to foster these exchanges at the level of scientist and student. Much can be accomplished to foster collaboration through an extended conversation among CFG
representatives via email.

Inasmuch as conservation is our task, we thought that for the cases in which protection does not already exist, we should seek it for areas where experimental and long term botanical studies are under way. Insuring that permanent plots will indeed be permanent, is a task we must forward to the ministerial level in CAFF.
X. COOPERATION BETWEEN CAFF FLORA GROUP (CFG) AND OTHER CONSERVATION GROUPS

Mora Aronsson
ArtDatabanken / Swedish Species Information Centre
SLU / Swedish University of Agricultural Sciences
Box 7007
75007 Uppsala, Sweden

E-mail: mora.aronsson@dha.slu.se

There are not many organizations dealing with the Arctic area, especially not in the field of plant conservation. Most organizations concerned with the Arctic work mainly with charismatic animals such as polar bears or spectacular birds. On a global level, however, there are at least some organizations potentially interested in plant conservation in the Arctic.

1. World Wide Fund for Nature (WWF) works with plant conservation on a global basis. So far the Arctic area is an exception, but this might change if the WWF receives some direction from the CAFF Flora Group (CFG). The Internet address of WWF is <www.panda.org>.

2. Fauna and Flora International (FFI) is currently working with the worldwide conservation of flora and fauna with the exception of the Arctic and Antarctic. In the future, however, they might be willing to participate in Arctic projects <www.fauna-flora.org>.

3. International Mire Conservation Group (IMCG) works with conservation of wetlands and wetland species, including plants. This organization might become a useful partner in conservation efforts concerning Arctic wetland plants <www.imcg.net>.

On the regional level there are some organizations that might cooperate in future such as Planta Europa. It is a network of European organizations working with flora conservation. This network is still forming, but in the future it will include plants of northernmost Europe. Their Internet address is <www.plantaeuropa.org>.
XI. FLORA MONITORING: CREATING A NETWORK OF SITES FOR LONG-TERM BIODIVERSITY MONITORING IN THE ASIAN ARCTIC

Boris A. Yurtsev
Head, Far Northern Vegetation Department
Komarov Botanical Institute
Russian Academy of Science
2 Professor Popof Street
St. Petersburg, 197376 Russia

E-mail: yurtsev@ik6026.spb.edu

When the term biological monitoring is used, it may mean monitoring at the species, population, community, or ecosystem level. But if creation of a long-term monitoring network is desired, the appropriate level of integration should be the local or elementary floras of a landscape.

In contrast to the more mobile fauna, flora consists of organisms attached to the substrate. These species may have a life-span of from a few tens to hundreds of years, and the species survive during changing environment due to the diversity of habitats and microniche. However, the expected global climate change may be great and rapid. To monitor the long-term transformation of the whole flora, and not simply some priority species, one needs a network of monitoring sites, where within a radius of 6 to 10 km, a set of plant species are examined in detail and an assessment of their frequency in the landscape and habitat preferences are recorded. Such a unit of flora in the Russian floristic literature is termed “local flora,” a sample of the floristic situation in a given geographical locality, a “floristic plot.” Another term “concrete, or elementary flora” is the flora of a landscape – i.e. area with certain set of habitats, where the habitats of the same type do not differ in species composition or have only minor differences. If the local flora (floristic plot) is examined within a homogenous concrete flora, it will characterize the concrete flora. But the local flora data may be taken at the boundary of two to three landscapes or within a phytogeographic boundary, and result in a floristic continuum. Such heterogeneous floras should be especially sensitive to global changes of climate, because they include contrasting, vicarious elements, coexisting under the same macroclimate, but usually on different habitats.

One needs a periodical re-inventory of local floras every 10–50 (100) years, with special attention to changes in the floristic data and status of both rare and common (indicator) species as well as the precise temporal attachment (recording) of the data. We need to bring the published and unpublished data for well-known local floras into computerized databases on local floras as part of the monitoring network. Additional local floras may also be studied to fill in network gaps. These monitoring data will identify changes and trends in the flora against a background of global or regional changes of the environment. They may also reveal the species under threat of extinction at local, regional, or total levels. Short-term use of such monitoring networks may lead to the recognition of terrestrial gradients of various floristic parameters and correlation with climate parameters.
In 1996–1998, research associates of the Far North Vegetation Laboratory, Komarov Botanical Institute, Russian Academy of Sciences (St. Petersburg) received two small three-year grants for "Developing the program and the preparation of biodiversity monitoring sites network in the Asian Arctic on local flora level" from the Russian Foundation for Fundamental Investigations (RFFI). This program for monitoring was published in Russian (Yurtsev 1997a, 1997b, 1998) and its short version distributed to the CAFF countries (1997). Out of several hundred local floras studied by this group in the Asian Arctic since 1955, 160 of them were selected for inclusion into the monitoring network – 130 basic and 30 supplementary ones. Selection of local floras was made according to certain criteria: (1) representativeness for certain zones and sectors, (2) presence of unique species, including relicts and endemic species, (3) floristic richness, (4) position at phytogeographic boundaries, (5) high degree of inventoring, (6) availability of phytosociological releves, (7) ecological characteristics of species, and (8) data on their landscape activeness. Notable gaps in the network were revealed in the Gyda Peninsula, the Polar Urals, the high-arctic islands, and western and eastern Yakutia.

The computerized database includes (1) records of local floras at 45 sites, (2) species lists of local floras with an assessment of their landscape frequencies and abundance classes, and (3) general information on the geographic distribution and growth-form of species.

Currently, the records of more than 80 local floras and the lists of 110 local floras have been entered into the database. The library of accepted names of species and subspecies includes 1,700 Latin names. An additional small grant was received from RFFI for 1999–2001 for completing the local flora reports, and entering the rest of lists and landscape frequency–abundance values of species as well as necessary textual characteristics into the database. The comparison of zonal changes of various parameters of floras such as the per cent of circumpolar species in various longitudinal sectors gave valuable results. Especially distinctive situations are recorded in Asian Beringia. The network should be coordinated with the AMAP network, weather station network, ITEX sites, and other geobotanical monitoring.

Whether or not this monitoring site network will become circumpolar is dependent on the other CAFF countries. As to the possibilities of involving western countries, it would be easiest for those areas using a grid-system of mapping the flora as has been done in all Scandinavian countries. In Alaska and Canada, the basis of the network could be provided by the places such as biological stations, habitat protected areas, and ITEX sites.

Elena and Igor Pospelov obtained very interesting results for eastern coast of Taymyr Lake where Tolmachev recorded detailed data on a local flora in 1928. Comparison with the modern flora revealed dramatic changes in the composition of the local flora and the frequencies of many species. Many lists of local floras studied in detail in the 1950s and 1960s are now available.
XII. PROPOSAL FOR "ATLAS OF RARE ENDEMIC BRYOPHYTES AND LICHENS OF THE ARCTIC"

Dr. Hörður Kristinsson
Icelandic Institute of Natural History
P.O. Box 180
IS-602 Akureyri, Iceland

E-mail: hkris@ni.is

One of the goals of CAFF and the CFG is to promote conservation of the circumpolar, arctic flora. A prerequisite for successful conservation measures is good knowledge of the species present and their distribution. We are now well on our way to obtain such a view of the vascular plants in the area.

Judging from information available on the Svalbard area (see Section V, “Definition of the Arctic for the CAFF Flora Group” by A. Elvebakk), there are good indications that the majority of the circumpolar arctic flora are bryophytes and lichens rather than vascular plants. Within the CAFF Flora Group, there was agreement that we should not neglect this substantial part of the arctic flora, but recommend to head towards an "Atlas of Rare Endemic Bryophytes and Lichens of the Arctic”.

In order to prepare such an Atlas, it was also agreed that it would first be necessary to obtain material for a checklist of the species of mosses and lichens within in the circumpolar arctic area, including information on, or at least bibliographic citations of information on their distribution. Such a list must also be surveyed by specialists in the various plant groups and brought into a uniform, consistent nomenclature for the total area.

The members of the CAFF Flora Group provided information on different checklists or floras which either exist already, or are in preparation for different parts of the circumpolar arctic area. Mention was made of John Thomson's North American Arctic Flora, the work of Eric-Steen Hansen in Greenland, Arve Elvebekk and Øvstedal in Svalbard, the St. Petersberg group for the Russian Arctic, and the work of Barbara Murray in Alaska.

In order to proceed with this work, the following recommendations were made:

1. Preparations should be made to collect information on available checklists of lichens and mosses for the different parts of the arctic area, and combine them into a database. It was recommended that Hörður Kristinsson should lead this approach for the lichens, but a bryologist will be needed to start similar preparations for a bryophyte checklist.

2. After these preparations have been made, it will probably be necessary to form a kind of workshop of bryologists and/or lichenologists with knowledge within parts of the area, in order to ensure consistent and uniform nomenclature, provide additional information, and at the end to finalize such a checklist.
3. As a last step, when all the information listed above has been collected, it should be relatively easy to produce an *Atlas of Rare Endemic Bryophytes and Lichens of the Arctic.*
XIII. PROPOSAL FOR A SECOND INTERNATIONAL WORKSHOP ON CLASSIFICATION OF ARCTIC VEGETATION

Fred J.A. Daniels
Institute of Plant Ecology
Westfälische Wilhelms-Universität
Hindenburgplatz 55
48143 Münster, Germany

E-mail: daniels@uni-muenster.de

The first international workshop on Classification of Circumpolar Arctic Vegetation was held March 5 - 9, 1992 in Boulder, Colorado, U.S.A. This successful event was organized by Dr. Marilyn Walker, at that time of the Institute of Arctic and Alpine Research, University of Colorado, Boulder. It was supported by the U.S. Man and Biosphere Program hosted by the Joint Facility for Regional Ecosystem Analysis, Institute of Arctic and Alpine Research, University of Colorado. The impact and outcome of this very stimulating workshop on arctic vegetation classification were considerable. The workshop proceedings were published as a special issue of an international journal, the Journal of Vegetation Science (Walker et al. 1995). In addition, the formulation of a resolution to prepare an arctic circumpolar database, classification, and vegetation map was signed by all participants from North America, Europe and the former USSR. This resulted some years later in the Circumpolar Arctic Vegetation Mapping (CAVM) Project under leadership of Donald A. ("Skip") Walker, Boulder, now Fairbanks. This prestigious international project has already completed four workshops held in St. Petersburg, Russia, Arendal, Norway, Anchorage, Alaska, and Moscow, Russia; a.o. Walker & Markon 1996) and a final one is planned in St. Petersburg in the beginning of 2002. Another highlight of the CAVM project was the 1999 CANTRAN expedition through all arctic subzones of the Canadian Arctic (Gonzales & et al. 2000) with CAVM scientists and students. Additionally, the classification workshop and mapping project stimulated international contacts, cooperation, and joint fieldwork.

In the meantime, a number of important new scientific contributions pertaining to the flora and vegetation have appeared. Ten years after Boulder we think the time is right to

1. survey and evaluate the progress made in arctic vegetation classification, mapping research, and other directly related geobotanical research, and

2. formulate goals for the near future.

The proposed second workshop should primarily deal with results of recent arctic fundamental geobotanical research with the main emphasis on vegetation classification, mapping and floristics. It should also address biodiversity, nature protection and future research items. Moreover, the workshop should have a substantial educational component, and young students with interest in arctic botany will be encouraged to
participate. The workshop will have invited and submitted lectures, poster sessions, and
at the end a field trip. Many countries have educational systems offering students
financial support for attending workshop and excursions. Participation will be credited
according to the international university/high school credit point system.

The workshop is proposed to be held in Greenland, in Kangerlussuaq, in the inland of
Southwest Greenland in the summer of 2003. A one week period in July seems to be
most appropriate. The following considerations were important in selecting this
location:

1. Greenland. The workshop dealing with the geobotany of the Arctic should be
preferably held within an arctic territory. Greenland has a central circumpolar arctic
position situated between the main part of the North-American Arctic and the
Eurosiberian Arctic. Greenland connects both parts of the Arctic.

2. We should pay special attention to the Greenlandic situation within the circumpolar
botanical world. Denmark had a long and excellent tradition in geobotanical
research in Greenland (cf. Daniels 1994). However, since the mid-1990's
geobotanical research in Greenland became less and less of a priority. As a result
only very few scientists are able to continue the task of the former Greenland
Botanical Research. Actually, floristic research, vegetation classification and
vegetation mapping research is mainly carried out now by non-Danish scientists.
There are still many poorly known regions in Greenland, while at the same time,
human pressure steadily increases on its vulnerable natural landscape. This is
particularly true for the more southern areas. Despite the occurrence of endemic
species in the south (Talbot & al. 1999), this is where most people live and where no
protected areas exist at all. Thus, there is a real concern that fundamental
knowledge of the flora and vegetation of Greenland will be lost forever if nothing
happens. To help educate and prepare the authorities for their responsibility for the
protection of nature, we propose to bring a large contingent of the international
scientific geobotanical community together in Greenland. We hope and are
confident, that this event will stimulate new geobotanical research and educational
approaches, particularly for the native students of Greenland.

3. Kangerlussuaq is a former US military base and the main entry for air traffic to
Greenland from Canada and Europe. It provides good facilities and logistics; the
Kangerlussuaq International Science Support (KISS) is situated here. It is located
just north of the Arctic Circle at the head of the 140 km long Kangerlussuaq Fjord.
The climate is continental and dry. The surroundings offer a well-investigated,
varied low arctic landscape with a rich flora and vegetation and a wealth of
scientific knowledge in many fields of the bio- and geosciences. The area has a
great variety of traveling possibilities and is connected by boat and aircraft with all
parts of Greenland. It is very appropriate for excursions.

CAFF Flora Group participants strongly supported this proposal by Fred Daniels and he
was encouraged to start with the preparations. Stephen Talbot’s offer to help was
gratefully accepted.
Literature Cited


XIV. CAFF FLORA GROUP SUPPORT FOR THE CIRCUMLAR PROTECTED AREAS NETWORK (CPAN)

Susan G. Aiken
Herbarium, Vascular Plant Section
Botany Division
Canada Museum of Nature
P.O. Box 3443, Station D
Ottawa, Ontario K1P 6P4

E-mail: saiken@mus-nature.ca

Protected areas in the Arctic have rarely (if ever) been chosen with flora or vegetation as the primary consideration. The result is that significant areas of flora are unprotected, and thus the CAFF Flora Group (CFG) has a contribution to make in this regard. The CFG is firmly behind the third objective in the CAFF mandate to establish protected areas in the Arctic where they will contribute to the conservation of ecosystems, habitats, or vegetation, and species. The group agreed that protected areas are key elements in efforts to conserve biological diversity and should involve:

1. Large representative areas of ecosystems and distinctive vegetation,

2. Sites that contain a large portion of a particular species or great species diversity, and

3. Cultural sites when a distinct flora is associated with them.

The CFG considered Habitat Conservation Report (HCR 1) and agreed that there is a need for more protection as a result of

1. Increasing numbers of people moving into the Arctic,

2. Development and introduction of southern technology by the new residents,

3. Extraction of non renewable resources (such as oil, gas, and minerals in particular), and

4. Increase in numbers of certain species of birds (geese in particular) that in limited places are destroying the vegetation and flora.

Concerning HRC 2 the group noted that areas proposed for protection rarely take flora or vegetation as the primary consideration for choosing protected sites. CFG is endorses the goals of HRC 2 and has members in a position to contribute to them by:

1. Increasing the level of knowledge and data collection,

2. Identifying the significant gaps in national networks of protected areas and selecting candidate sites for further action, and
3. Identifying needs and opportunities for modifying existing protected areas to take flora into consideration.

From HRC 3, the CFG identified with the primary concerns of habitat, species, and ecosystem conservation. Among the many secondary concerns in HRC 3, the group identified areas where members might contribute:

1. Establishing trans-boundary protected areas, international parks and wildlife refuges,
2. Focusing on specific specialized habitat types, and
3. Providing thorough pre-designation scientific studies and environmental impact assessments.

From HRC 4, CFG focused on the guidelines for selection of sites with flora as a criterion, and they agreed that a circumpolar network should incorporate and protect sites that:

1. Have a high flora diversity,
2. Contain rare, endangered or unique flora,
3. Contain flora having significant food value, and
4. Have high potential for research and monitoring.

The suggestion that protected areas should be important for marine primary production was noted but the focus of CFG now is terrestrial, and members did not feel qualified to comment.

The gap analyses of HRC 5 were noted with doubts expressed about percentage statistics that seem unreliable given the different definitions of Arctic applied by the CAFF countries.

CFG endorsed the goal of the Circumpolar protected Areas Network (CPAN) Strategy and Action plan to "facilitate implementation of initiatives to establish, within the context of an overall Arctic habitat conservation strategy, an adequate and well managed network of protected areas that have a high probability of maintaining the dynamic biological diversity of the Arctic region in perpetuity”.

CFG is in a strong position to support CAFF work in:

1. Evaluating the contribution by existing protected area system to the conservation of circumpolar ecosystems, habitats, and species and identifying significant gaps in protected area coverage, and
2. Identifying and evaluating impacts on protected areas to ensure no diminution of their biological diversity.
The current CFG members did not identify actions necessary to enhance the marine component of CPAN (in co-operation with PAME, Protection of the Arctic Marine Environment). Current members of CFG have terrestrial backgrounds and did not feel qualified to comment.

In Canada, it was noted that Parks Canada is in the process of setting up a network of parks in the Arctic but to date none of them have been chosen with flora as the first consideration, and three areas of particular plant interest are not included. The Parks Canada shift in emphasis since 1998 to ecological integrity as the first priority in park management was considered a concept that could be useful in the circumpolar area.

An ecosystem has integrity:

1. When it is deemed characteristic for its natural region, including the composition and abundance of native species and biological communities, rates of change and supporting processes, or

2. When they have their native components (plants, animals and other organisms) and processes (such as growth and reproduction) intact.

In the breakout session, the discussion that followed indicated several areas where protection of arctic flora would be desirable including:

1. Svalbard where the existing protected areas effectively exclude a floristically significant habitat.

2. Southern Greenland where increasing activities are destroying sites of unique vegetation.

3. Canadian Arctic Archipelago.
   a) Axel Heiberg Island, Expedition Fiord, where the McGill Biological Station has been recording data for many years.
   b) Baffin Island, along the Soper River, where willow trees as tall as people occur in a limited area that has not received significant floristic study. This may become a Nunavut initiative.
   c) Ellesmere Island, Hot Weather Creek, a thermal oasis with a surprising number of plants for a latitude of 80°N.
   d) Victoria Island, Minto Inlet, where willow trees taller than people occur, and where there has been no detailed floristic study.
At CAFF VII in Nuuk, Greenland some questions arose from United States botanists over the criteria for selection of non-endemic plant species. Criteria of species selection for the list was regarded as insufficient and imprecise. Thus, we have been discussing the criteria with colleagues (D. F. Murray) via e-mail for a year. A consensus was reached at a Panarctic Flora meeting at in Oslo (1998) with the participation of the Norwegian botanist Arve Elvebakk. A decision was made that the list of rare plants of the circumpolar concern should include the following groups:

1. **Rare arctic endemics** (as presented in the CAFF *Atlas of Rare Endemic Vascular Plants of the Arctic*),

2. **Rare metaarctic endemics**, which are in common to both the Arctic and the alpine belt of the same sector of the Subarctic, with the total number of localities not exceeding 20, also with narrow distribution in the Arctic (one to two areas);

3. **Rare hypoarctic (lowland-subarctic) endemics**, which are common to one to two areas in the Arctic and the neighboring plain and low mountains in the Subarctic, with the same quantitative limitations. Species of categories 2 and 3 are subendemics in the Arctic and, besides, could be the candidates for inclusion into the Global List of imperiled or, at least, vulnerable species, especially if the number of populations is fewer than ten, the populations being widely separated and with few individuals.

4. **Plants which are non-endemic but very rare in the Arctic** (with fewer than ten distant localities in one to two areas), whose arctic localities are widely disjunct from the ones in the other, non-arctic zones such as the boreal, nemoral, or steppe taxa or those located in mountainous areas remote from the Arctic. These arctic populations of non-arctic species either adapted to the arctic climate and became an irreplaceable component of the gene pool of the arctic biota, or persisted as components of relic plant communities on special extrazonal habitats within the Arctic such as relic, steppe complexes on south-facing bluffs in the Beringian Arctic. Thus, representatives of the category 4 could be grouped ecologically.

Presently, the list includes 57 species, of which two are metaarctic rare endemics, 15 are the hypoarctic, and 40 are non-arctic rare disjuncts.
It is important to complete the work on the List of rare plants of the Arctic as it could become an essential component in planning the further development of the Circumpolar Protected Areas Network (CPAN), and for determining the priorities of CAFF conservation activities on flora, as a tool in gap analysis.

Our modified "List of rare species of circumpolar concern" is given below:

I. Arctic Endemics (additions to the CAFF Atlas):
   1. Senecio arcticisibiricus Jurtz. et Korobk., Asteraceae
   2. Trisetokoeleeria taimyrca Tzvel., Poaceae

II. Metaarctic Endemics:
   3. Papaver walpolei A. Porsild, Papaveraceae
   4. Phlox richardsonii Hook. subsp. richardsonii, Polemoniaceae

III. Hypollarctic Endemics:
   5. Gagea samojedorum Grossh., Liliaceae
   6. Polygonum caurianum B. L. Robins. subsp. hudsonianum Wolf & McNeill, Polygonaceae
   7. Chenopodium glaucum L. var. pulchrum Aellen, Chenopodiaceae
   8. Smelowskia calycina (Steph. ex Willd.) var. media Drury & Rollins, Brassicaceae
   9. Thlaspi kamtschaticum Karav., Brassicaceae
   10. Dryas grandiflora Juz., Rosaceae
   11. Oxytropis schmorgunoviae Jurtz., Fabaceae
   12. Oxytropis sublongipes Jurtz., Fabaceae
   13. Castilleja yukonensis Pennell, Scrophulariaceae
   15. Artemisia samojedorum Pamp., Asteraceae
   16. Erigeron yukonensis Rydb., Asteraceae
   17. Taraxacum anadyricum Tzvel., Asteraceae
   18. Taraxacum stepanovae Worosh., Asteraceae

IV. Non endemics with disjunct distribution:

IVA. Steppe Plants

   19. Festuca kolyzensis Drob., Poaceae
   20. Hierochloe annulata V. Petrov, Poaceae
   21. Heliototrichon krylovii (Pavl.) Henrard., Poaceae
   22. Carex duriuscula C. A. Mey., Cyperaceae
   23. Carex enervis C. A. Mey., Cyperaceae
   24. Carex sabulosa Turcz. ex Kunth., Cyperaceae
   25. Anemone sylvestris L. s.str., Ranunculaceae
26. *Thellungiella salsuginea* (Pall.) O. E. Schulz, Brassicaceae
27. *Phlox sibirica* L., Polemoniaceae
28. *Eritrichium sericeum* (Lehm.) DC. subsp. *sericeum*, Boraginaceae
29. *Taraxacum jacticum* Tzvel., Asteraceae

IVb. Hot Spring Plants

30. *Ruppia maritima* L., Ruppiaceae
31. *Juncus ambigus* Guss. var. *ossoracis* (V. Novikov) V. Novikov, Juncaceae
32. *Chenopodium glaucum* L. var. *pulchrum* Aellen, Chenopodiaceae
33. *Mentha sachalinensis* (Briq.) Kudo, Lamiaceae

IVc. Warm Sea Transgressive Plants

34. *Puccinellia kurilensis* (Takeda) Honda, Poaceae
35. *Bolboschoenus planiculmis* (Fr. Schmidt) Egor., Cyperaceae
36. *Atriplex gmelini* C. A. Mey., Chenopodiaceae
37. *Spergularia canadensis* G. Don, Caryophyllaceae

IVd. Montane

38. *Carex albonigra* Mackenzie, Cyperaceae
40. *Claytoniella bostockii* (A. E. Porsild) Jurtz., Portulacaceae
41. *Draba incerta* Payson, Brassicaceae
42. *Smelowskia alba* (Pall.) Regel. Brassicaceae
43. *Douglasia alascana*, Primulaceae
46. *Aster alpinus* L. subsp. *vierhapperi* (Ohno) Cronq., Asteraceae
47. *Leontopodium kurilense* Takeda s. l., Asteraceae
48. *Saussurea schanginiana* (Wyd.) Fisch., Asteraceae

IVe. Halophytes

49. *Suaeda calceoliformis* (Hook.) Moq., Chenopodiaceae
50. *Plantago eriopoda* Torr., Plantaginaceae

IVf. Group Unclear

51. *Carex laxa* Wahlenb., Cyperaceae
52. *Minuartia yukonensis* Hultén, Caryophyllaceae
53. *Aphragmus escholzianus* Andrèz., Brassicaceae
54. *Nesodraba grandis* (Langsd. in DC.) Greene, Brassicaceae
55. *Thlaspi arcticum* Porsild, Brassicaceae
56. *Tillaea aquatica* L., Crassulaceae
57. *Astragalus bodinii* Sheldon, Fabaceae
58. *Gentiana raupii* Porsild, Gentianaceae
59. *Cryptantha spiculifera* (Piper) Payson s.l., Boraginaceae
60. *Crepis elegans* Hook., Asteraceae

V. Arctic Endemics (with great disjunction in the Arctic)

63. *Puccinellia beringensis* Tzvel., Poaceae

**XVI. CIRCUMPOLAR ARCTIC VEGETATION MAP (CAVM)**

Stephen S. Talbot  
U.S. Fish and Wildlife Service  
1011 East Tudor Road  
Anchorage, Alaska 99503 USA

E-mail: stephen_talbot@fws.gov

A new vegetation map will provide a common legend and language for ecosystems of the Arctic region. Such a map is needed for numerous international efforts, including global-change and conservation studies, land-use planning, large-scale resource development and education. Remote sensing and geographic information system (GIS) technology now provide the means to develop a moderately detailed vegetation database for the entire Arctic. The Circumpolar Arctic Vegetation Map (CAVM) is based on current knowledge of arctic plant communities and their environmental controls. During the past six years, the CAVM participants have defined the project organization and methods in a series of workshops in Russia, Norway, Alaska, and Canada. Six groups of collaborators are now working on regional maps of Alaska, Canada, Greenland, Iceland, Svalbard, and Russia.

The First CAVM Workshop was held in St. Petersburg, Russia and funded by the Alaska Region, U.S. Fish and Wildlife Service. Realizing the importance of the CAVM, the Conservation of Arctic Flora and Fauna (CAFF) program supports CAVM as a priority action item for completion in 2002. Publication of CAVM would fully complete this CAFF action item. The National Science Foundation has supported the compilation over a five-year period by funding three workshops and map development; the Bureau of Land Management in Alaska supported one workshop in Anchorage. Of direct value to the Circumpolar Protected Areas Network (CPAN), the circumpolar arctic vegetation map will depict similarities and differences of physiognomic vegetation types on a circumpolar basis. It can be used to assist CPAN in selecting sites.

**Proposed Initial Map:** A single map sheet (48 X 36 inches) with color maps on both sides of the map sheet is proposed. It will be produced at 1:7.5 million scale, with inset maps at smaller scales, possibly 1:20 million. The front side of the map will present a large vegetation map showing the physiognomy of vegetation complexes. Inset maps will include (1) AVHRR base image, (2) topography, (3) bioclimatic subzones, (4) floristic subprovinces, (5) maximum NDVI, (6) dominant plant functional types, (7) horizontal structure, (8) above- and below-ground biomass, and (9) annual primary production. Given the considerable investment of time, effort, and money spent in
developing the Circumpolar Arctic Vegetation Map, the map will reflect state of the art technology and be printed on synthetic paper. Synthetic paper offers outstanding surface smoothness to achieve a high level of printability. The CAVM map product will be waterproof, stain-resistant, tear-resistant, strong, and durable.

A map based purely on automated remote-sensing procedures cannot portray the details of plant communities because of the large variability of tundra vegetation with similar spectral properties. Due to the small scale of the map and lack of previous vegetation maps for much of the Arctic, vegetation information must be inferred from expert knowledge of the plant communities in relation to principal landforms and terrain features that are visible on small-scale satellite imagery. In the Arctic, vegetation of a given landscape can be predicted on the basis of summer temperature regime (bioclimatic subzones), available plants in the regional flora (floristic sectors), soil chemistry, and prevailing drainage conditions. Our approach uses manual ‘photo-interpretation’ of AVHRR satellite image and requires expert knowledge of plant communities.

The initial map is intended for a broad-based audience; examples of potential users include vegetation scientists, ecosystem modelers, Native people of the Arctic, university and high school students. The initial map will be followed by a book with a more comprehensive treatment of arctic vegetation using CAVM as a framework and will include a complete vegetation database.

Proposed Publication Date: July 2002. A legend for the map will be prepared by August 30, 2001; first draft by February 7, 2002; review by May 15, 2002; final draft by June 15, 2002.
XVII. GENERAL CONCLUSIONS AND RECOMMENDATIONS

The general conclusions and recommendations of the CAFF Flora Group are:

**CAFF Flora Group Charter:** Minor modifications were made to the charter and the CFG approved the final revisions published herein.

*Recommendation:* Adopt the CAFF Flora Group Charter with minor revisions offered by the CAFF Flora Group.

**Use of the Term “Flora”:** The term flora in the title “CAFF Flora Group” is broadly interpreted to include flora and vegetation. CFG distinguishes between flora, an enumeration and separate description of each of the various kinds of plants, from vegetation, the mosaic of plant communities over the landscape.

*Recommendation:* Accept the term flora as broadly interpreted in the name of the organization “CAFF Flora Group”, but distinguish between the terms flora and vegetation in other uses.

**Arctic Climate Assessment (ACIA):** The relationship between the CFG and ACIA should avoid parallel processes within CAFF; coordination between the various subactivities should be the goal. CFG established contact with a lead author, Terry Callaghan, and will send copies of this report to him. How the CFG can contribute to the process is still open to discussion.

*Recommendation:* Continue the dialogue with ACIA. Lead: CFG.

**Definition of the Arctic for the CAFF Flora Group:** CFG accepts the Panarctic Flora Project map to delimit the Arctic. Thus, the polar tree line distinguishes the Arctic from the neighboring boreal zone, with the exception of the amphi-Beringian sector where additional criteria are necessary to determine the status of some areas. However, many species and vegetation types occurring in the Arctic do indeed occur south of the southern limit of the Arctic, particularly in adjacent mountains. Therefore, we take a pragmatic approach to treat conservation issues broadly and recognize the importance of adjacent areas. For the most part, the PAF map is congruent with the CAVM map.

*Recommendation:* CFG follows the PAF definition of Arctic, but extends the geographical consideration, when necessary, to include boreal mountains neighboring the Arctic.

**Circumpolar Arctic Vegetation Map Project (CAVM):** CFG recognizes the importance of the new circumpolar vegetation map to provide a common legend and language for the ecosystems of the Arctic. This map will show similarities and differences of physiognomically defined vegetation types on a circumpolar basis. It will be widely used by CPAN as well as in the fields of conservation, education, global change study, land-use planning, large-scale resource development, and vegetation science.
**Recommendation:** Encourage the distribution and use of the Circumpolar Arctic Vegetation Map, particularly by CPAN. Lead: Stephen Talbot, USA.

**Panarctic Flora Project (PAF):** PAF shows a critical scientific attitude and demonstrates results with immediate applications to other projects, particularly those that are circumpolar in scope, involved in arctic botany, and with a need for standardized taxonomies and nomenclature. Inasmuch as the participants in PAF all are curators or associated with active herbaria with major arctic collections, they have the knowledge and documentation of rare plants in the Arctic and thereby constitute a valuable resource to serve CAFF needs. The network of herbaria and their activities is therefore at least as important as the checklist in itself.

**Recommendation:** Encourage support by the CAFF National Representatives of PAF.

**CAFF Flora Group (CFG):** Financial support is central to work on arctic plants. It is understood that CAFF is not a granting agency, but to the extent its endorsement of projects is desirable, the CFG wants to see that sort of influence applied. The CFG can assume the role of broker on behalf of projects and use CAFF to gain support. But, it has become clear that there are funding issues related to the travel of CAFF Flora Group members to CFG workshops that will be held every two years. For the CFG to function, there must be funding dedicated by each national representative to support travel for him/her or his/her designee to CFG meetings. This minimum of support must be met.

**Recommendation:** The role of the CFG will be that of broker on behalf of projects and to obtain CAFF support. There must be sufficient funding to support travel to CFG meetings. Lead: Stephen Talbot, USA.

**Monitoring of “Local Floras”:** The approach for monitoring of local floras used in Russia is of interest to CFG. It was concluded that the approach should be described in detail.

**Recommendation:** Boris Yurtsev, Komarov Botanical Institute, will write a detailed instruction and method for monitoring local floras. The CAFF Flora Group will evaluate the approach for possible use on a circumpolar basis. Lead: Boris Yurtsev, Russia, and David Murray, USA.

**Monitoring of Rare Species:** Long-term monitoring of rare species was endorsed.

**Recommendation:** PAF serve as lead group for long-term monitoring of rare species. Lead: PAF.

**Checklists of Lichens and Bryophytes:** CFG recognizes the importance of bryophytes and lichens as major ecological components of arctic flora and vegetation. They account for a large portion of both its biomass and diversity. It was concluded that proposed projects for bryophytes and lichens could be accomplished by reviving the cryptogamic component of the original Panarctic Flora Project (PAF).
Recommendation: We recommend an initiative, encouraged by the CAFF National Representatives, to begin work on a checklist of lichens and bryophytes of the Arctic. Specialists should be contacted and two separate groups of taxonomic specialists in the fields of bryology and lichenology should be established. These checklists are an essential first step prior to assessment of rare taxa. Lead: Hórdur Kristinsson, Iceland.

Revised Atlas of Rare Vascular Plants of the Arctic: As the Panarctic Flora Project (PAF) checklist nears completion, new information is becoming available on the distribution and identification of rare vascular plants in the Arctic. It was concluded that a second edition of CAFF Technical Report No. 3 *Atlas of Rare Vascular Plants of the Arctic* be prepared that enlarges and revises the original. The new edition would include not only species of rare arctic endemics, but also rare boreal and alpine species that make incursions into the Arctic.


Circumpolar Protected Areas Network (CPAN): Flora and vegetation should be considered when making selections of new protected areas.

Recommendation: In planning areas for CPAN, the flora and vegetation should be considered in selecting areas for protection. Components to be considered should include, but not be limited to (1) special habitats such as hot springs and sand dune areas (western Victoria Island); (2) areas where significant disjuncts or extrazonal species occur; (3) areas with rare or endemic plants; and (4) areas with good examples of common plant communities as well as rare plant communities. Lead: Susan Aiken, Canada, and PAF.

Education of Next Generation of Botanists: There is a growing lack of competence in arctic botany as senior scientists age and leave the field. It is essential that young people become involved in arctic botany.

Recommendation: A plan should be developed to interest students our work and train of the cadre of specialists who will in time replace us. We must facilitate student exchange among participating countries. Lead: Bengt Jonsell, Sweden.

Second International Workshop on the Classification of Arctic Vegetation: Ten years have passed since the First International Workshop on the Classification of Arctic Vegetation was held. With a wealth of new information available, the time is right for a Second Workshop to be held in the year 2003 in Kangerlussuaq, Greenland, with formal papers and a field practicum (as a course for credit). Funding will be sought to support student participation.

Recommendation: Endorsement by CAFF National Representatives of the proposed Second International Workshop on the Classification of Arctic Vegetation. Lead: Fred Daniels, Germany, and Stephen Talbot, USA.

International Tundra Experiment (ITEX): The representatives recognize the importance of the ITEX studies in monitoring global change. Protected areas could be
of great value as potential ITEX sites because many are undisturbed and possess the infrastructure to assist researchers and provide locally interested individuals or groups.

**Recommendation:** Seek ways to harness the resources in terms of infrastructure, personnel, and access to undisturbed tundra sites within protected areas. **Lead:** CFG.

**Greenlandic Involvement in Botany:** CFG agrees on the importance of botany in Greenland. Engagement of the Greenlandic community in the study of Greenland's plants, from both research botanists and policy makers, is essential.

**Recommendation:** Encourage development of botanical expertise for Greenland. **CFG offers to assist.**

**Cooperation Between the CAFF Flora Group and Other Conservation Groups:** Although CFG brings a unique perspective by specializing on the botanical aspects of the circumpolar Arctic, there are other groups that share some of the CFG's interests. Examples include the World Wide Fund for Nature (WWF), Fauna and Flora International (FFI), and the International Mire Conservation Group (IMCG). As stated in the CFG Charter, our goals are “To promote, encourage, and co-ordinate internationally the conservation of biodiversity of arctic flora and vegetation and their habitats and research activities in this field; and to enhance the exchange of information relating to arctic flora and vegetation and factors affecting them.” Communication is essential to develop partnerships and to avoid replication of effort.

**Recommendation:** With the help of WWF and IMCG, and other organizations and parties, establish more effective communication by setting up a CFG web site within the CAFF web site and submit articles to journals such as *Plant Talk* to disseminate information about the goals and objectives of the CFG. **Lead:** CAFF Flora Group.
Appendix I. List of Participants

CANADA
Dr. Susan G. Aiken
Herbarium, Vascular Plant Section
Botany Division
Canada Museum of Nature
P.O. Box 3443, Station D
Ottawa, Ontario K1P 6P4
Phone: +1 613 990 6438
E-mail: saiken@mus-nature.ca

FINLAND
Dr. Henry Väre
Botanical Museum
Finnish Museum of Natural History (H)
P.O. Box 7
FIN-00014 University of Helsinki
Finland
Phone: +358-9-191 24433
Fax: +358-9-191 24456
E-mail: henry.vare@helsinki.fi

GREENLAND
Prof. Dr. Fred J. A. Daniëls
Institute of Plant Ecology
Westfälische Wilhelms-Universität
Hindenburgplatz 55
48143 Münster, Germany
Phone: +49 251 833835
E-mail: daniels@uni-muenster.de

ICELAND
Dr. Hördur Kristinsson
Icelandic Institute of Natural History
P.O. Box 180
IS-602 Akureyri, Iceland
Phone: +354 462 29 83
Fax: +354 461 12 96
E-mail: hikris@in.is

NORWAY
Dr. Arve Elvebakk
Department of Biology
University of Tromsø
N-9037 Tromsø, Norway
Phone: +47 77 64 43 94
E-mail: arve@ibg.uit.no

Dr. Reidar Elven
Herbarium, Botanical Garden and Museum
University of Oslo
Trondheimsveien 23 B
N-0562 Oslo 5
Norway
Phone: +47 22 85 16 32
E-mail: reidar.elven@toyen.uio.no
RUSSIAN FEDERATION
Dr. Boris A. Yurtsev
Head, Far Northern Vegetation Department
Komarov Botanical Institute
Russian Academy of Science
2 Professor Popof Street
St. Petersburg, 197376 Russia
Phone: +7 812 543 8367
E-mail: yurtsev@ik6026.spb.edu

SWEDEN
Dr. Bengt Jonsell
Bergius Foundation of the Royal Swedish Academy of Sciences
P. O. Box 50017
S-104 05 Stockholm, Sweden
Phone: +46 8 15 68 96
Fax: +46 8 612 9005
E-mail: bengtj@bergianska.se

Mr. Mora Aronsson
ArtDatabanken / Swedish Species Information Centre
SLU / Swedish University of Agricultural Sciences
Box 7007
75007 Uppsala, Sweden
Phone: +46 18 67 34 14
Fax: +46 18 67 34 80
E-mail: mora.aronsson@dha.slu.se

Mr. Sune Sohlberg
CAFF Chairman
Swedish Environmental Protection Agency
Natural Resources Department
Bleholmsterrassen 36
S-106 48, Stockholm, Sweden
E-mail: Sune.Sohlberg@environ.se

Dr. Philip A. Wookey
Uppsala University
Department of Earth Sciences
Villavägen 16
S-752 36 Uppsala, Sweden
E-mail: Philip_Andrew.Wookey@natgeog.uu.se

Mr. Torleif Ingelöf
Director
ArtDatabanken / Swedish Species Information Centre
SLU / Swedish University of Agricultural Sciences
Box 7007, 75007 Uppsala, Sweden
E-mail: Torleig.Ingelof@dha.slu.se

UNITED STATES OF AMERICA
Dr. David F. Murray
Professor Emeritus
University of Alaska Museum
907 Yukon Drive
Fairbanks, AK 99775 USA
Phone: +1 907 474 7109
E-mail: ffdfm@aurora.uaf.edu

Dr. Stephen S. Talbot
Chairman, CAFF Flora Group
U.S. Fish and Wildlife Service
1011 East Tudor Road
Anchorage, AK 99503 USA
Phone: +1 907 786 3381
Fax: +1 907 786 3905
E-mail: Stephen_Talbot@fws.gov
Appendix II. First International CAFF Flora Group Workshop Schedule

Monday, March 26

Arrival, check into hotels.

Tuesday, March 27

9:00-9:15 Welcome, history and progress of the CFG — Stephen Talbot
9:15-9:30 Welcome to the Swedish Threatened Species Unit — Torleif Ingelög
9:30-10:15 Circumpolar Arctic Vegetation Map (CAVM) — Stephen Talbot
10:15-10:30 **Break**
10:30-11:00 Panarctic Flora (PAF) — Reidar Elven/David Murray/Boris Yurtsev
11:00-11:30 Flora Monitoring — Boris Yurtsev
11:30-12:00 Swedish Threatened Species Unit Overview — Mora Aronsson
12:00-1:00 **Lunch**
1:00-1:30 Draft “CAFF Flora Group Charter” — Chair/All
1:30-3:00 CFG Recommendations — Chair/All
   Overview: Ad Hoc CFG Discussion Paper Tabled at CAFF VIII
   Trondheim — Chair/All
   Concept of the Arctic and Adjacent Geographical Areas — Arve Elvebak/AI/All
   Role of CFG in Harmonizing CAVM and PAF Arctic Boundaries — Fred Daniels/All
3:00-3:15 **Break**
3:15-5:00 CFG Recommendations (continued) — Chair/All
   Role of CFG and International Scientific Initiatives — David Murray/All
   Proposal for “Atlas of Rare Endemic Bryophytes and Lichens of the Arctic” — Hörður Kristinsson/All
   CFG Support for Circumpolar Protected Areas Network (CPAN) — Susan Aiken/All

Wednesday, March 28

9:00-10:15 CFG Recommendations (continued) — Chair/All
   CFG and Areas of High Biodiversity) — Boris Yurtsev/All
10:15-10:30 **Break**
10:30-12:00 CFG Recommendations (continued) — Chair/All
   Revision of the rare non-endemic plant list and preparation of a status
   report for CAFF IX — Boris Yurtsev/All
   The Role of the CFG in the Conservation of Arctic Flora — Bengt Jonsell/All
12:00-1:00 **Lunch**
1:00-3:00 CFG Recommendations (continued) — Chair/All
   Role of CFG in “Arctic Climate Impact Assessment” — Chair/All
   Role of CFG in Biodiversity Monitoring — Henry Väre/All
3:00-3:15 **Break**
3:15-5:00  CFG Recommendations (continued) — Chair/All
CFG and Working with Other Conservation Groups — Mora Aronsson/All
Initiative for a Second International Workshop on Classification of Arctic Vegetation — Fred Daniels/All
6:30  **Banquet**

Thursday, March 29
9:00-10:00  Prioritizing CFG Recommendations — Chair/All
10:00-10:15  Comments from the CAFF National Representative for Sweden — Sune Sohlberg
10:15-10:30  **Break**
10:30-12:00  Recommendations to CAFF National Representatives
12:00-1:00  **Lunch**
1:00-5:00  Field Trip (Optional)

Friday, 30 March

Departure
Appendix III. Conservation of Arctic Flora and Fauna Trondheim, Norway, 6 - 9 September 2000, United States Report

AD HOC CAFF FLORA GROUP DISCUSSION PAPER

Introduction: CAFF directed the establishment of an Ad hoc CAFF Flora Group at CAFF VII meeting in Yellowknife, Canada. The Ad hoc CAFF Flora Group is charged with advising the CAFF National Representatives on circumpolar flora issues of common concern. The prime responsibility of the group is to provide a discussion paper to the CAFF VIII meeting in Trondheim, Norway, September 6-9, 2000, with recommendations for future flora work and, in general, on how flora issues should be handled by CAFF.

The names of potential group members were submitted by CAFF National Representatives. The Ad hoc CAFF Flora Group members are: Canada (Susan Aiken, Canada Museum of Nature, Ottawa), Finland (Henry Väre, Finnish Museum of Natural History, Helsinki), Greenland (Christian Bay, Ny Strandvey 10 B, Humlebaek, Denmark; Fred J. A. Daniëls, Institute of Plant Ecology, Westfälische Wilhelms-Universität, Münster, Germany), Iceland (Hórdur Kristinsson, Iceland Museum of Natural History, Akureyri), Norway (Reidar Elven, Botanical Garden and Museum, University of Oslo; Arve Elvebakk, Department of Biology, University of Tromsø), Russia (Sergei Balandin, Department of Geobotany, Moscow State University; Boris Yurtsev, Komarov Botanical Institute, St. Petersburg), Sweden (Bengt Jonsell, Bergius Foundation of the Royal Swedish Academy of Sciences, Stockholm; Mora Aronsson, Artdatabanken, Swedish Threatened Species Unit, Swedish University of Agricultural Sciences, Uppsala), and United States (David Murray, University of Alaska Museum, Fairbanks; Stephen Talbot, U.S. Fish and Wildlife Service, Anchorage). George Argus, Canada Museum of Nature, Ottawa, a member of the Flora Group, also provided many useful suggestions to this discussion paper. We are grateful to W. B. Schofield, Department of Botany, University of British Columbia, Vancouver for thoughtful comments on the final draft.

To help identify future flora work and determine how flora issues might be handled by CAFF, a questionnaire was developed and sent to each member of the Flora Group. The responses were compiled and then returned to all members to permit them to comment on the initial suggestions and to clarify their ideas. This document provides a summary of the responses. There are some overlaps; these are retained to provide greater clarity in particular responses.

CAFF Flora Projects Established Before the Formation of the Ad hoc Flora Group: Prior to the formation of the Ad hoc Flora Group, two major flora projects were undertaken as action items under the auspices of CAFF. The first project was the preparation of an "Atlas of Rare Endemic Vascular Plants of the Arctic" and was published as CAFF Technical Report No. 3 in 1999. In this report, the vascular flora of the Arctic was surveyed by specialists from eight arctic countries to:

1. Identify rare taxa endemic to the region.

2. Establish an annotated list of these taxa.
3. Determine the level of protection currently afforded these plants.

Ninety-six rare endemic taxa were identified. Information was compiled for each included taxonomy, geographic distribution, habitat preferences, biological characteristics, estimates of endangerment, and citations of supporting literature. Gap analysis determined the relation of rare taxa to areas of protected habitats. Taxa were grouped into three categories: (1) unprotected (no occurrences are within protected areas); (2) partially protected (some occurrences are within protected areas); and (3) protected (all occurrences are within protected areas). Results indicate that 47% of the rare endemics are unprotected, 23% partially protected, and 30% protected. According to IUCN Red List threat categories, 19% of the taxa are vulnerable, 29% near threatened lower risk, 26% least concern lower risk, 1% endangered, and 24% data deficient. The majority of rare endemic taxa, 61%, occur outside IUCN protected areas (categories I-V); 25% occur within strict nature/scientific reserves (IUCN category I); 12% in managed nature reserves/wildlife sanctuaries (IUCN category IV); and 1.6% in national parks (IUCN category II).

In this report, the "Arctic" was defined as those lands beyond latitudinal tree line and included oceanic boreal heaths such as those occurring on the Alaska Peninsula and Aleutian Islands. At CAFF VII Finland noted that this definition in some countries should be expanded to include the northern timberline zone in order to make the work more relevant to the Scandinavian countries. The CAFF Flora Group thinks that we should not redefine what is Arctic, but redefine the CAFF mission in a way that shows clearly why the forest-tundra and northernmost boreal forest are also critical to the CAFF view of arctic flora and fauna.

A second CAFF flora action item, the Circumpolar Arctic Vegetation Mapping Project (CAVM) project, is a work in progress. For this project, a map is being prepared to provide a common legend and language for ecosystems of the Arctic region. Such a map is needed for a wide variety of purposes related to anticipated global changes, land-use planning, and biodiversity monitoring. The goals of CAVM are:

1. Develop a single 1:7,500,000-scale vegetation map of the circumpolar region.

2. Develop a legend and method that can be used consistently in all the circumpolar countries.

3. Unify information existing in a wide variety of maps at different scales.

4. Establish a model for mapping other global biomes such as the boreal forest.

Some anticipated applications are 1) ecologically sound natural resource management, 2) models of trace gas fluxes, 3) and ecoregions mapping. Continental syntheses for North America and Eurasia will be completed in 2001 and the final circumpolar synthesis will be completed in 2002. Four major products will be produced:

1. Photo-quality cloud-free false-color infrared image of the circumpolar region derived from satellite imagery.
2. Map of relative greenness of the circumpolar region as the maximum normalized difference vegetation index (NDVI).

3. Simple land cover map with eight classes.

4. Geobotanical database and derived maps of the circumpolar arctic and polar desert region. The database will consist of an integrated map coded with landscape and vegetation information.

**Proposed CAFF Flora Group Objectives:** To promote, encourage, and co-ordinate within an international context, the conservation of arctic plants and their habitats; and to enhance internationally the exchange of information relating to arctic flora and vegetation and factors affecting them.

1. Seek international opportunities to support the conservation needs of arctic plant species and their habitats.

2. Identify the potential for conservation partnerships within the circumpolar Arctic.

3. Support appropriate research and education, and enhance the conservation of arctic plants and their habitats.


**Flora Issues for CAFF - Summary of Questionnaire Responses**

**1) What are some priority areas for circumpolar arctic flora conservation, where our group might be effective?** To ensure that each country is fully represented, a list was compiled of all their suggestions:

A. In order to make plans about circumpolar arctic flora conservation, we need to assemble a rich data base of information on the taxa, their ecology and their distribution in the arctic. "The Atlas of rare endemic vascular plants of the Arctic" is a step forward. I would be invaluable to acquire similar information about cryptogams as well as non-endemic vascular plants. Before we can apply this information to compare different regions, we must make consistent use of the terms for the whole Arctic, use the same species concepts, and use the same epithet for the same species. After these problems have been solved, it should be relatively easy to make a critical checklist of the vascular plants present in the Arctic, and classify them according to their need for conservation. This would provide a sound basis to progress towards the Panarctic Flora project. In order to produce rational plans for conservation and protection of the circumpolar arctic flora before these prerequisites are fulfilled, a strong dependence will rest with the circumpolar botanic knowledge found within the CAFF Flora Group.

B. To review and recommend plant taxa for listing (or delisting) would be a continuing responsibility for CAFF. Support for mapping activities would continue as with CAVM.
C. There is a need to concentrate on non-protected areas with rare/endangered or endemic plants. Such areas, because of the endemics, posses restricted vegetation types in a unique landscape. Particular instances can be cited in which the vegetation is extremely vulnerable to rapid deterioration (e.g., niveo-eolian deposits near the town of Ammassalik, Greenland). Another suggestion is to concentrate on areas with high species diversity within a zone or subzone.

D. A Catalog of rare or threatened or very poorly known cryptogams could be prepared. Cryptogams are extremely important in Arctic vegetation.

E. There is need for further refinement in the assessment of vegetation on a more detailed level than will be featured on the CAVM maps. This could include bird cliff vegetation, hot spring vegetation, warm azonal southern enclaves with southern vegetation in a relative sense, etc. To this could also be linked areas of especially high biodiversity, which could be a step to follow after the Atlas.

F. Focus on hot-spots, following up the Rare plant report, and the article by David Murray.

G. Coordination of efforts of eight northern countries for conservation of the plant cover (flora, vegetation) of the circumpolar Arctic: data and experience exchange, including inventory and re-inventory (monitoring) of the flora on the circumpolar base.

H. The whole of Russia and indeed the East Siberian - Beringian area would have high priority in action plans. Moreover it appears that for Greenland critical taxonomic work is badly needed in many groups to make it possible to assess them in relation with other Arctic areas.

I. The final result will be a joint conservation plan for all arctic, but that is rather far in the future. Another important task is to solve how some monitoring should be done. How do we know the changes in time to prevent them?

J. Long-term plans of exploiting natural resources of the Arctic dictate the necessity of creation of the Flora Group of CAFF on a permanent basis. It should provide an integral circumpolar approach to the long-term task of the conservation of biodiversity of the flora (and vegetation; plant cover in general) of the Arctic and the circumpolar coordination of research and measures for conservation.

K. CAFF should deal not with individual rare and threatened species, but with the whole flora as full biodiversity of plants of the circumpolar Arctic. As a result of global or regional changes of environment, some ecological-geographic and biological groups of species weaken (including decrease of species diversity), whereas some others strengthen. The CAFF Flora Group should control these processes on the level of regions, landscapes (local floras) and their parts (down to ITEX experimental plots or plant communities transects), which suggests monitoring dynamics of species diversity, plant communities and ecosystem diversity as a reflection of global and regional changes of environment.
L. Contact with Panarctic Flora Project (PAF) is vital, because the latter unifies taxonomically nomenclature and, in its data base, gives the rough survey of plant species distribution throughout 25 floristic areas of the circumpolar Arctic, with rough estimation of frequency of a taxon in each area.

M. Contact with the CAVM project permits one to trace the plant community distribution around the pole. But the CAFF Flora Group responsibility is to extract and up-to-date information on the status of different species and their groups and warn about necessary adequate conservation measures. In the focus of interests of the Flora Group should be not only the species at risk, but also indicator ("functional") species, common and abundant in some part of the Arctic, but lacking in the others - with clear distribution boundaries within the Arctic. Local floras monitoring sites should be created not only in the typical parts of some sectors or subzones of the Arctic, but also in ectonal areas and in the vicinities of phytogeographic boundaries. Such monitoring LF network is being created in the Russian Arctic and may be easily created in countries with regular square (grid) mapping of the flora. In other countries (e.g. in North American Arctic) it can be created first in the ITEX sites and other biological and AMAP station areas as well as in protected areas.

N. Monitoring arctic local floras is less costly than for highly mobile animals, because arctic plants are mostly long living and attached to the substrate, asa well as able to persist in micro niches. In consequence, for long-term monitoring arctic local floras an interval of 30-50 (100) years may be sufficient.

O. Our approach to arctic flora conservation should be two fold:

1) Control of the status of species at risk (of different categories) within and outside protected areas, contributing to gap analysis and to planning Circumpolar Protected Areas Network (CPAN) network development <http://www.grida.no/caff/cpanstratplan.htm>.

2) Control of the status of whole local floras within different phytogeographic division of the Arctic - in both cases, with close interaction with the CPAN working Group.

P. The main responsibility of the CAFF Flora Group might be the creation and supporting the Lists of plant species of the Arctic at risk, of several categories: 1) those candidates into Global List of plants in need of protection (very rare arctic, metaarctic, and hypoarctic endemics); 2) those of circumpolar (circumarctic) conservation concern besides the 1st group's members also the most rare in the Arctic (non endemic of the Arctic) disjunct species, presumed relicts in the Arctic or even long-distance natural (non anthropogenic) migrants.

Q. CAFF Flora Group should also coordinate national and regional lists of species of regional or national conservation concern (some species may be very rare in two or more sectors, but non rare in the others).
R. The publication of such lists, along with the works on floras of protected areas in the Arctic, or lists of rare plant communities enriched by relicts and other rare species deserves support from CAFF as well.

2) How can we ensure that CAFF’s responsibility for flora conservation is adequately addressed?

The Flora Group should be proactive; it should not simply respond. To accomplish this task, a permanent CAFF Flora Group should be established. See Question 11.

3) How can we explore the concept of "Arctic" so that adjacent geographical areas might be included?

A working definition of Arctic has been exasperatingly elusive; the very nature of the CAFF effort would seem to require one. Inasmuch as CAFF is addressing the conservation of biota, a biological definition for the Arctic is inescapable. Reduced to its essence, then, the Arctic can be accurately described as a northern treeless region, for which the treelessness is a function of regional climate and not of local edaphic features. Tree line or some portion of the tundra-taiga ecotone defines the southern boundary of the Arctic. Although there are treeless areas, which on climatic terms would be classified as subarctic tundra or boreal oceanic, these are, for our (CAFF) purposes, also classified as Arctic, i.e. southernmost Greenland, Iceland, northernmost Fennoscandia, the Aleutian Islands, the Commander Islands.

In some parts of the world tree line is rather abrupt, in others the boundary between forest and tundra stretches over many tens of kilometers. The northern limit of woodland, which lies in the southern portion of the tundra-taiga ecotone, or the limit of continuous boreal forest have both been suggested as boundaries. These empirical limits have the advantage of being susceptible to rather precise mapping. Certain values for abiotic factors– summer temperature, net solar radiation, permafrost– correlate well with tree line and together they more or less explain major changes in the environment that the disappearance of trees manifest. At least this seems to be true for the Russian and North American Arctic, but the picture is far less clear in Western Europe.

Astronomically determined southern boundaries of the Arctic such as 60° N latitude or the Arctic Circle (66° 30’ N) are unambiguous and can be drawn precisely at any map scale; however, in terms of biological questions, these definitions add to the Arctic a large portion of what is unmistakable taiga or boreal forest, i.e. not treeless, not Arctic. Forest and tundra, trees and treeless are not only obviously different from one another, these differences have biological meaning.

Some of the misunderstandings of what is Arctic may very well derive from using the term Arctic in two senses: one to define a region and another to define plants and animals (as arctic ones). These are different issues! The question "is this place in the Arctic" is important, germane, and has an answer. The question "is this an arctic bird" is unnecessary, essentially irrelevant, for once having defined the region Arctic, we then concern ourselves with the health and well-being of the arctic biota, including its many constituent parts. It would follow, therefore that all the plants and animals found within this region are subjects of interest and concern to CAFF, not just the native taxa, but the
introduced ones as well. What we must do is establish priorities from among these many choices.

That some of the plants common in the Arctic are also found in the alpine tundra of high mountains far to the south or are components of boreal forest has no bearing on the question whether we should deal with them in CAFF. That some of the animals, particularly the migratory ones, spend only part of their annual life cycles in the Arctic, perhaps wintering in distant countries, is equally irrelevant to the choice of our subject taxa. It does not matter that the caribou may travel from the Arctic far into the boreal forest, that some arctic terns nest in the boreal forest, etc. What is important is that populations of these plants are persisting in the Arctic and populations of these animals breed and/or produce and raise their young in the Arctic. These attributes place them within the sphere of CAFF. To accomplish our conservation objectives, a fuller understanding of these plants may very well require that we know about their occurrence and biology in regions that are clearly not Arctic, but we do not redefine the region Arctic---we simply expand our investigational reach to include these other areas. Let common sense be our guide.

Even if agreement on an absolute definition is not possible, we must nevertheless define what Arctic means much more explicitly than it is in CAFF and AMAP documents. It is difficult enough to focus clearly on complex issues, but the difficulty is compounded when the same term is used for demonstrably different things. Until an accepted definition is available, it is difficult, if not literally impossible, to achieve valid numerical comparisons among countries, and because of this -- the credibility of a great deal of hard work is at stake.

CAVM and PAF are very close to agreement in their delimitation of the Arctic. Their approach will undoubtedly establish a standard. Close cooperation between these groups and the CAFF Flora group is required so that the delimitation is the same. The CAFF Flora Group should work toward redefining the CAFF mission in a way that shows clearly why the forest-tundra and northernmost boreal forest are also critical to the CAFF view of arctic flora and fauna. In this manner, we may keep an ecologically meaningful definition of the Arctic and include those CAFF countries that do not fall within a strict floristic definition of the Arctic such as Finland and Sweden. Active discussion of this topic is recommended for a CAFF Flora Group meeting to determine how best to deal with the issue.

There are a number of possible solutions. The Arctic delimitation is a problem because of the gap between political ambitions and the biological and climatic realities. If we accept what CAFF has proposed, that is, the inclusion of parts of Finland and the Sweden, we need to say something more about those areas that will fall outside the delimitations to be established by PAF and CAVM. Actually Fig. 2.1. in the CAFF Conservation Report No 1 from 1994 shows the CAFF definition. But the whole area could have been called 'The Arctic and adjoining areas' or something similar, because the legend for Northern Europe reads "Regions in the Nordic Arctic" and then portrays the northern and middle boreal (forest) zone as important subunits of this 'Arctic'. This sounds ridiculous to everybody, and reduces the respect for what is being done below such classification. There are at least four options:
A. Accept the geographical delimitation (shown in Fig. 2.1) in all our efforts, but call the problematic regions what they are.

B. Do as above, but call all also forested areas 'Arctic' for political reasons (totally unacceptable in our opinion).

C. Neglect the 2.1 map, and just treat real arctic areas, like the CAVM and PAF do.

D. Revise the 2.1. map to exclude forested areas and include real arctic areas, plus (1) the adjoining mountains in Iceland, northern Fennoscandia but not elsewhere, and (2) the Aleutians. Then we could also raise the question about 'broarctic' vegetation. For instance the Finns like this concept, but it is difficult to define the oroarctic from neighboring alpine, and the boundary shown in Fig. 2.1. in Fennoscandia between 'arctic-alpine' (=probably oroarctic) and 'alpine' has not been published in the literature.

The concept of the Arctic as cold treeless region of the northern hemisphere should be kept, but it might be supplemented by including into the sphere of interests and conservation activities of CAFF some bordering northern areas of the Subarctic where tundra vegetation normally exists south of tundra zone (e.g. forest-tundra; "alpine" belt in the Subarctic mountains - especially in Fennoscandia where a variety of arctic species occurs). This will be dealt with in a CAFF Flora Working Group workshop.

4) What might be our role in the light of other circumpolar and international initiatives?

The role of the CAFF Flora Group could facilitate communication between each of them and CAFF. Additionally, since plant species occur in communities and not as single populations in most of the arctic we should stimulate vegetation ecological research. Presently, we lack an international effort to synthesize new information on the classification of arctic plant communities. Our proximate goal might be to support and promote a Second International Workshop on Classification of Arctic Vegetation, while our long-term goal might be to develop such an organization within CAFF. In March 1992, an International Workshop on Classification of Arctic Vegetation was held in Boulder, Colorado to begin the task of completing a global synthesis on arctic vegetation. The Arctic holds great potential for a phytosociological and ecological synthesis, but suffers from the lack of data in many areas and from an absence of history of collaboration. The Boulder workshop was the first international attempt to bring about such a synthesis. This workshop was published as a Special Feature in the Journal of Vegetation Science 5, but clearly much hard work and cooperation will be necessary to gain a true circumpolar understanding of this important region. In the Special Feature of JVS 5:763-764, it states “The Arctic Survey would profit from a strong and effective organization, both for the scientific organization and for fund raising. It would be ideal if this organization could work under the auspices of the International Association for Vegetation Science (IAVS), perhaps as a working group, which could take care of the organization of regular scientific meetings.” No organization has taken on the challenge. This might be an excellent opportunity to move the process forward under the auspices of CAFF.
After PAF completes an arctic flora, our role might be in producing distribution maps of each species. If data could be produced as grid-cells of defined scale, it could be possible to perform richness and area selection analyses (see Acta Botanica Fennica 162: 11-21, 1999). A program WORLDMAP for windows does this. Technical assistance would be required from Britain. These data would be useful in selecting areas of primary importance for nature conservation. However, a critical question remains, do we have enough distribution data on the Arctic?

5) How can the activities of CAVM, ITEX, and PAF support the CAFF initiatives?

One of the main roles of CAVM, ITEX, and PAF for CAFF is as a source of unbiased, scientific information. The work of PAF is vital for the CAFF flora work, mainly to provide uniform taxonomy and delimitation of species throughout the Arctic, and as a result making it possible to compare the floras of different parts of the Arctic. One of the main goals of CAVM is creating a framework for diverse botanical research, thus also for floristics. The three programs focus on fundamental research problems (two of them, CAVM and PAF, being supported by CAFF as well), providing a circumpolar view and approach to the studies; whereas CAFF focuses on the conservation tasks with respect to flora and vegetation of the Arctic, extracting necessary circumpolar information from CAVM, ITEX and PAF. The close interacting of CAFF with CAVM, PAF, and ITEX, as well as the personal participation of at least some of CAFF's people in the above projects, is extremely useful and strongly welcome.

6) Can the CAFF Flora Group serve as support for CAVM, ITEX, and PAF?

Notwithstanding these other activities, there is a CAFF role for the Flora Group to fulfill. Because the membership of this group consists of people already participants in CAVM, ITEX, and PAF, connections to those groups do not have to be sought, they exist already. There is an advantage to having the members working within the CAFF framework and reaching out to other activities. Endorsements by CAFF could very well help when the other activities go to funding agencies. It would show that coordination exists and duplication does not. The Flora Group is presently supporting CPAN by providing data for gap analysis through the "Atlas of Rare Endemic Vascular Plants of the Arctic."

CAFF could serve as a driving force to ensure that the PAF-work continues, because it is needed for the Flora conservation work.

7) Is there a need for a relatively-permanent CAFF Flora Working Group beyond our present responsibilities?

Strong support was expressed for an on-going CAFF Flora Group. There is no other international organization with a special task of conservation of the circumpolar arctic flora. The recognition of this problem among other global ones on conservation of biodiversity and healthy environments for all groups of organisms including humans does not only justify, but also necessitates the creation of a permanent CAFF Flora Group. In fact, it legitimizes an activity that is occurring informally among botanists in arctic countries. A permanent group would provide an on-going organization with a role for botanical expertise. A permanent group would also facilitate communication of our results and future projects with the governments of arctic countries as well as
collaborating with local conservation groups. It would provide a better platform for our work.

8) Could CAFF serve as an outlet for publications dealing with circumpolar flora issues?

It is in the interest and mandate of CAFF to support publications on the circumpolar flora and vegetation by assisting or supporting applications for grants, editing, and publishing important works on botanical aspects of the Arctic and on plants in need of protection or on rare plant communities enriched by relict plant species. Some examples are the already published "Atlas of Rare Endemic Vascular Plants of the Arctic" and the upcoming Circumpolar Arctic Vegetation Map (CAVM) as well as checklists of vascular plants (with consistent species delimitation for all areas), checklists of other plants, distribution maps of selected species, and other milestones on the way towards a Panarctic Flora. By publishing the Panarctic Flora in a timely, stepwise manner, it would make parts of work available earlier for immediate use before the complete flora is ready.

9) Would a Web mirror site be useful?

There was widespread support for a Web mirror site, if it is effectively linked with other projects. The more possibilities on the web, the more goodwill for the project. Links need to be established to other Web pages like the University of Alaska Herbarium, PAF, Alaska Natural Heritage Program, etc. For Russian mirror site, Moscow State University (http://herba.msu.ru) would be glad to supply the resources of their Botanical Server. Canada is looking for an alternative web site to put its Arctic data on, which is currently at <www.biodiversity.uno.edu/delta> but support for having it there to stop at the end of 2000.

10) Will funding be required to fulfill any of the needs identified above?

A. Absolutely. The plans that CAFF has cannot be done without research and that will cost money. It would be possible, of course, to develop a number of projects with less financial support. If there is a real concern about protecting arctic flora then the states that can afford it must come through with funding.

B. It would be very useful to obtain a financial support to cover our travel expenses during CAFF workshops and meetings. Russia is especially interested in some international support, because their national conservation organizations have too modest a budget. Funding is also required for publishing. If the CAFF Flora Group intends to produce publications on the Arctic flora, we need a publisher, unless the articles are printed in scientific journals. If the reports are published through the CAFF series reports, funding will be required for editing and printing.

C. It should be recognized that the agencies that are represented at CAFF represent only a small part of the scientific resources that are needed to do the research. Funding to support collaborators is needed. CAFF cannot really decide what species and habitats are at risk, where they occur, their taxonomic status, what the risks are, and now they may be ameliorated without conducting new research. The success of
CAFF in designating species and habitats at risk rests on enlisting the collaboration of botanists all of whom should be paid to do the work.

11) Should we prepare a charter for a more permanent CAFF Flora Group?

Generally, the concept of a charter was well received. A charter is dependent in part on the establishment of a permanent flora group. A charter would probably be useful when subjects like funding are discussed with organizations such as the University or with the Ministry of Environment. It would be an important topic for the discussion at a future Flora Group meeting.

12) Is a meeting needed or via e-mail?

Initially, we accomplished a great deal through e-mail. It was agreed that a meeting of our group would be necessary to discuss and formulate future work and clarify our goals. An attempt was made to hold a meeting in Trondheim, Norway, in conjunction with CAFF VIII but a large number of group members had previous commitments. A CAFF Flora Group meeting sometime after CAFF VIII is therefore suggested. This would permit feedback from the CAFF National Representatives on the discussion paper. We suggest a 2-3 day working group meeting in some centrally located site in Scandinavia. If the group is not too large, Sweden offered to host such a meeting in Stockholm. Norway also offered meeting space in Trondheim.

Stephen S. Talbot  
Chairman, Ad hoc CAFF Flora Group  
U.S. Fish and Wildlife Service  
1011 East Tudor Road  
Anchorage, AK 99503 USA  

E-mail: stephen_talbot@fws.gov
Appendix IV. Example from the taxonomic part of the provisional Panarctic Flora checklist.

35.1.7 *Juncus effusus* L. (1753), Sp. Pl. 326.
2n= (1) 40. (2) 42.
G CAN?
Comments: Tentatively added to Egorova's draft.
(1) Mapped from S Hudson Bay area (York Factory) by Hultén & Fries (1986 map 195) on the authority of Macoun 1888. A border case to be checked by the Canadians; the report is not fully accepted by Scoggan (1978) but is included in the map by Moore & Clements (2000). Several American races (varieties) are described. As specimens from Hudson Bay seem to be absent, it is probably impossible to say anything about races. (Elven)

**WARNING! Will be excluded if not confirmed from arctic Canada.**

35.1.8 *Juncus filiformis* L. (1753), Sp. Pl. 326.
2n= (1) 80. (2) 84.
2nD (1) Løve & Løve (1975) listed several counts, one Icelandic and one Greenlandic, e.g., Jørgensen et al. (1958 Grl), Taylor & Mulligan (1968 W Can); Yurtsev & Zhukova (1978 NE As). (2) Snogerup (1971 Scand).
G ICE NOR RUS SIB RFE CAN GRL

35.1.9 *Juncus brachyspathus* Maxim. (1859), Prim. Fl. Amur. 293.
G SIB RFE

T [Described from N Scandinavia ('Lapland').]
Comments:
(1) *Juncus arcticus, J. balticus* and *J. haenkei* are proposed as three species by Egorova. I have here very tentatively proposed to reduce them to rank of three subspecies and added two other subspecies. The most recent North American treatment (Moore & Clements 2000) recognised three varieties, two as arctic (var. *alaskanus* and var. *balticus*), but there are some problems with this treatment (see below). We can, however, probably subscribe to their comment about this group as: "a wide-ranging and obviously polymorphic complex that has not read the literature".

*Juncus arcticus* and *J. balticus* were both originally described from N Europe. In most of this area they are very different in general morphology and in many features of detail. When comparing a series of 'typical' plants, no one would be in doubt about them being two different species. But even here the separation of them as species is now disputed. There are large areas with transitions, e.g. more or less the entire Icelandic population described as a subspp. *intermedius* Hyl. (1953), nomen nudum, Nord. Kärłväxfl. 1: 178. The Iceland case is indicative of extensive interfertility as are the fertile intermediates found in the meeting zone along the coast of Finnmark, N Norway. These intermediates are more or less fully fertile as far as we know. This is a second area where we can report only the intermediates, not *J. balticus* itself, from the arctic parts. A third area might be S Greenland.
Another argument is found in the ambiguities concerning the 'alaskanus' entity, as a race of J. arcticus or of J. balticus. The same ambiguity concerns the J. haenkei taxon. Moore & Clemants (2000) included most northern North American (incl. Greenland) material in their concept of subsp. alaskanus but they noted that "Perhaps J. arcticus var. alaskanus is not distinct from the Eurasian J. arcticus var. arcticus". That is certainly the case with much of the Greenland material which is indistinguishable from the N European (type area) and Svalbard material. The Alaskan material is more different, but not very much so. The 'alaskanus' entity is obviously much closer to the N European 'arcticus' entity than it is to the N European 'balticus'.

The options are then either to regard the entire complex as one large, polymorphic species with 4-5 subspecies, as two species (J. arcticus with the 'arcticus', 'alaskanus' and 'sitchensis' entities; J. balticus with the 'balticus' and 'littoralis' entities), or as numerous ill-defined, morphologically overlapping and probably fully interfertile species. The 'littoralis' race is the one reported from the Hudson Bay area. (Elven)

35.1.10.1 Juncus arcticus Willd. subsp. arcticus
2n= (1) 80. (2) 84.
2nD (1) Löve & Löve (1975) listed several counts, four as arctic. (2) Snogerup (1971 Scand).
G ICE? NOR RUS SIB RFE? CAN GRL

35.1.10.2 Juncus arcticus Willd. subsp. alaskanus Hultén (1943), Lunds Univ. Årsskr., n. f., avd. 2, 39, 1: 418.
2n= 80.
2nD Knaben (1968 Ala); Zhukova & Petrovsky (1976 E Chuk).
G RUS? SIB? RFE? ALA CAN
Comments:
(1) This taxon is perhaps identical to J. arcticus s. str. (Egorova).
(2) That opinion was also tentatively shared by Moore & Clemants (2000). (Elven)
(3) Tolmachev (1963) considered subsp. alaskanus to be a subarctic race of the mainly Eurasian J. arcticus s. str. In North America, however, it looks like the western race replaced east of Hudson Bay by subsp. arcticus (Porsild & Cody 1980, but these authors subordinated subsp. alaskanus Hultén to J. balticus Willd.). (Yurtsev)
(4) The 'parallel' occurrence of subsp. arcticus and subsp. alaskanus through arctic Russia-Siberia contrasts strongly with the W/E disjunction of the two races in N America. This indicates that the races are considered differently in Russia and North America. The discrepancy must be solved. Note that Flora Arctica URSS mapped only three occurrences altogether of 'arcticus/alaskanus' E of Lena R. (Elven)

**Juncus balticus** Willd. subsp. *sitchensis* (Engelm.) Hultén (1943), Lunds Univ. Årsskr., n. f., avd. 2, 39, 1: 420; *J. haenkei* E.Mey. (1822), Syn. Juncor. 10; *J. balticus* Willd. var. *haenkei* (E.Mey.) Buchenau (1890), Monogr. Junc. 215. [Described from Alaska: Sitka. *Juncus haenkei* was described from Canada: British Columbia, Nutka Bay.]

2n= (1) 74. (2) 80. (3) 84.


G RFE ALA

Comments:

(1) The valid name as subspecies is subsp. *sitchensis*, as species *J. haenkei*. The deviating chromosome number of 2n = 74 might be aneuploid or a miscount. I have now some field experience of both *balticus* and *sitchensis* and see them as fairly well differentiated. If we consider two species I would rather subordinate the *sitchensis* entity to *J. arcticus* than to *J. balticus*. (Elven)

35.1.10.4 *Juncus arcticus* Willd. subsp. *balticus* (Willd.) Hyl. (1953), Nord. Kärlväxtnl. 1: 178 [without indication as new combination and sufficient basionym citation].


2n= (1) 80. (2) 84.

2nD (1) Löve & Löve (1975) listed three non-arctic counts. (2) Jørgensen et al. (1958 Danm).

G ICE? NOR? GRL?

Comments: See distributional part.

**WARNING! Could perhaps better be included as a comment only, to subsp. arcticus.**

35.1.10.5 *Juncus arcticus* Willd. subsp. *littoralis* (Engelm.) Hultén ***

B *J. arcticus* Willd. var. *littoralis* Engelm. ***

G CAN

Comments: Added to Egorova's draft.

(2) Hultén & Fries (1986 map 198) accepted a subsp. *littoralis* for the Canadian material. This name has to be added, either as a separate entity as here or in synonymy. If *J. balticus* is retained as a species it is natural to accept (at least) two subspecies: subsp. *balticus* (NW European) and subsp. *littoralis* (NE American). (Elven)

35.1.11 *Juncus drummondii* E.Mey. in Ledeb. (1853), Fl. Ross. 4: 235.

G ALA

Comments: Added to Egorova's draft.
Appendix V. Example of the distributional part of the provisional Panarctic Flora checklist. Key to Abbreviations, see below).

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<th>Code</th>
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<th>Distribution Notes</th>
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Distributional notes

Juncus effusus (350107)

CAN  BH  Scoggan: Old, unvoucheded report from York Factory. See text.

Juncus arcticus ssp. arcticus (35011001)

ICE  le  Doubts due to the intermediacy of Icelandic plants (arcticus - balticus).
RFE  CN-CE  Doubts about identity vs ssp. alaskanus.

Juncus arcticus ssp. alaskanus (35011002)

RUS-RFE KP-CS  Doubts about identity of all Russian material referred to ssp. alaskanus.

Juncus arcticus ssp. balticus (35011004)

ICE  le  Doubts due to the intermediacy of Icelandic plants (arcticus - balticus).
NOR  FN  Only arcticus-balticus intermediates approach the arctic (border case).
GRL  GW  Identity and characteristics of S Greenland plants, balticus or littoralis?
Juncus arcticus ssp. littoralis (35011005)
   GRL  GW  Identity and characteristics of S Greenland plants, balticus or littoralis?

Juncus drummondii (350111)
   ALA  AW  FNA22: Inside or as a border case in SW Alaska, a clear extension compared with H68 and PC80.

Abbreviations of regions:
A-E - Arctic bioclimatic zones from the northernmost/coldest ('polar desert') to the southernmost/warmest ('shrub tundra'), N - Marks occurrence and frequency in bordering boreal or alpine areas.

Abbreviations of occurrences:
Natives: f - frequent, s - scattered, r - rare (according to definitions), X - native occurrence but frequency unknown, b - border case along the arctic boundary, ? - uncertain occurrence. Introduced: * - stable, ** - casual.