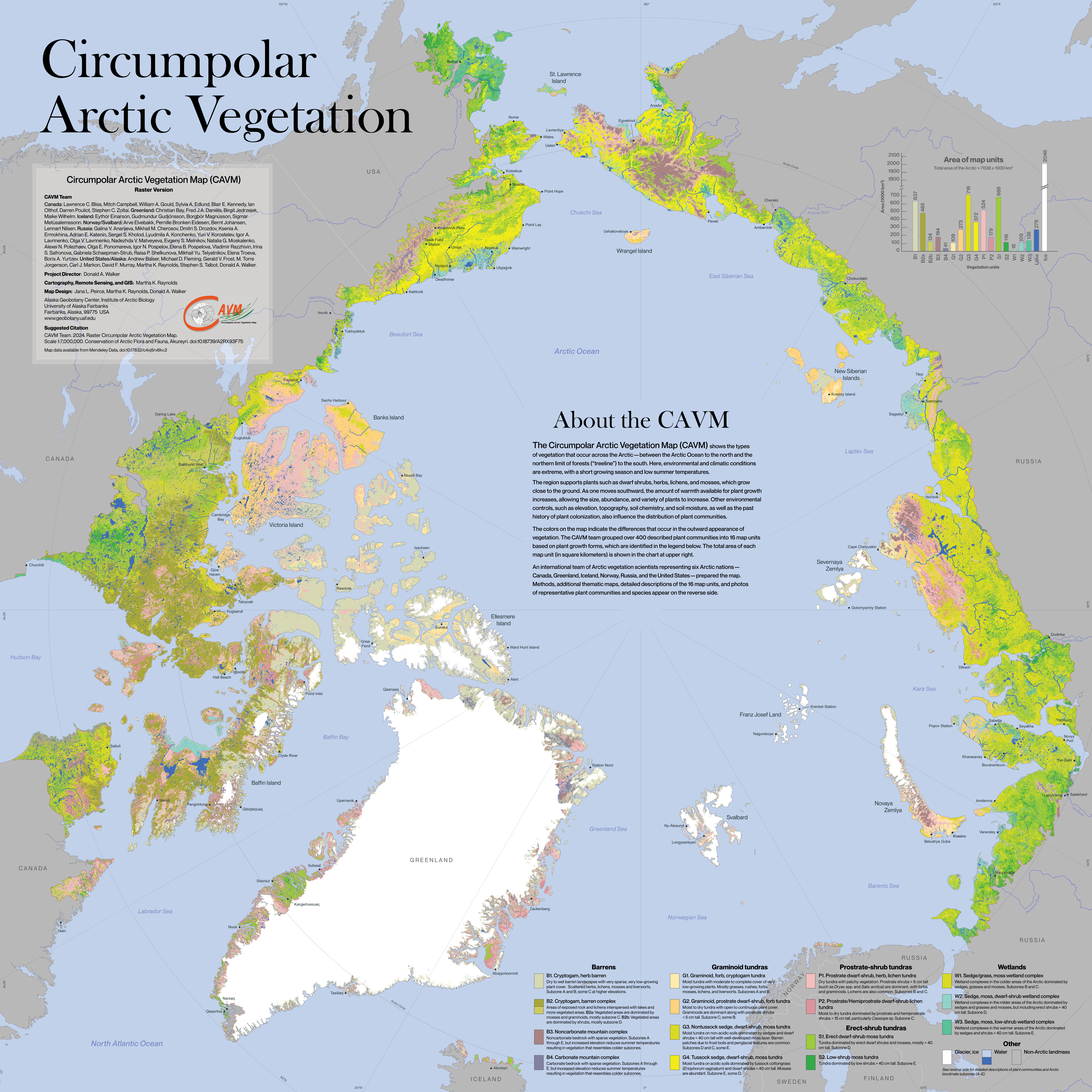
Circumpolar Arctic Vegetation



Circumpolar Arctic Vegetation Map (CAVM)

Raster Version

CAVM Team

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About the CAVM

The Circumpolar Arctic Vegetation Map (CAVM) shows the types of vegetation that occur across the Arctic — between the Arctic Ocean to the north and the northern limit of forests ("treeline") to the south. Here, environmental and climatic conditions are extreme, with a short growing season and low summer temperatures.

The region supports plants such as dwarf shrubs, herbs, lichens, and mosses, which grow close to the ground. As one moves southward, the amount of warmth available for plant growth increases, allowing the size, abundance, and variety of plants to increase. Other environmental controls, such as elevation, topography, soil chemistry, and soil moisture, as well as the past history of plant colonization, also influence the distribution of plant communities.

The colors on the map indicate the differences that occur in the outward appearance of vegetation. The CAVM team grouped over 400 described plant communities into 16 map units based on plant growth forms, which are identified in the legend below. The total area of each map unit (in square kilometers) is shown in the chart at upper right.

An international team of Arctic vegetation scientists representing six Arctic nations — Canada, Greenland, Iceland, Norway, Russia, and the United States — prepared the map. Methods, additional thematic maps, detailed descriptions of the 16 map units, and photos of representative plant communities and species appear on the reverse side.

Barrens

B1. Cryptogam, herb barren
Dry to wet barren landscapes with very sparse, very low-growing plant cover. Scattered herbs, lichens, mosses and liverworts. Subzone A and B, some C at higher elevations.

B2. Cryptogam, barren complex
Areas of exposed rock and lichens interspersed with lakes and more vegetated areas. **B2a:** Vegetated areas are dominated by mosses and graminoids, mostly subzone C. **B2b:** Vegetated areas are dominated by shrubs, mostly subzone D.

B3. Noncarbonate mountain complex
Noncarbonate bedrock with sparse vegetation. Subzones A through E, but increased elevation reduces summer temperatures resulting in vegetation that resembles colder subzones.

B4. Carbonate mountain complex
Carbonate bedrock with sparse vegetation. Subzones A through E, but increased elevation reduces summer temperatures resulting in vegetation that resembles colder subzones.

Graminoid tundras

G1. Graminoid, forb, cryptogam tundra
Moist tundra with moderate to complete cover of very low-growing plants. Mostly grasses, rushes, forbs, mosses, lichens, and liverworts. Subzones A and B.

G2. Graminoid, prostrate dwarf-shrub, forb tundra
Moist to dry tundra with open to continuous plant cover. Graminoids are dominant along with prostrate shrubs < 5 cm tall. Subzone C, some B.

G3. Nontussock sedge, dwarf-shrub, moss tundra
Moist tundra on non-acidic soils dominated by sedges and dwarf shrubs < 40 cm tall with well-developed moss layer. Barren patches due to frost boils and periglacial features are common. Subzones D and C, some E.

G4. Tussock sedge, dwarf-shrub, moss tundra
Moist tundra on acidic soils dominated by tussock cottongrass (*Eriophorum vaginatum*) and dwarf shrubs < 40 cm tall. Mosses are abundant. Subzone E, some D.

Prostrate-shrub tundras

P1. Prostrate dwarf-shrub, herb, lichen tundra
Dry tundra with patchy vegetation. Prostrate shrubs < 5 cm tall (such as *Dryas* spp. and *Salix arctica*) are dominant, with forbs and graminoids. Lichens are also common. Subzones B and C.

P2. Prostrate/Hemiprostrate dwarf-shrub lichen tundra
Moist to dry tundra dominated by prostrate and hemiprostrate shrubs < 15 cm tall, particularly *Cassiope* sp. Subzone C.

Erect-shrub tundras

S1. Erect dwarf-shrub moss tundra
Tundra dominated by erect dwarf shrubs and mosses, mostly < 40 cm tall. Subzone D.

S2. Low-shrub moss tundra
Tundra dominated by low shrubs > 40 cm tall. Subzone E.

Wetlands

W1. Sedge/grass, moss wetland complex
Wetland complexes in the colder areas of the Arctic dominated by sedges, grasses and mosses. Subzones B and C.

W2. Sedge, moss, dwarf-shrub wetland complex
Wetland complexes in the milder areas of the Arctic dominated by sedges and grasses and mosses, but including erect shrubs < 40 cm tall. Subzone D.

W3. Sedge, moss, low-shrub wetland complex
Wetland complexes in the warmer areas of the Arctic dominated by sedges and shrubs > 40 cm tall. Subzone E.

Other

Glacier, ice · Water · Non-Arctic landmass

See reverse side for detailed descriptions of plant communities and Arctic bioclimate subzones (A–E).

Vegetation Descriptions

Barrens

B1 Cryptogam, herb barren

Barren areas mainly in dry landscapes of bioclimate subzones A and B. This unit is dominated by barren soils or bedrock and lacks much cover of vascular plants. Biological soil crusts cover most soils with a few scattered vascular plants, lichens, and mosses. Woody plants, sedges (Cyperaceae), and bog mosses (e.g. *Sphagnum* spp.) are normally absent. Horizontal plant cover is sparse (2–40% cover), and vertical structure is very low (generally < 2 cm tall), with a single layer of plants where they occur. In upland areas, vascular plant cover is generally very sparse (< 2%), often in crevices between stones or small cryoturbated polygons and hummocks (< 50 cm diameter). Snow-flush communities, composed mainly of bryophytes and biological soil crusts with cyanobacteria, often form dark streaks on the otherwise barren lands of bioclimate subzones A and B. Map unit G1 is a common inclusion in more mesic areas. B1 is also mapped in recently deglaciated areas of other subzones and was used to map small areas of mudflats and barren wetlands on coasts and deltas in more southern subzones where plant communities are not described.

Typical species. Forbs: *Braya glabella* ssp. *purpurascens, Cardamine bellidifolia, Cerastium arcticum, C. regelii, Deschampsia sukatschewii, Draba arctica* s.l., *D. corymbosa, D. oblongata, D. pauciflora, D. simmonsii, D. subcapitata, Minuartia rossii, Papaver dahlianum* aggr., *Potentilla hyparctica, P. pulchella, Saxifraga cernua, S. cespitosa, S. hyperborea, S. oppositifolia, S. platysepala, Stellaria longipes* s.l. **Graminoids:** *Alopecurus borealis, Deschampsia sukatschewii* ssp. *borealis, Festuca baffinensis, Luzula confusa, L. nivalis, Phippsia algida, Poa abbreviata, Puccinellia angustata.* **Mosses:** *Aulacomnium turgidum, Dicranoweisia crispula, Ditrichum flexicaule, Polytrichastrum alpinum, Polytrichum piliferum, P. strictum, Racomitrium ericoides, R. lanuginosum, Schistidium frigidum.* **Liverworts:** *Anthelia juratzkana, Gymnomitrion corallioides, Sphenolobus minutus.* **Lichens:** *Alectoria ochroleuca; Catapyrenium cinereum, Cetraria ericetorum, C. islandica, Cetrariella delisei, Dactylina arctica, D. ramulosa, Flavocetraria cucullata, F. nivalis, Gowardia nigricans, Parmelia omphalodes, P. skultii, Sphaerophorus globosus, Stereocaulon rivulorum, Sticta arctica, Thamnolia vermicularis* s.l.

Representative syntaxa. Class: *Drabo corymbosae-Papaveretea dahliani* Daniëls, Elvebakk et Matveyeva in Daniëls et al. 2016; **alliance:** *Papaverion dahliani* Hofmann ex Daniëls, Elvebakk et Matveyeva in Daniëls et al. 2016 (polar deserts of the Arctic Ocean archipelagos).

Ellef Ringnes Island, Nunavut, Canada (Inset: *Papaver radicatum*)

B2a Cryptogam, barren complex

Mainly deglaciated Precambrian bedrock and glacial deposits abundantly covered by lichens and mosses and with inclusion of many lakes in bioclimate subzones C and B and in subzone D at higher elevations. Large areas with continuous cover of vascular plants are uncommon.

Typical species. Lichens: *Aspicilia* spp., *Caloplaca* spp., *Lecidea* spp., *Lecanora* spp., *Buellia* spp., *Parmelia* spp., *Porpidia* spp., *Rhizocarpon* spp., *Umbilicaria* spp., and *Xanthoria* spp. cover the rock surfaces. Slopes with fine-grained erosional material have associations of terricolous lichens (*Cladonia* spp., *Flavocetraria* spp., *Masonhalea richardsonii, Stereocaulon* spp., *Bryocaulon divergens, Alectoria ochroleuca*).

Representative syntaxa. Class: *Rhizocarpetea geographici* Wirth 1972 (ombrophilous lichen communities of siliceous rock surfaces, Canada). **Class:** *Racomitrietea heterostichi* Neumayr 1971 (bryophyte communities on sunny, exposed siliceous rocks, boulders and screes). Complex with graminoid and prostrate dwarf-shrub communities of bioclimate subzones B and C (see map units G1, G2, P1, P2).

Hall Peninsula, Baffin Island, Nunavut Canada (Inset: *Rhizocarpon geographicum*)

B2b Cryptogam, barren, dwarf-shrub complex

Mainly deglaciated Precambrian bedrock and glacial deposits abundantly covered by lichens and mosses, intermixed with lakes and zonal dwarf- and low-shrub vegetation of bioclimate subzones D and E.

Typical species. Lichens: *Aspicilia* spp., *Caloplaca* spp., *Lecidea* spp., *Lecanora* spp., *Buellia* spp., *Parmelia* spp., *Porpidia* spp., *Rhizocarpon* spp., *Umbilicaria* spp., and *Xanthoria* spp. cover the rock surfaces, commonly separated by low-growing dwarf-shrub tundra (*Betula glandulosa, Arctous alpina, Cassiope tetragona, Rhododendron tomentosum* ssp. *decumbens, Vaccinium uliginosum* ssp. *microphyllum, V. vitis-idaea*), and the grass *Hierochloe alpina.* Slopes with fine-grained erosional material have associations of terricolous lichens (*Cladonia* spp., *Flavocetraria* spp., *Masonhalea richardsonii, Stereocaulon* spp., *Bryocaulon divergens, Alectoria ochroleuca*) and the same dwarf shrubs.

Representative syntaxa. Class: *Rhizocarpetea geographici* Wirth 1972 (ombrophilous lichen communities of siliceous rock surfaces, Canada). **Class:** *Racomitrietea heterostichi* Neumayr 1971 (bryophyte communities on sunny, exposed siliceous rocks, boulders, and screes). Complexes include graminoid and erect dwarf-shrub-dominated communities of bioclimate subzones D and E (see map units G4, S1, S2).

Qaupat Lake, Baffin Island, Nunavut, Canada (Inset: *Empetrum nigrum*)

B3 Noncarbonate mountain complex

Arctic-alpine tundra complexes on mountains and plateaus with noncarbonate bedrock. Predominantly saxicolous lichen plant communities occur in dry azonal rocky habitats of stony ridges, boulder fields, talus, and screes. Plant communities of other typical alpine habitats (e.g., snowbeds, fellfields, springs, and meadows) are also common. Inclusions of mesic acidic vegetation occur on plateaus and valleys with finer-grained soils within elevation belts (A to E) that roughly correspond to latitudinal bioclimate subzones based mainly on available summer warmth.

Typical species. Generally only areas with a predominance of unvegetated or lichen-covered noncarbonate bedrock are mapped as this unit.

Representative syntaxa. Elevation belt A (roughly corresponding to latitudinal bioclimate subzone A) **class:** *Thlaspietea rotundifolii* Br.-Bl. 1948. **Elevation belt B class:** *Carici rupestris-Kobresietea bellardii* Ohba 1974. **Elevation belt c class:** *Caricetea curvulae* Br.-Bl. 1948. **Elevation belt D class:** *Loiseleurio-Vaccinietea* Eggler ex Schubert 1960. **Elevation belt E class:** *Juncetea trifidi* Hadač in Klika et Hadač 1944; **alliance:** *Carici-Juncion trifidi* Nordh 1943 (windswept chionophobus habitats on acidic soils dominated by rushes).

Near Nanortalik, South Greenland (Inset: *Kalmia procumbens*)

B4 Carbonate mountain complex

Arctic-alpine tundra complexes on mountains and plateaus with carbonate bedrock. The most common plant communities are those occurring in dry azonal rocky habitats of stony ridges, boulder fields, talus, and screes with predominantly saxicolous plant communities. Communities typical of other alpine habitats (e.g., snowbeds, fellfields, springs, and meadows) are also common. Larger inclusions of mesic nonacidic vegetation occur on plateaus and valleys with finer-grained soils within elevation belts (A to E) that climatically correspond to equivalent bioclimate subzones based mainly on available summer warmth.

Typical species. Generally only areas with a predominance of unvegetated or lichen-covered carbonate bedrock are mapped as this unit.

Representative syntaxa. Elevation belt A (roughly corresponding to latitudinal bioclimate subzone A) **class:** *Thlaspietea rotundifolii* Br.-Bl. 1948. **Elevation belt B class:** *Carici rupestris-Kobresietea bellardii* Ohba 1974; **alliances:** *Kobresio-Dryadion* Nordh. 1943 (dry zonal habitats on base-rich soils, subzones B and C); *Dryadion integrifoliae* Ohba ex Daniëls 1982 (Greenland, N America). **Elevation belt c class:** *Carici rupestris-Kobresietea bellardii* Ohba 1974; **alliance:** *Kobresio-Dryadion* Nordh. 1943; **class:** *Carici arctisibiricae–Hylocomietea alaskani* Matveyeva et Lavrinenko 2021; **alliance:** *Carici arctisibiricae–Hylocomion alaskani* Matveyeva et Lavrinenko 2023. **Elevation belt D and E class:** *Saxifrago tricupidatae-Calamagrostietea purpurascentis* Drees et Daniëls 2009 (cryoxerophytic steppe and associated shrub on base-rich soils); **alliances:** *Saxifrago tricuspidatae-Calamagrostion purpurascentis* Cooper ex Drees et Daniëls 2009; *Puccinellion nuttallianae* Daniëls et Chytrý et al. 2015.

Brooks Range, Alaska (Inset: *Saxifraga oppositifolia*)

Representative syntaxa (formal vegetation units) follow the Braun-Blanquet nomenclature system (Weber et al. 2000, Westhoff and Van der Maarel 1978) and are recognized worldwide by the International Botanical Congress. Color bars to the left of each map unit description correspond to colors on the CAVM map and legend on the reverse side.

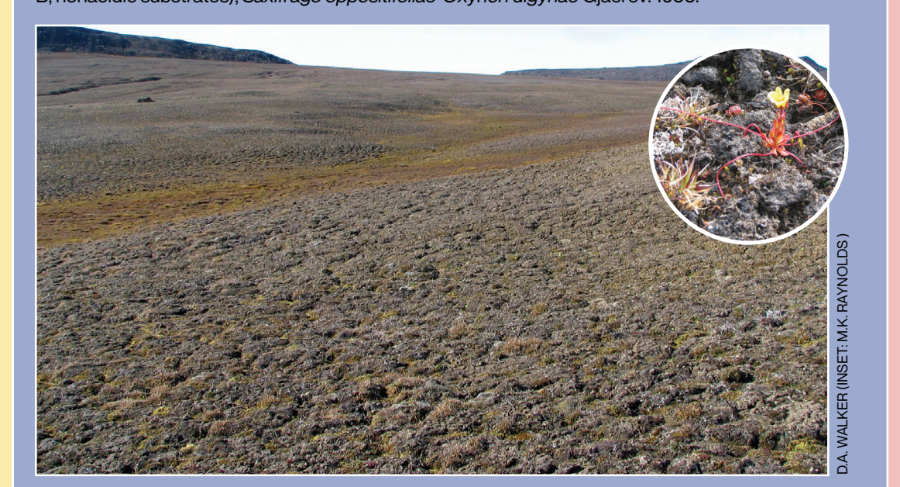
Graminoid tundras

G1 Graminoid, forb, cryptogam tundra

Tundra dominated by graminoids with large components of forbs, mosses, and lichens, mainly on mesic, often hummocky, soils in more maritime portions of bioclimate subzones A and B. Horizontal plant cover is generally 5–80%, often with a large component of soils covered by biological soils crusts; vegetation consists of a single layer generally 5–10 cm tall. In bioclimate subzone A, this unit generally occurs in more protected mesic areas with more snow and, except for the greater density of plant cover, is similar in composition to map unit B1. Sedges, woody shrubs, and bog mosses are generally absent. In bioclimate subzone B, the zonal vegetation cover is often > 75% on mesic sites and includes a mix of sedges (Cyperaceae), rushes (Juncaceae), grasses (Poaceae), forbs, prostrate dwarf shrubs (*Salix* spp. and *Dryas* spp.), lichens, and mosses. Cryptogamic crusts composed of cyanobacteria, liverworts, small mosses, and black crustose lichens are common in mesic habitats in bioclimate subzone B but not in subzone A.

Typical species. Common species in bioclimate subzone A are similar to those in map unit B1 but with greater cover, especially of vascular plants. In subzone B, the vegetation is often dominated by rushes (*Luzula* spp.) and can include large components of sedges (e.g., *Carex* spp., *Eriophorum* spp.), prostrate dwarf shrubs (*Dryas integrifolia, Salix arctica, S. nummularia, S. polaris*), and forbs. **Graminoids:** *Alopecurus borealis, Dupontia fisheri, Deschampsia brevifolia, D. cespitosa, D. sukatschewii* ssp. *borealis, Luzula nivalis, L. confusa, Phippsia algida, Poa abbreviata, P. arctica.* **Forbs:** *Cardamine bellidifolia, Cerastium regelii, Draba* spp., *Minuartia rossii, Oxyria digyna, Papaver dahlianum* aggr., *Potentilla hyparctica, Ranunculus hyperboreus, Saxifraga oppositifolia, Stellaria* spp. **Mosses:** *Aulacomnium turgidum, Ditrichum flexicaule, Oncophorus wahlenbergii, Polytrichum* spp., *Racomitrium* spp., *Schistidium* spp., *Tomentypnum nitens.* **Liverwort:** *Anthelia juratzkana.* **Lichens:** *Lecanora* spp., *Biatora* spp., *Pertusaria* spp., *Ochrolechia* spp., *Thamnolia vermicularis, Flavocetraria* spp., *Stereocaulon* spp.

Representative syntaxa. Class: *Drabo corymbosae-Papaveretea dahliani* Daniëls, Elvebakk et Matveyeva in Daniëls et al. 2016; **alliances:** *Papaverion dahliani* Hofmann ex Daniëls, Elvebakk et Matveyeva in Daniëls et al. 2016; *Luzulion nivalis* (Nordh. 1936) Gjaerev. 1956 (Svalbard, subzone B, nonacidic substrates); *Saxifrago oppositifoliae-Oxyrion digynae* Gjaerev. 1956.



Prince Patrick Island, Northwest Territories, Canada (Inset: *Saxifraga flagellaris*)

G2 Graminoid, prostrate dwarf-shrub, forb, moss tundra

Moist to dry tundra in subzone C and warmer parts (local oases) of subzone B on fine-grained, often hummocky, circumneutral soils with moderate snow. Plant cover is moderate (40–100%) and 5–15 cm tall. The diversity of plant communities is much greater than in map unit G1 and includes subpixel areas of *Cassiope tetragona* snowbeds, well-developed mires, and streamside communities.

Typical species. Sedges: *Carex bigelowii* s.l., *C. concolor* (moister sites), *C. fuliginosa, C. rupestris, Eriophorum triste, Kobresia myosuroides.* **Rushes:** *Juncus biglumis, Luzula nivalis, L. confusa.* **Grasses:** *Alopecurus borealis, Arctagrostis latifolia, Deschampsia cespitosa, D. sukatschewii* ssp. *borealis, D. brevifolia, Dupontia fisheri, Festuca brachyphylla, Poa arctica, Puccinellia vahliana, P. wrightii.* **Forbs:** *Bistorta vivipara, Cardamine bellidifolia, Cerastium regelii, Draba nivalis, Micranthes hieraciifolia, Oxyria digyna, Papaver dahlianum* aggr., *Parrya nudicaulis, Pedicularis capitata, Potentilla hyparctica, Saxifraga cernua, S. hirculus, Stellaria* spp. **Prostrate dwarf shrubs:** *Dryas integrifolia, Salix arctica, S. polaris, S. reticulata, S. rotundifolia.* **Mosses:** *Aulacomnium turgidum, Campylium stellatum, Hylocomium splendens, Oncophorus wahlenbergii, Polytrichum* spp., *Racomitrium lanuginosum, Tomentypnum nitens, Warnstorfia sarmentosa.* **Liverworts:** *Anastrophyllum minutum, Tetralophozia setiformis.* **Lichens:** *Cladonia rangiferina, Cladonia pyxidata, Dactylina arctica, Flavocetraria cucullata, F. nivalis., Masonhalea richardsonii, Sphaerophorus globosus, Thamnolia* spp.

Representative syntaxa. Class: *Carici arctisibiricae–Hylocomietea alaskani* Matveyeva et Lavrinenko 2023; **alliance:** *Salici polaris–Hylocomion alaskani* Matveyeva et Lavrinenko 2021 (Russia, Svalbard). **Class:** *Carici rupestris-Kobresietea bellardii* Ohba 1974; **alliances:** *Kobresio-Dryadion* Nordh. 1943; *Dryadion integrifoliae* Ohba ex Daniëls 1982 (Greenland, N America). **Class:** *Saxifrago tricuspidatae-Calamagrostietea purpurascentis* Drees et Daniëls 2009; **alliance:** *Saxifrago tricuspidatae-Calamagrostion purpurascentis* Cooper ex Drees et Daniëls 2009 (cryoxerophytic steppes in Greenland, N America).

D.A. WALKER (INSET: M.K. RAYNOLDS)
D.A. WALKER (INSET: M.K. RAYNOLDS)

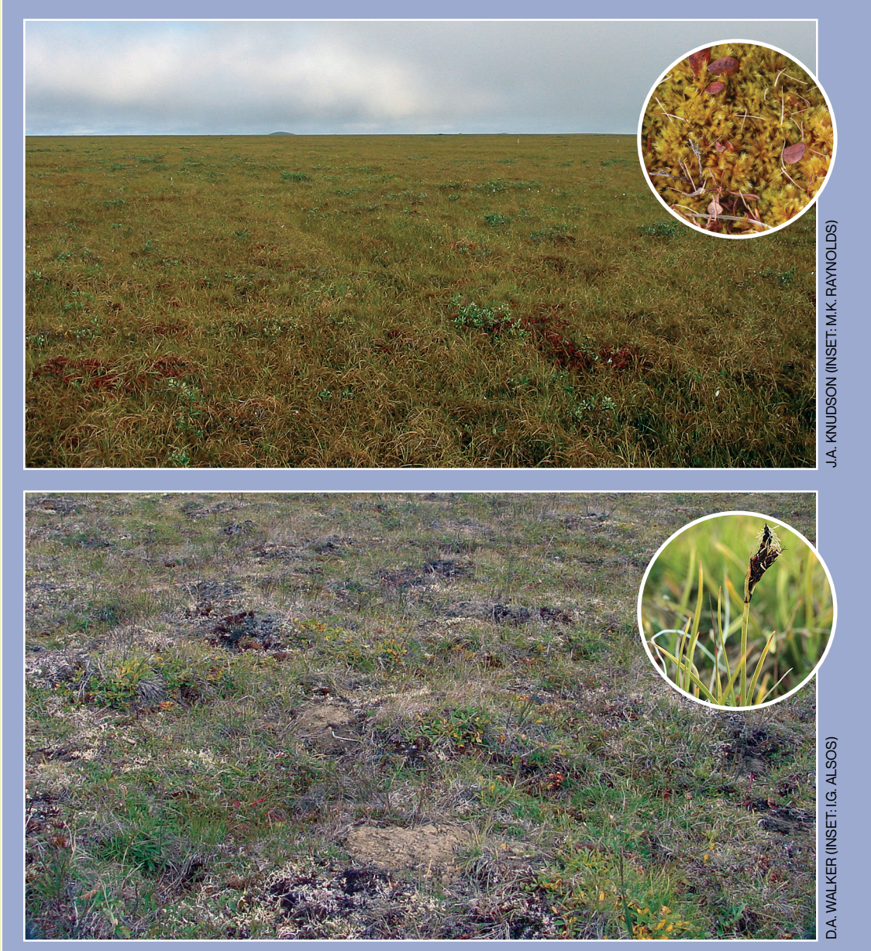
Above: Green Cabin, Banks Island, Northwest Territories, Canada (Inset: *Carex rupestris*)
Below: Near Eureka, Ellesmere Island, Nunavut, Canada (Inset: *Salix arctica*)

G3 Nontussock sedge, dwarf-shrub, moss tundra

Areas with tundra vegetation on peaty nonacidic soils in bioclimate subzone D, where it is the zonal vegetation, and also on moist nonacidic soils in bioclimate subzones C and E. Frost boils (barren patches of cryoturbated soil) are common on silty soils ("spotted tundra" in the Russian literature). Plant cover varies from 50–100%. Plant heights are generally 10–20 cm. Hemiprostrate and erect dwarf shrubs are common, but generally do not form a closed canopy and may grow up to 40 cm high at the southern extent. Well-developed moss layers (5–20 cm thick) are common. Low-shrub (40–200 cm tall) and some tall-shrub (> 2 m) willow thickets occur as subpixel inclusions along stream margins.

Typical species. Sedges: *Carex bigelowii, C. concolor, C. fuliginosa, C. membranacea, C. scirpoidea, Eriophorum triste.* **Rushes:** *Juncus biglumis, Luzula arcuata, L. confusa.* **Grasses:** *Arctagrostis latifolia, Deschampsia sukatschewii* spp. *borealis, Poa arctica.* **Erect dwarf shrubs:** *Rhododendron lapponicum, Salix glauca, S. hastata, S. krylovii, S. pulchra, S. reptans, S. richardsonii.* **Prostrate and hemiprostrate dwarf shrubs:** *Arctous rubra, Betula nana, Cassiope tetragona, Dryas integrifolia, D. punctata, Salix arctica, S. polaris, S. reticulata.* **Forbs:** *Astragalus umbellatus, Bistorta vivipara, Equisetum scirpoides, Eutrema edwardsii, Hulteniella integrifolia, Lagotis glauca, Pedicularis capitata, P. lanata, Pyrola grandiflora, Sagina nivalis, Saxifraga oppositifolia, S. hirculus, Stellaria longipes* s.l., *Tephroseris frigida, Tofieldia coccinea, T. pusilla, Valeriana capitata.* **Mosses:** *Aulacomnium turgidum, Dicranum* spp., *Ditrichum flexicaule, Distichium capillaceum, Hylocomium splendens, Racomitrium lanuginosum, Rhytidium rugosum, Tomentypnum nitens.* **Liverworts:** *Ptilidium ciliare.* **Lichens:** *Bilimbia lobulata, Cladonia pocillum, Dactylina arctica, Flavocetraria cucullata, F. nivalis, Lobaria linita, Nephroma expallidum, Peltigera aphthosa, P. scabrosa, Psoroma hypnorum, Thamnolia vermicularis.*

Representative syntaxa. Class: *Carici arctisibiricae–Hylocomietea alaskani* Matveyeva et Lavrinenko 2023; **alliances:** *Salici pulchrae–Caricion lugentis* Sinelnikova 2021 (E Siberia, Chukotka); *Carici arctisibiricae–Hylocomion alaskani* Matveyeva et Lavrinenko 2023 (W Arctic Russia and Siberia). **Class:** *Carici rupestris-Kobresietea bellardii* Ohba 1974; **alliance:** *Dryadion integrifoliae* Ohba ex Daniëls 1982 (Greenland, N America).


J.A. KNUDSON (INSET: M.K. RAYNOLDS)
D.A. WALKER (INSET: I.G. ALSOS)

Above: Franklink Bluffs, North Slope, Alaska, USA (Inset: *Tomentypnum nitens*)
Below: Near mouth of the Kolyma River, Ambarchik, Sakha Republic, Russia (Inset: *Carex bigelowii* ssp. *arctisibirica*)

G4 Tussock-sedge, dwarf-shrub, moss tundra

Tussock tundra vegetation, mainly in bioclimate subzone E, on silty, unglaciated, acidic, ice-rich permafrost soils, especially in Beringia (NE Russia, W and N Arctic Alaska, and NW mainland Canada). Horizontal plant cover is nearly continuous (80–100% cover). Vertical plant structure includes 2–3 layers and is 20–40 cm tall. A less robust form of tussock tundra grows in subzone D on acidic sands, with smaller tussock sedges and less abundant and shorter dwarf shrubs that do no overtop the tussocks. In warmer areas the erect dwarf shrubs are dominant.

Typical species. Tussock sedge: *Eriophorum vaginatum, Carex bigelowii* s.l. **Other graminoids:** *Eriophorum angustifolium, Poa arctica.* **Prostrate and erect dwarf shrubs:** *Arctous alpina, A. rubra, Betula nana, Chamaepericlymenum suecicum, Empetrum nigrum, Rhododendron tomentosum* ssp. *decumbens, Rubus arcticus, R. chamaemorus, Salix pulchra, Vaccinium uliginosum, V. vitis-idaea.* **Forbs:** *Aconogonon tripterocarpum, Bistorta plumosa, Micranthes nelsoniana, Pedicularis lapponica, P. labradorica, Tephroseris frigida.* **Mosses:** *Aulacomnium palustre, A. turgidum, Dicranum elongatum, D. laevidens, Hylocomium splendens, Polytrichum strictum, Sphagnum balticum, S. rubellum.* **Liverworts:** *Tritomaria quinquedentata.* **Lichens:** *Alectoria nigricans, Bryocaulon divergens, Cladonia amaurocraea, C. arbuscula, C. mitis, C. rangiferina, Flavocetraria cucullata, F. nivalis, Ochrolechia frigida, Peltigera aphthosa, P. canina.*

Representative syntaxa. Class: *Carici arctisibiricae–Hylocomietea alaskani* Matveyeva et Lavrinenko 2023; **alliance:** *Cassiopo tetragonae–Eriophorion vaginati* Matveyeva et Lavrinenko 2023 (Russia, Alaska). **Class:** *Oxycocco-Sphagnetea* Br.-Bl. et Tx. ex Westhoff et al. 1946; **alliance:** *Sphagnion medii* Kästner et Flössner 1933.

Sagwon, Brooks Range foothills, North Slope, Alaska, USA (Inset: *Eriophorum vaginatum*)

Prostrate-shrub tundras

P1 Prostrate dwarf-shrub, herb, lichen tundra

Dry and mesic tundra dominated by prostrate dwarf shrubs, mainly on nonacidic soils in continental and drier parts of bioclimate subzones B and C and corresponding elevational belts (which can include acidic substrates). Plant cover is dominated by prostrate dwarf shrubs (< 10 cm tall) with many forbs and lichens. The vegetation is open or patchy (20–80% cover), with plants 5–10 cm tall. Vascular plants cover about 5–25%, lichens and mosses cover 30–60%. In subzone C this vegetation is richer in vascular species, particularly sedges, grasses, and forbs.

Typical species. Prostrate dwarf shrubs: *Dryas integrifolia, D. punctata, D. octopetala* s.l., *Salix arctica, S. polaris, S. rotundifolia, S. nummularia.* **Graminoids:** *Alopecurus borealis, Carex misandra, C. rupestris, Deschampsia brevifolia, D. cespitosa, D. sukatschewii* ssp. *borealis, Eriophorum triste, Juncus biglumis, Luzula confusa, L. nivalis.* **Forbs:** *Androsace chamaejasme, Bistorta vivipara, Geum glaciale, Lloydia serotina, Oxytropis arctica, Pedicularis oederi, Saxifraga hirculus, S. cespitosa, S. oppositifolia, Silene acaulis.* **Mosses:** *Aulacomnium turgidum, Distichium capillaceum, Ditrichum flexicaule, Encalypta* spp., *Hylocomium splendens, Hypnum bambergeri, Pohlia* spp., *Polytrichum* spp., *Sanionia uncinata, Tomentypnum nitens.* **Lichens:** *Cladonia pocillum, Flavocetraria nivalis, Lecanora epibryon, Ochrolechia frigida, Pertusaria* spp., *Thamnolia vermicularis.*

Representative syntaxa. Class: *Carici arctisibiricae–Hylocomietea alaskani* Matveyeva et Lavri- nenko 2021; **alliance:** *Salici polaris–Hylocomion alaskani* Matveyeva and Lavrinenko 2021. **Class:** *Carici rupestris-Kobresietea bellardii* Ohba 1974; **alliances:** *Kobresio-Dryadion* Nordh. 1943 (Atlantic and Arctic Ocean Islands); *Dryadion integrifoliae* Ohba ex Daniëls 1982 (Greenland, N America).

D.A. WALKER (INSET: D.A. WALKER)
D.A. WALKER (INSET: PLANETARIUM RUSSIA)

Above: Green Cabin, Banks Island, Northwest Territories, Canada (Inset: *Dryas integrifolia*)
Below: Near Popov Polar Station, Ostrov Belyy, Yamalo-Nenets Autonomous Okrug, Russia (Inset: *Salix nummularia*)

P2 Prostrate/hemiprostrate dwarf-shrub, lichen tundra

Hemiprostrate, ericaceous, dwarf-shrub communities in sites with somewhat deeper than average winter snow cover. Zonal vegetation in maritime and acidic portions of bioclimate subzone C, where these communities occupy a large portion of the landscape. This unit is common on siliceous bedrock of Svalbard, Greenland, Baffin Island, and Ellesmere Island. Plants cover 40–100% of the surface. The height of the plant canopy is 10–20 cm.

Typical species. Hemiprostrate dwarf shrubs: *Cassiope tetragona, Empetrum nigrum.* **Prostrate dwarf shrubs:** *Dryas integrifolia, Rhododendron tomentosum* ssp. *decumbens, Salix arctica, S. herbacea, S. nummularia, S. polaris.* **Graminoids:** *Luzula confusa, L. nivalis.* **Mosses:** *Aulacomnium turgidum, Hylocomium splendens, Polytrichum juniperinum, Sanionia uncinata, Tomentypnum nitens.* **Forbs:** *Bistorta vivipara, Oxyria digyna, Silene acaulis.* **Lichens:** *Cetrariella delisei, Peltigera aphthosa, Solorina crocea, Stereocaulon* spp., *Thamnolia vermicularis.*

Representative syntaxa. Class: *Loiseleurio procumbentis-Vaccinietea* Eggler ex Schubert 1960; **alliances:** *Loiseleurio-Arctostaphylion* Kalliola ex Nordh. 1943 (windswept acidic habitats, N Europe); *Hierochloo alpinae-Dryadion octopetalae* Peinado et al. 2019 (N America counterpart to *Loiseleurio-Arctostaphylion*). **Class:** *Carici rupestris–Kobresietea bellardii* Ohba 1974; **alliances:** *Oxytropidion nigrescentis* Ohba 1974 (Taymyr, Yakutia); *Androsacio arctisibiricae–Aconogonion laxmannii* Kucherov et Daniëls 2005 (tundra steppe and ridges, NE Asia). **Class:** *Salicetea herbaceae* Br.-Bl. 1948; **alliance:** *Cassiopo-Salicion herbaceae* Nordh. 1943 (mesic acidic tundra with moderate snow in maritime regions).

Near Zackenberg, East Greenland (Inset: *Cassiope tetragona*)

Erect-shrub tundras

S1 Erect dwarf-shrub, moss tundra

Communities dominated by hemiprostrate and erect dwarf shrubs less than 40 cm tall. This is the zonal vegetation in maritime areas of bioclimate subzone D on moist to dry acidic soils in Greenland and the Canadian Shield. Drier lichen-rich, dwarf-shrub tundras are common in the Russian Arctic and occur in vegetation complexes with lichen-covered bedrock on the Canadian mainland and Baffin Island. Sedge-tussock understory is common in Beringia. Plant cover is continuous (80–100% in moist areas) to sparse (5–50% on dry ridges).

Typical species. Dwarf shrubs: *Arctous alpina, A. rubra, Betula nana, B. glandulosa, Cassiope tetragona, Diapensia lapponica, Empetrum nigrum, Kalmia procumbens, Rhododendron tomentosum* ssp. *decumbens, Salix glauca, S. nummularia, Vaccinium myrtillus, V. uliginosum* ssp. *microphyllum, V. vitis-idaea.* **Graminoids:** *Avenella flexuosa, Carex bigelowii* s.l., *Eriophorum vaginatum, Festuca brevissima.* **Mosses:** *Aulacomnium turgidum, Dicranum* spp., *Hylocomium splendens, Polytrichum hyperboreum, P. piliferum, Racomitrium lanuginosum.* **Liverworts:** *Gymnomitrion corallioides.* **Lichens:** *Alectoria ochroleuca, A. nigricans, Bryocaulon divergens, Cetraria nigricans, Cladonia arbuscula, C. rangiferina, Flavocetraria cucullata, F. nivalis, Masonhalea richardsonii, Sphaerophorus globosus, Stereocaulon alpinum.*

Representative syntaxa. Class: *Carici arctisibiricae–Hylocomietea alaskani* Matveyeva et Lavrinenko 2023; **alliance:** *Salici pulchrae–Caricion lugentis* Sinelnikova 2021 (E Siberia, Chukotka); *Dryado octopetalae–Caricion arctisibiricae* Koroleva et Kulyugina in Chytrý et al. 2015 (Russian Arctic). **Class:** *Loiseleurio-Vaccinietea* Eggler ex Schubert 1960; **alliances:** *Phyllodoco-Vaccinion myrtilli* Nordh. 1943 (Fennoscandia, Iceland, NW Russia, Greenland); *Loiseleurio-Arctostaphylion* Kalliola ex Nordh. 1943 (wind-exposed habitats of Scandinavia, N Russia, Svalbard, Iceland, and Greenland). **Class:** *Betulo carpaticae-Alnetea viridis* Rejmánek ex Boeuf, Theurillat, Willner, Mucina et Simler in Boeuf et al. 2014; **alliance:** *Arcto erythrocarpae–Salicion* Sekretareva 2003 (Chukotka, Alaska).

D.A. WALKER (INSET: M.K. RAYNOLDS)
D.A. WALKER (INSET: M.K. RAYNOLDS)

Above: Near Laborovaya, northern Polar Urals foothills, Yamalo-Nenets Autonomous okrug, Russia (Inset: *Betula nana*)
Below: Daring Lake, Northwest Territories, Canada (Inset: *Arctous alpina*)

S2 Low-shrub, moss tundra

Communities dominated by low shrubs greater than 40 cm tall, often with well-developed peatlands on moist surfaces and including well-drained uplands. Zonal vegetation in warmer and maritime parts of bioclimate subzone E, and common in areas with deep active layers, such as riparian corridors. This unit includes some areas with scattered *Pinus pumila* stlaniks east of the Anadyr River in Chukotka.

Typical species. Low shrubs: *Alnus viridis, Betula glandulosa, B. divaricata, Salix* spp., *Spiraea stevenii.* **Dwarf shrubs:** *Betula nana, Empetrum nigrum, Rhododendron tomentosum* ssp. *decumbens, Vaccinium uliginosum, V. vitis-idaea.* **Mosses:** *Aulacomnium turgidum, Hylocomium splendens, Sanionia uncinata, Sphagnum* spp. Low and tall willows and alders are abundant along drainages and near treeline. Rich assemblages of forbs occur in shrublands along streams. A few trees reach into this subzone along the southern river valleys (e.g., *Betula pubescens* ssp. *tortuosa, B. platyphylla, Larix laricina, L. cajanderi, Picea abies* ssp. *obovata, P. glauca, P. mariana, Populus balsamifera, P. suaveolens, Salix arbusculoides*).

Representative syntaxa. Class: *Loiseleurio procumbentis–Vaccinietea* Eggler ex Schubert 1960; **alliance:** *Polytrichastro alpini–Alnion fruticosae* all. prov. Sekretareva 1999 (foothills, Chukotka). **Class:** *Betulo carpaticae-Alnetea viridis* Rejmánek ex Boeuf, Theurillat, Willner, Mucina et Simler in Boeuf et al. 2014; **alliances:** *Alnion viridis* Schnyder 1930 (moist to dry *Alnus viridis* communities and alder savannas); *Salicion callicarpeae* Daniëls in Mucina et al. 2016 (herb-rich willow scrub, Greenland); *Salicion phylicifoliae* Dierssen 1992 (willow scrub of montane stream banks in N Europe and Greenland); *Geranio albiflorum–Salicion* Sekretareva 2011 (Polar Urals); *Empetro sibiricae-Pinion pumilae* Neshatayeva 1990 (Chukotka); *Polemonio acutiflorum–Salicion glaucae* Lavrinenko et Lavrinenko 2021 (willow scrub, Siberia); *Ribo tristis–Alnion fruticosae* all. prov. Sekretareva 1999 (Chukotka); *Carici scirpoideae–Alnion fruticosae* Sekretareva 1999 all. prov.

J. BICKLEY (INSET: CENTRAL YUKON SIP)
D.A. WALKER (INSET: PEGANUM CC BY-SA 2.0)

Above: Happy Valley, Brooks Range foothills, North Slope, Alaska, USA (Inset: *Salix pulchra*).
Below: Vaskiny Dachi, Central Yamal Peninsula, Yamalo-Nenets Autonomous okrug, Russia (Inset: *Salix lanata*)

Wetlands

W1 Sedge/grass, moss wetland complex

Wetland complexes of bioclimate subzones B and C dominated by sedges, grasses, and mosses. The complexes occur as a mix of wetland vegetation in low wet areas with many ponds and moist elevated microsites (e.g. map unit G2) associated with patterned ground.

Typical species. Graminoids: *Alopecurus borealis, Arctagrostis latifolia, Calamagrostis holmii, Carex concolor, C. rariflora, Eriophorum russeolum, E. scheuchzeri, E. triste, Pleuropogon sabinei.* **Forbs:** *Bistorta vivipara, Cardamine polemonioides, Cerastium regelii, Caltha palustris* ssp. *radicans, Saxifraga cernua, Micranthes foliolosa, Pedicularis albolabiata, P. arctoeuropaea.* **Mosses:** *Bryum pseudotriquetrum, Calliergon giganteum, Campylium stellatum, Cinclidium arcticum, C. subrotundum, Hamatocaulis vernicosus, Limprichtia revolvens, Meesia triquetra, Plagiomnium ellipticum, Warnstorfia sarmentosa.* Grasses (*Alopecurus borealis, Dupontia fisheri, Pleuropogon sabinei*) are more important in bioclimate subzone B wetlands than in subzone C. Elevated microsites have moist graminoid, prostrate dwarf-shrub, forb, moss tundra species such as *Carex atrofusca, C. fuliginosa, C. membranacea, Eriophorum triste, Kobresia simpliciuscula, Salix arctica, S. reticulata,* and *Tomentypnum nitens* (see also map unit G2).

Representative syntaxa. Class: *Scheuchzerio-Caricetea* (Nordh. 1936) Tx. 1937 nom. ambiguum; **alliances:** *Caricion stantis* Matveyeva 1994 (Taymyr Peninsula, Vaigach Island); *Scheuchzerion palustris* Nordh. ex Tx. 1937.

Near Resolute, Cornwallis Island, Nunavut, Canada (Inset: *Eriophorum angustifolium*)

W2 Sedge, moss, dwarf-shrub wetland complex

Wetland complexes of bioclimate subzones C and D, primarily fens with slightly acidic to circumneutral soil pH. Moist graminoid, dwarf-shrub, moss tundra (as in map unit G3) and water are usually present in slightly elevated microsites such as hummocks, strangs in strangmoor complexes, and rims of low-centered ice-wedge polygons.

Typical species. Graminoids: *Arctophila fulva, Calamagrostis neglecta, Carex aquatilis, C. chordorrhiza, C. rariflora, Dupontia fisheri, Eriophorum angustifolium.* **Prostrate dwarf shrubs:** *Salix arctica, S. fuscescens, S. reptans.* **Forbs:** *Caltha palustris, Cardamine pratensis, Comarum palustre, Epilobium palustre, Pedicularis albolabiata, P. parviflora.* **Mosses:** *Calliergon richardsonii, C. stramineum, Catoscopium nigritum, Cinclidium latifolium, Drepanocladus* spp., *Meesia triquetra, Scorpidium scorpioides, Warnstorfia exannulata, W. sarmentosa.* On acidic variants, raised microsites have hypoarctic, oligotrophic dwarf shrubs (e.g. *Rhododendron tomentosum* ssp. *decumbens, Salix pulchra, Empetrum nigrum, Betula nana* s.l., *Vaccinium* spp.) (see also map unit S1).

Representative syntaxa. Class: *Scheuchzerio palustris–Caricetea fuscae* Tx. 1937 nom. ambiguum; **alliances:** *Caricion stantis* Matveyeva 1994; *Drepanocladion exannulati* Krajina 1933; *Aulacomnio palustris–Caricion rariflorae* Lavrinenko et Lavrinenko 2021; *Scheuchzerion palustris* Nordh. ex Tx. 1937. **Class:** *Oxycocco-Sphagnetea* Br.-Bl. et Tx. ex Westhoff et al. 1946; **alliance:** *Oxycocco microcarpi-Empetrion hermaphroditi* Nordh. ex Du Rietz 1954 nom. conserv. propos.

Near Teshekpuk Lake, Arctic Coastal Plain, North Slope, Alaska, USA (Inset: *Carex aquatilis*)

W3 Sedge, moss, low-shrub wetland complex

Wetland complexes in subzone E, often bog/fen complexes with deep organic soils. Dwarf-shrub or low-shrub tundra (map units S1 or S2) or tussock tundra (map unit G4) are usually present in slightly elevated microsites such as strangs, peat plateaus, and palsas. Includes some saline coastal communities that differ in species composition from the more common freshwater communities described here.

Typical species. Graminoids: *Carex aquatilis, C. chordorrhiza, C. rariflora, C. rotundata, Eriophorum angustifolium, E. scheuchzeri.* **Shrubs:** *Andromeda polifolia* ssp. *pumila, Oxycoccus microcarpus.* **Mosses:** *Aulacomnium turgidum, Calliergon stramineum, Dicranum elongatum, Drepanocladus* spp., *Polytrichum jensenii, Sphagnum balticum, S. lindbergii.* **Lichens:** *Icmadophila ericetorum.* The main plant communities on elevated microsites are shrublands with dwarf and low shrubs (e.g., *Alnus viridis, Betula nana/glandulosa, Empetrum nigrum, Rhododendron tomentosum* ssp. *decumbens, Rubus chamaemorus, Salix fuscescens, S. myrtilloides, S. pulchra, Vaccinium uliginosum* ssp. *microphyllum*), mosses, and lichens typical of map units S1 and S2.

Representative syntaxa. Class: *Oxycocco-Sphagnetea* Br.-Bl. et Tx. ex Westhoff et al. 1946; **alliance:** *Rubo chamaemori-Dicranion elongati* Lavrinenko et Lavrinenko 2015. **Class:** *Scheuchzerio-Caricetea* (Nordh. 1936) Tüxen 1937; **alliance:** *Scheuchzerion palustris* Nordhagen ex Tüxen 1937.

O.V. LAVRINENKO (INSET: O.V. LAVRINENKO)
A.L. BREEN (INSET: M.K. RAYNOLDS)

Above: Near Naryan-Mar, Pechora River, Western Siberia, Russia (Inset: *Rubus chamaemorus*)
Below: Near Council, Seward Peninsula, Alaska, USA (Inset: *Sphagnum angustifolium*)

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Making the Raster CAVM

The original Circumpolar Arctic Vegetation Map (CAVM), produced in 2003, was the first vegetation map that covered the entire Arctic using a single, unified legend (CAVM Team 2003). It has been widely used as a base map for studies in the Arctic. However, the relatively coarse resolution and vector format of the map were not compatible with many other datasets. To meet this need, we built on the strengths of the original CAVM to create a version in raster format, providing a finer spatial resolution, raster format, and improved mapping (Raynolds et al. 2019).

The Raster CAVM uses the legend, extent, and projection of the original CAVM. The legend includes 16 vegetation types, as well as glacier/ice, water (saline and freshwater), and non-Arctic land. The map portrays the dominant vegetation physiognomy—the general appearance of the vegetation based on the dominant plant growth forms. Since 1-km pixels can contain many vegetation types, the dominant zonal vegetation was generally mapped for each pixel. Zonal sites are areas where the vegetation develops under the prevailing climate, uninfluenced by extremes of soil moisture, snow, soil chemistry, or disturbance. Zonal sites are flat or gently sloping, moderately drained, with fine-grained soils. Non-zonal areas such as mountain ranges, large wetlands, and river systems can also be seen on the map.

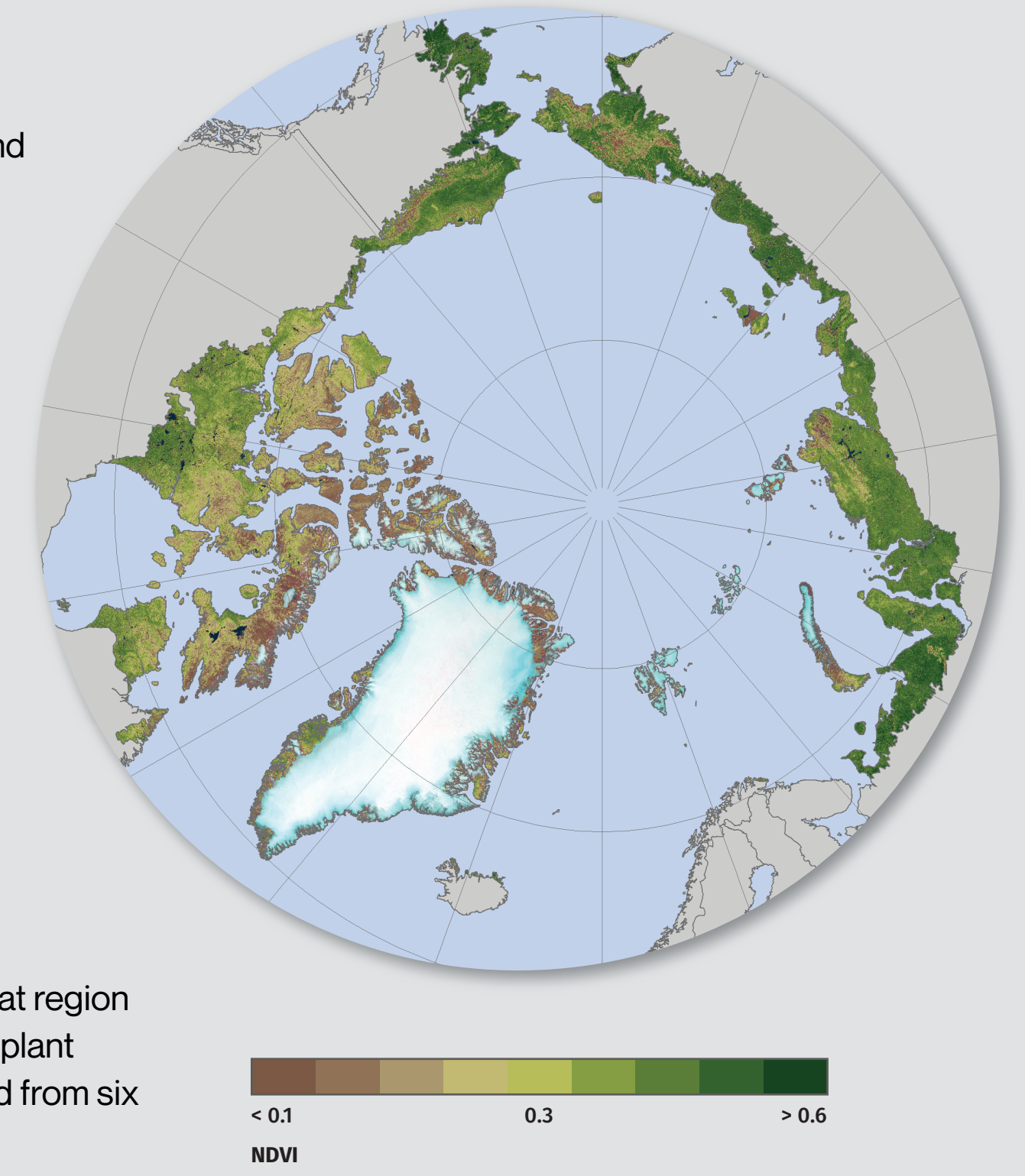
The extent of the Raster CAVM is the full Arctic tundra, defined as the Arctic bioclimate subzone north of the climatic limit of trees that is characterized by an Arctic climate, Arctic flora, and tundra vegetation. It excludes tundra regions with a boreal flora such as the boreal oceanic areas of Iceland and the Aleutian Islands, and alpine tundra regions south of the latitudinal treeline. The Lambert Azimuthal Equal Area Polar Projection allows effective comparisons of different areas of the map.

How Vegetation is Classified

The Raster CAVM is based on unsupervised classifications of 18 geographic/floristic subsections of the Arctic (Yurtsev 1994, CAVM Team 2003), using AVHRR and MODIS data (red and infrared reflectance, and NDVI) and elevation data (ESRI 1993). The MODIS data, displayed as Normalized Difference Vegetation Index (NDVI), is shown at right. This index compares the red and infrared reflectances and indicates the amount of vegetation on the ground. The value of each pixel was determined by its reflectance at the time of maximum NDVI, selected from biweekly midsummer images from 2000–2009 (Trishchenko et al. 2009). The image shows the Arctic with minimum snow and cloud cover. Green areas represent greater amounts of vegetation; brown areas represent sparse vegetation; black areas represent fresh water; and bluish-white areas represent ice.

The classification units were compared with ancillary data layers to assign each unit to a preliminary CAVM vegetation unit. Regional vegetation maps were the most important resources for this step. Climate data, including locally available ground data and interpolated data, were also important. Ground studies and vegetation descriptions were consulted for all sections of the map. High-resolution imagery and ground photos hosted on Google Earth were especially helpful for areas with limited ground data. Geology maps were used to differentiate between acidic and nonacidic mountain units. Elevation data were used to identify areas over 1,000 m in elevation, where adiabatic cooling would result in a significantly cooler climate than at sea level, resulting in a different bioclimate subzone and different vegetation than the surrounding areas at lower elevations.

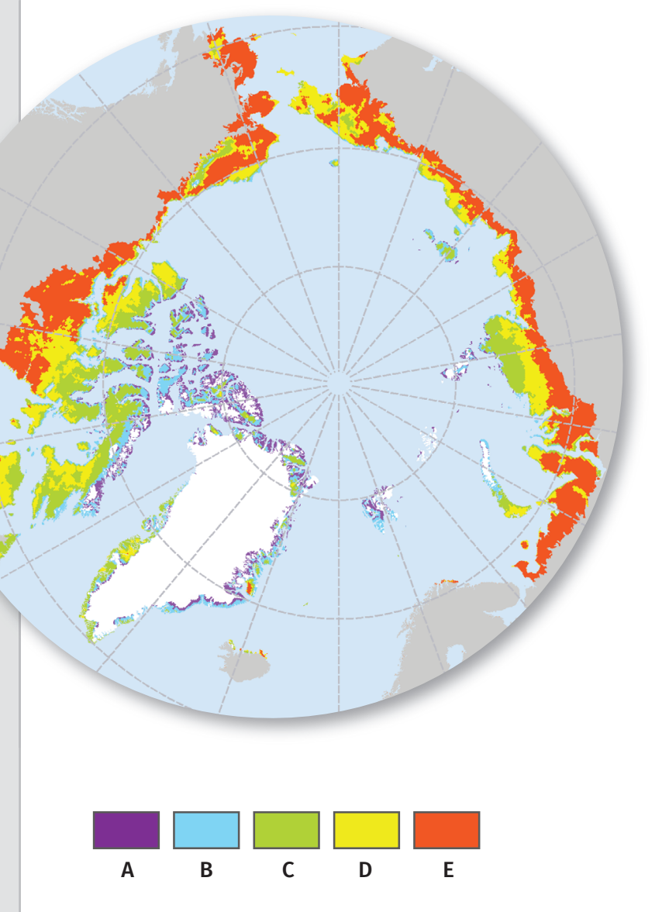
Each portion of the draft Raster CAVM was sent to experts with experience mapping the vegetation of that region of the Arctic. The input from these reviewers was used to improve the map and the legend description of plant communities included in each mapping unit. Accuracy assessment of 604 random 1-km pixels interpreted from six Landsat 8 OLI scenes showed an average of 70% accuracy (Raynolds et al. 2019).



Bioclimate: north–south variation in plant communities

Although the Arctic has warmed, especially in the last few decades, plants grow slowly in the north, and plant communities have not yet adapted to these new conditions. On the northernmost Arctic islands, plants are at their metabolic limits and small differences in the total amount of summer warmth make large differences in the amount of energy available for maintenance, growth and reproduction. The number of plants in local floras available to form plant communities increases from fewer than 50 species in the coldest parts of the Arctic (subzone A) to as many as 500 species near treeline (subzone E).

Woody plants and sedges are absent in subzone A, where pre-2000s mean July temperatures were less than 3 °C. Woody plants first occur as prostrate (creeping) dwarf shrubs in subzone B (mean July temperatures about 3–5 °C), and increase in stature to hemiprostrate dwarf shrubs (< 15 cm tall) in subzone C (mean July temperatures about 5–7 °C), erect dwarf shrubs (< 40 cm tall) in subzone D (mean July temperatures about 7–9 °C), and low shrubs (40–200 cm tall) in subzone E (mean July temperatures about 9–12 °C). At treeline, with mean July temperatures of about 10–12 °C, woody shrubs up to 2 m tall are abundant. All mean July temperatures used here are pre-2000s ranges, based on Edlund (1990) and Matveyeva (1998), to minimize the effects of climate change.



Bioclimate Subzones

As one moves from north to south in the Arctic, the amount of warmth available for plant growth increases. Warmer summer temperatures cause the size, horizontal cover, abundance, productivity, and variety of plants to increase (see table at right).

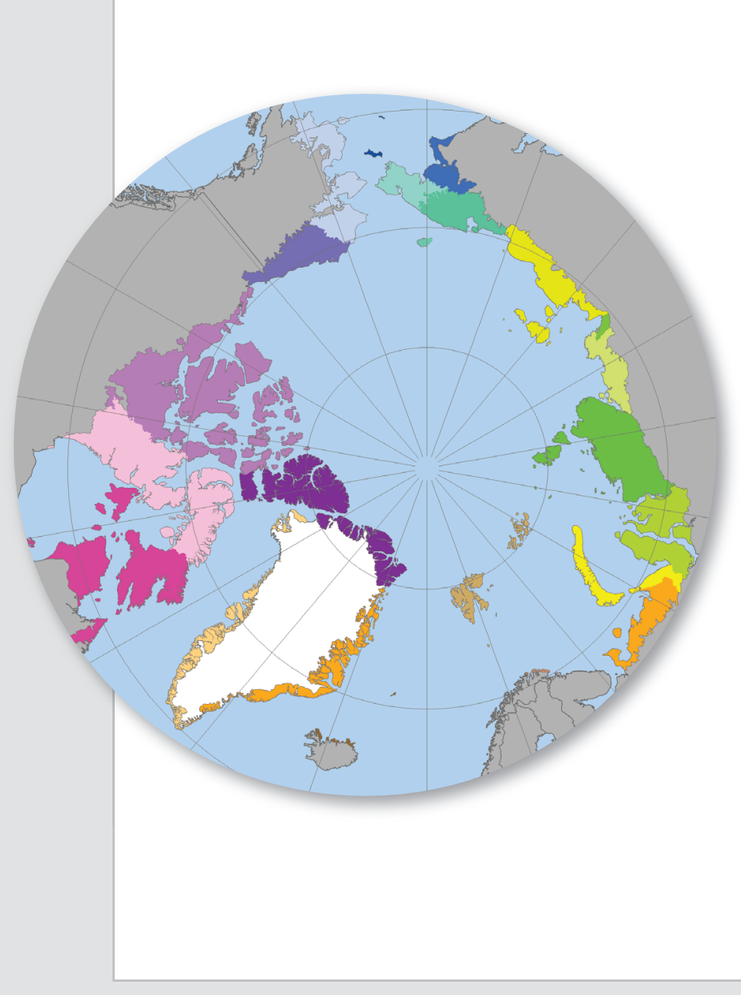
Table 1. Vegetation properties in the five Arctic bioclimate subzones (A-E) prior to climate warming

Subzone	Mean pre-2000s July temp[1] (°C)	Summer Warmth Index[2] (°C)	Vertical structure of plant cover[3]	Horizontal structure of plant cover[3]	Dominant vegetation unit[4]	Total phytomass[5] ($t\ ha^{-1}$)	Net annual production[6] ($t\ ha^{-1}yr^{-1}$)	Vascular plant species in local floras[7]
A	0-3	< 6	Mostly barren. In favorable microsites, 1 lichen or moss layer < 2 cm tall, very scattered vascular plants hardly exceeding the moss layer	< 5% cover of vascular plants, up to 40% cover by mosses and lichens	B1, G1	< 3	< 0.3	< 50
B	3–5	6–9	2 layers, moss layer 1–3 cm thick and herbaceous layer, 5–10 cm tall, prostrate dwarf shrubs < 5 cm tall	5–25% cover of vascular plants, up to 60% cover of cryptogams	P1, G1	5–20	0.2–1.9	50–100
C	5–7	9–12	2 layers, moss layer 3–5 cm thick and herbaceous layer 5–10 cm tall, prostrate and hemiprostrate dwarf shrubs < 15 cm tall	5–50% cover of vascular plants, open patchy vegetation	G2, P2	10–30	1.7–2.9	75–150
D	7–9	12–20	2 layers, moss layer 5–10 cm thick and herbaceous/dwarf-shrub layer 10–40 cm tall	50–80% cover of vascular plants, interrupted closed vegetation	G3, S1	30–60	2.7–3.9	125–250
E	9–12	20–35	2–3 layers, moss layer 5–10 cm thick, herbaceous/dwarf-shrub layer 20–50 cm tall, sometimes with low-shrub layer to 80 cm	80–100% cover of vascular plants, closed canopy	G4, S1, S2	50–100	3.3–4.3	200–500

Notes: [1]Based on Edlund (1990) and Matveyeva (1998). [2]Sum of mean monthly temperatures greater than 0 °C, modified from Young (1971) and Walker et al. (2005). [3]Chernov and Matveyeva (1997). [4]See Vegetation Descriptions at left for representative syntaxa in vegetation units. [5]Based on Bazilevich et al. (1997), aboveground + belowground, live + dead. [6]Based on Bazilevich et al. (1997), aboveground + belowground. [7]Based mainly on Young (1971).

Floristic Provinces: east–west variation in plant communities

Many Arctic plants have a circumpolar distribution, but mountain ranges and glacial histories have limited the distribution of some species, creating differences in Arctic plant communities (Yurtsev 1994, Elvebakk et al. 1999).



European Russian–West Siberian
- Kanin–Pechora
- Polar Ural–Novaya Zemlya
- Yamal–Gydan

East Siberian
- Taimyr
- Anabar–Olenyek
- Kharaulakh
- Yana–Kolyma

Beringian
- West Chukotka
- Wrangel Island
- East Chukotka
- South Chukotka
- North Beringian Islands
- Beringian Alaska
- North Alaska

Canadian
- Central Canada
- West Hudson
- Ellesmere–North Greenland

North Atlantic
- Baffin–Labrador
- West Greenland
- East Greenland
- North Iceland–Jan Mayen
- North Fennoscandia
- Svalbard–Franz Josef Land

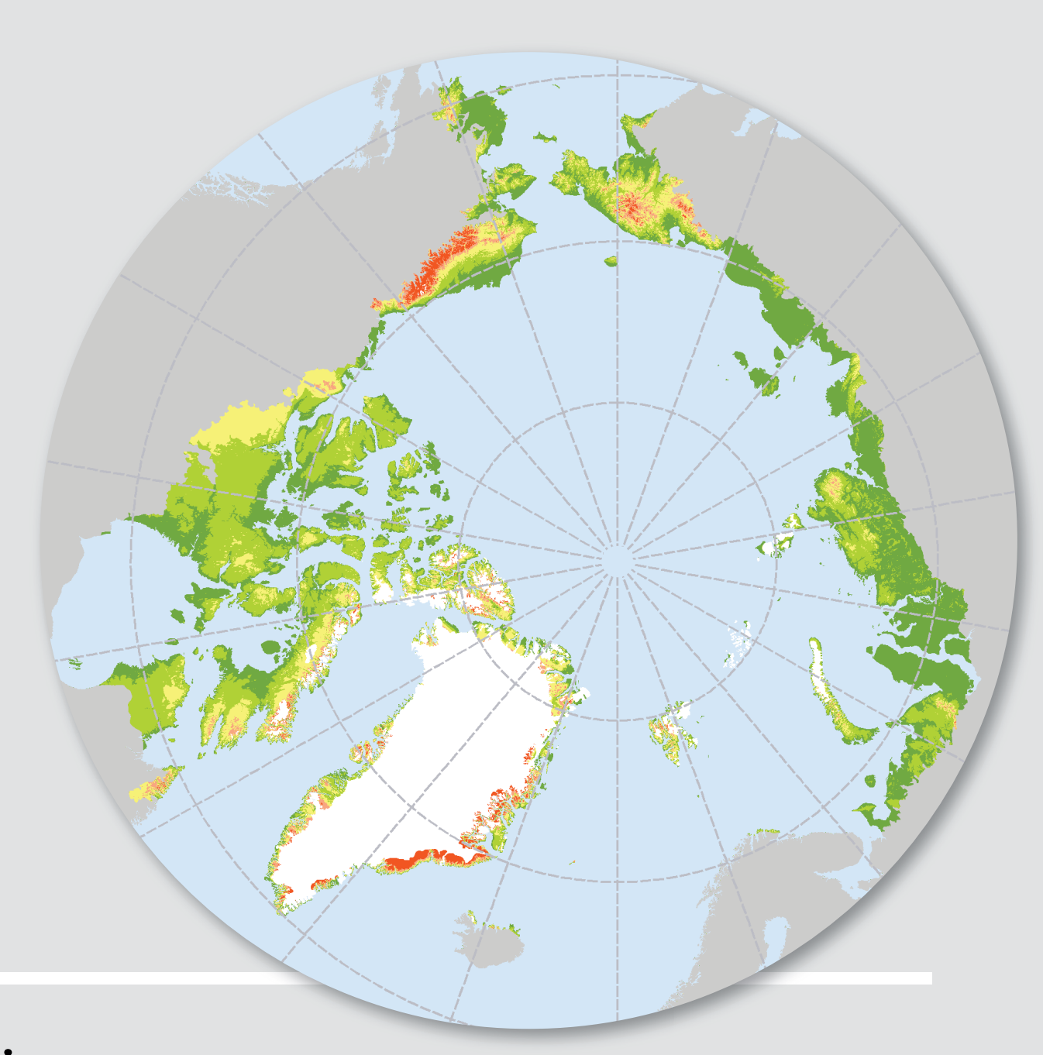
Elevation

Topography strongly influences soil moisture and patterns of tundra plant communities. Vegetation in mountainous regions changes with elevation, forming distinctive elevational belts that correspond approximately to the bioclimatic subzones. For every 333 m in elevation, the mean July temperature decreases by about 2 °C, as predicted by the adiabatic lapse rate of 6 °C per 1000 m. The elevation map at right (ESRI 1993) uses 333-m elevation intervals to show approximate 2 °C temperature shifts in the mountainous areas. Areas below 100 m are separated to show low-elevation plains.

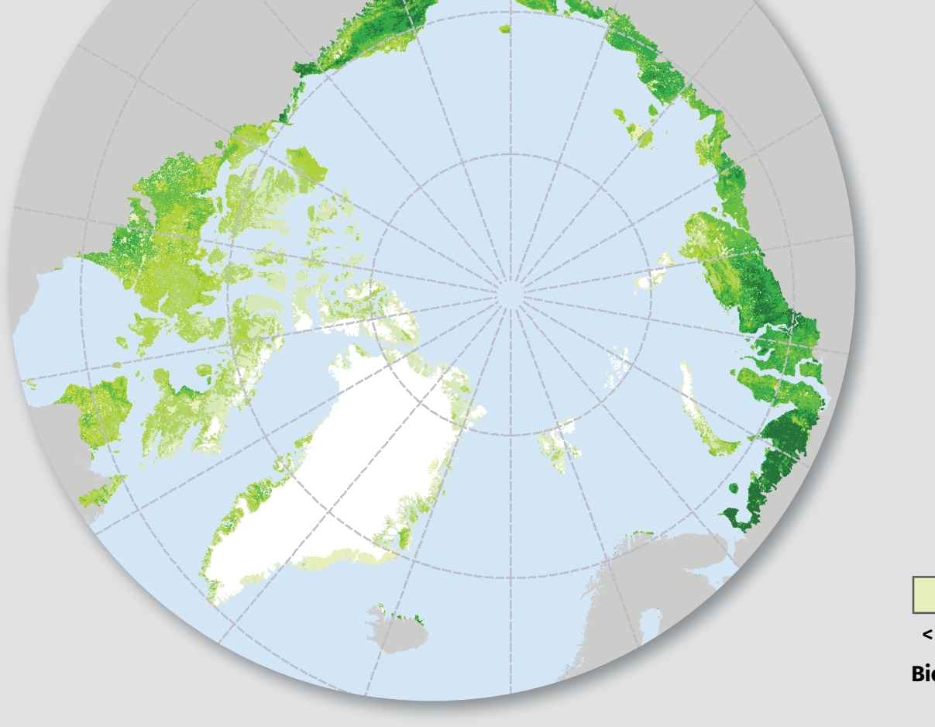
A mountain in subzone E, if high enough, can have elevation belts roughly corresponding to Arctic bioclimate subzones A through E. The lowest belt (< 100 m) is dominated by low-shrub tundra (S2); the next higher belt (100–333 m) has erect dwarf-shrub tundra (S1); then prostrate dwarf-shrub, herb tundra (P1) at 333–666 m; rush/grass, forb, cryptogam tundra (G1) at 666–999 m; cryptogam, herb barrens (B1) at > 999 m; and finally the nival belt which is snow- and ice-covered. The distribution of vegetation communities is also modified by local topographic effects such as slope, aspect, and cold-air drainage.

< 100 | 100-333 | 333-666 | 666-999 | > 999

Elevation (m)



Aboveground Plant Biomass



The Normalized Difference Vegetation Index (NDVI) shows relative maximum greenness (see map at top of panel). Vegetation greenness is calculated as: $NDVI = (NIR - R)/(NIR + R)$, where NIR is the spectral reflectance in the AVHRR near-infrared channel (0.725-1.1 µm) where light reflectance from the plant canopy is dominant, and R is the reflectance in the red channel (0.5 to 0.68 µm), the portion of the spectrum where chlorophyll absorbs maximally. The relationship between NDVI and aboveground plant biomass was calculated from clip harvest data (Walker et al. 2003). The biomass values in the map at left were grouped into eight classes that meaningfully separate the vegetation according to biomass. Dark green areas represent areas of shrubby vegetation with high biomass, while light green areas have low biomass.

< 30 | 30-70 | 70-160 | 160-370 | 370-850 | 850-1,300 | > 1,300

Biomass (g/m²)