Alaska Arctic Tundra Vegetation

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Derived from the Circumpolar Arctic Vegetation Map

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About the Map

This map portrays the vegetation of the Arctic Tundra within Alaska, north and west of the forest boundary. The Arctic Tundra Bioclimate Zone is characterized by an arctic flora, an arctic climate and tundra vegetation (Elvebakk et al. 1999). It excludes areas that have a boreal flora such as the Aleutian Islands and alpine tundra regions south of treeline. The color of the units and the first letter and number of the labels indicate the dominant vegetation physiognomy, and are based on the Circumpolar Arctic Vegetation Map (CAVM) (CAVM Team 2003). The numeric suffix following the decimal point on the labels differentiates dominant vegetation types within the CAVM physiognomic units, resulting in the 33 types shown on this map. Each of the dominant vegetation types is described in the legend, with reference to the plant community table on the reverse side. The table lists 85 Alaska arctic plant communities with their common and characteristic species and literature citations for the original community descriptions. The legend is organized hierarchically by dominant vegetation physiognomy, bioclimate subzone, and region.

The mapping process: A 1:4 million-scale color-infrared (CIR) image of AVHRR satellite data was used as a base map (see inset A at right side of map). Data for each 1-km AVHRR pixel were selected at the time of maximum greenness from biweekly images from 11 July to 30 August 1993 and 1995.

Key environmental and biological factors which control plant communities in arctic Alaska were used to determine the dominant vegetation type of a mapped polygon (Walker 1999, 2000, Walker et al. 2002). Temperature and vegetation data together define bioclimate subzones (map B). East-west variations in species distribution were defined by floristic provinces (map C). Bedrock geology and surficial geology were used to determine the general chemistry of the substrate on which plant communities grow (map D). Landscape topography and lake cover are important factors affecting soil moisture availabe to plants (maps E and F). Plant biomass was estimated from the normalized difference vegetation index (NDVI, map G). All of these factors were combined to determine the dominant vegetation type of a polygon.

The minimum polygon size on the map is 14 km diameter (8 km for linear features). The dominant vegetation type of each polygon was mapped with the recognition that polygons at this scale contain many vegetation types. Some of this heterogeneity can be characterized by a topographic sequence (see diagram and table on reverse side). Typical dry, moist, wet, snowbed and riparian plant communities that might be inclusions within another polygon are described for each bioclimate subzone, floristic region, and acidic and non-acidic substrates. Nomenclature follows the USDA Plants Database (USDA 2005), with input from David Murray.

Bioclimate subzones: The Arctic Tundra Bioclimate Zone is subdivided into five subzones (A-E). The southern three subzones occur in Alaska (C-E) (map B). As one goes from north to south, and farther from the ocean, summer temperatures increase, along with size, horizontal cover, abundance, productivity and variety of plants. Shrub height is a key distinguishing feature of each subzone. Only hemiprostrate and prostrate dwarf shrubs (<15 cm tall) occur in Subzone C, along the northern coast of Alaska where mean July temperatures are about 5-7 ^{o}C. Erect dwarf shrubs (<40 cm tall) occur in Subzone D where the mean July temperatures are about 7-9 ^{o}C. Low shrubs (40-200 cm tall) occur in Subzone E where mean July temperatures are about 9-12 ^{o}C. The southern boundary of Subzone E is treeline, where the mean July temperatures are about 10-12 ^{o}C and woody shrubs up to 2 m tall are abundant (Walker 2005).

Floristic provinces: Floristic Provinces are used to explain the east-west variation in species distribution in the Arctic (map C). The Arctic has a relatively consistent core of plant species that occur throughout the circumpolar region, but there is also considerable east to west variation in regional floras, particularly in southern bioclimate subzones. These differences are evident in the species listed in the table on the reverse side, and are due to a number of factors including different histories related to glaciations, land bridges, and north-south trending mountain ranges that have influenced the exchange of species between parts of the Arctic. Alaska is included within the Beringian Floristic Province, and includes three of the 23 circumpolar Sub-Provinces: North Beringian Islands, Beringian Alaska, and Northern Alaska (Yurtsev 1994), (Walker 2005).

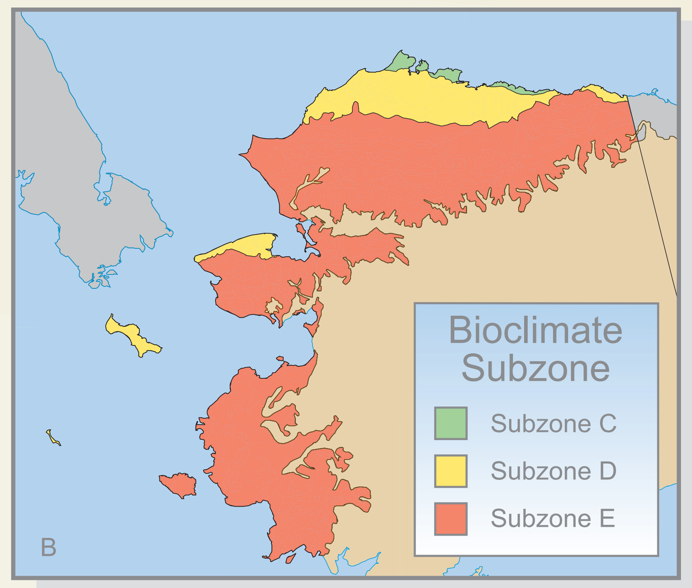
Substrate chemistry: Differences in substrate chemistry, including pH, govern the availability of essential plant nutrients. Soils in the circumneutral range (pH 5.5-7.2) are generally mineral rich, whereas the full suite of essential nutrients is often unavailable in acidic soils (pH < 5.5) or in soils associated with calcareous bedrock (pH > 7.2). Both extremes have unique assemblages of plant species. The substrate chemistry map (map D) is derived from a wide variety of sources including soil, surficial geology and bedrock geology maps, and from spectral patterns that could be recognized on the AVHRR base image. Vegetation types in the table on the reverse side are listed by substrate type. Carbonate and circumneutral substrates were combined to simplify the table. Carbonate substrates occur mostly in mountainous regions, while circumneutral substrates are mostly fine-grained loess occurring at lower elevations in foothills or plains.

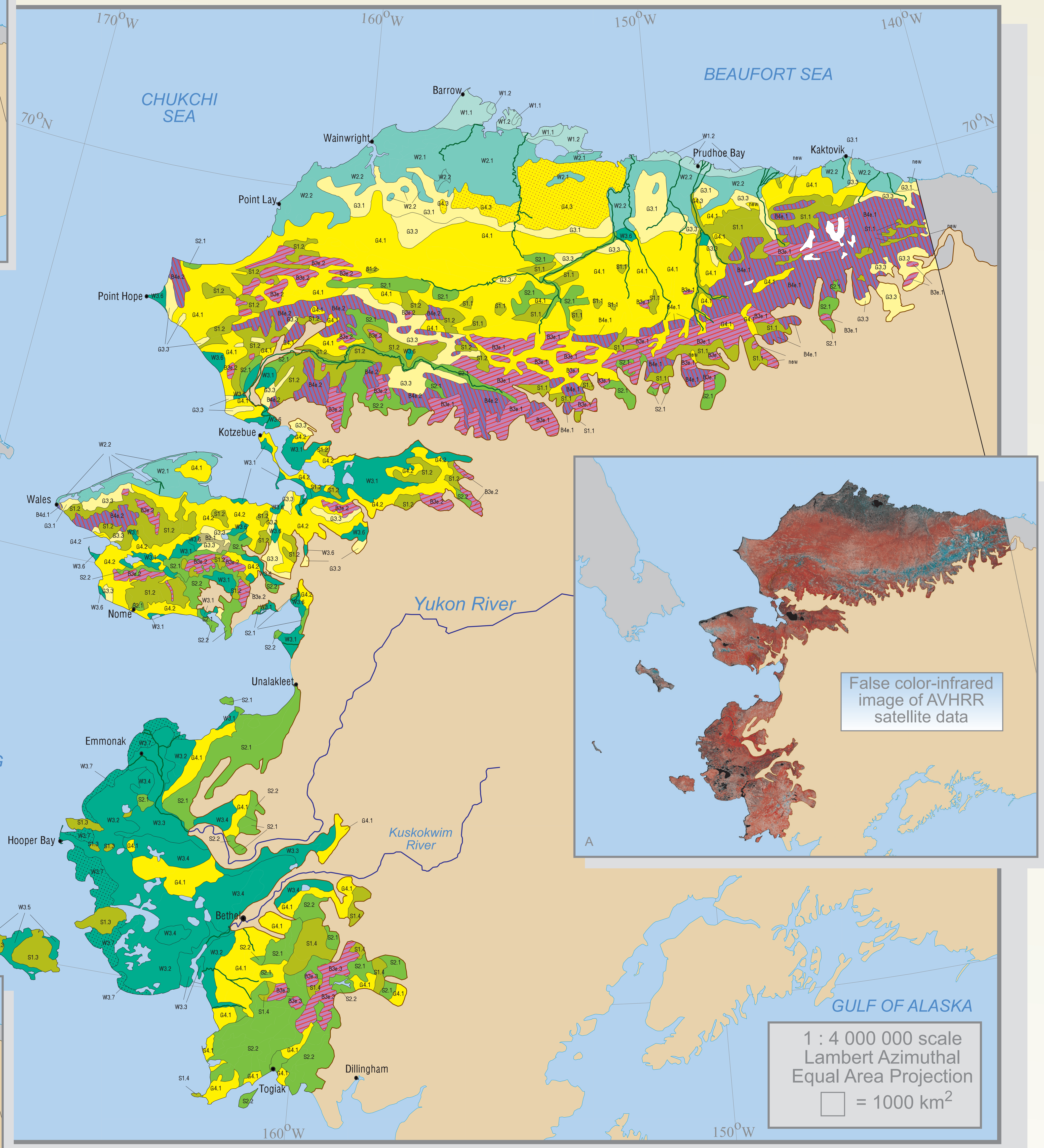
Elevation: Elevation strongly influences temperature, soil moisture and patterns of tundra plant communities (map E). Areas less than 100 m above sea level were separated to show low-elevation plains. Elevation above 100 m was divided into 333-m intervals to show decreases of about 2 ^{o}C, as predicted by a lapse rate of 6 ^{o}C per 1000 m elevation.

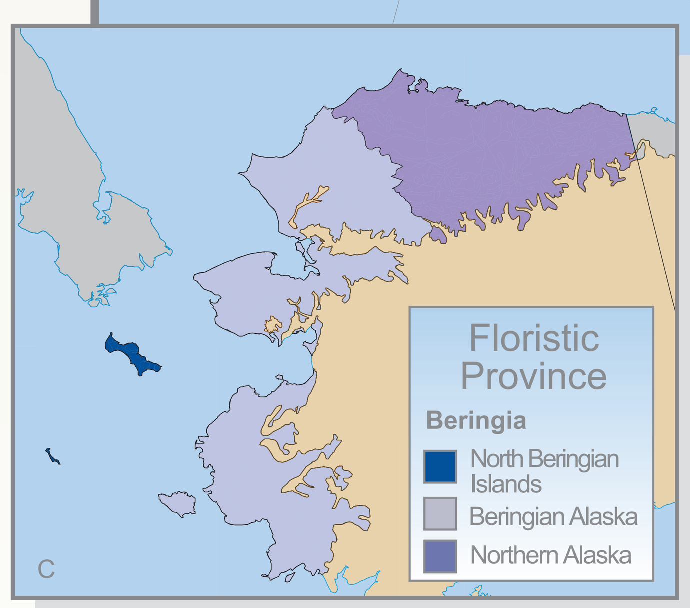
Vegetation in mountainous regions changes with elevation, forming distinct elevational belts which correspond approximately to bioclimatic subzones. Vegetation is also modified by local topographic effects such as slope, aspect, and cold-air drainage. This heterogeneity was too detailed to map at this scale, so vegetation of mountainous areas was mapped as a complex, using a diagonal line pattern. The background color and the orientation of the lines represent the pH of the dominant bedrock (magenta for non-carbonate bedrock including sandstone and granite, purple for carbonate bedrock including limestone and dolomite). The color of the diagonal lines represents the bioclimate subzone at the lowest elevation within the polygon (yellow for Subzone D, red for Subzone E).

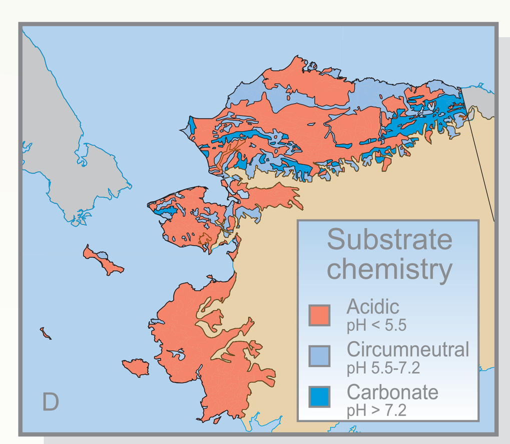
Lake cover: Lake cover strongly affects the reflectance of the land surface over large areas of Alaska, and was useful for identifying extensive wetlands (map F). Lake cover was based on the number of AVHRR water pixels in each mapped polygon, divided by the number of pixels in the polygon. Since the imagery has a pixel size of 1 km^2, lake cover is underestimated for areas with many small lakes. Pixels within 2 km of the coastline were excluded to avoid ocean water.

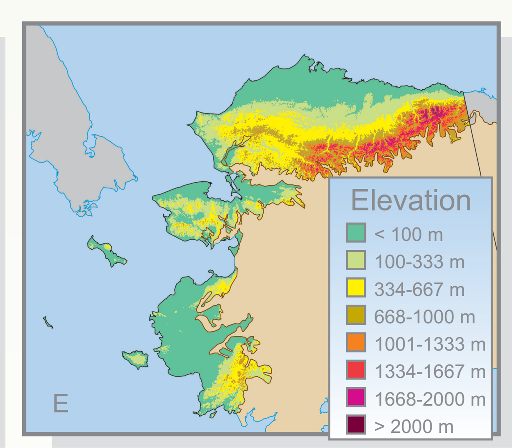
NDVI and biomass: The normalized difference vegetation index (NDVI) shows relative maximum greenness (map G). This image was created from the same data as the AVHRR base image. Vegetation greenness is calculated as: $NDVI = (NIR - R)/(NIR + R)$, where NIR is the spectral reflectance in the AVHRR near-infrared 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- 0.68 µm), the portion of the spectrum where chlorophyll absorbs maximally. The NDVI values were grouped into eight classes related to biomass. Red and orange areas in the image are areas of shrubby vegetation with high biomass, and blue and purple areas are mostly barren areas with low biomass. The relationship between NDVI and aboveground plant biomass as shown in the legend was calculated from clip harvest data (Walker et al. 2003). For more information refer to the CAVM and supporting papers (Walker et al. 2005, Raynolds et al. *in press*).

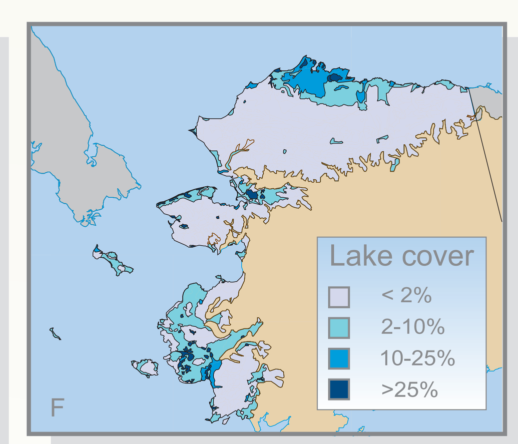


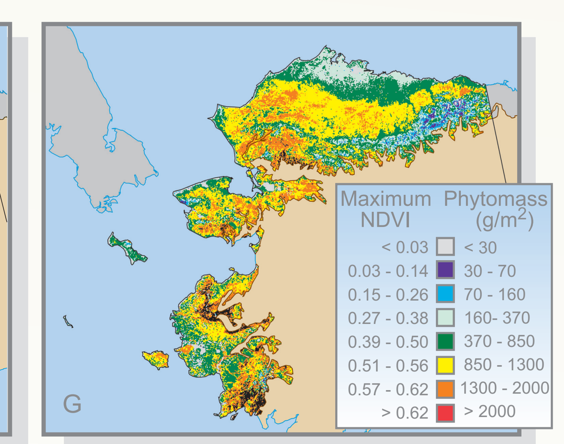


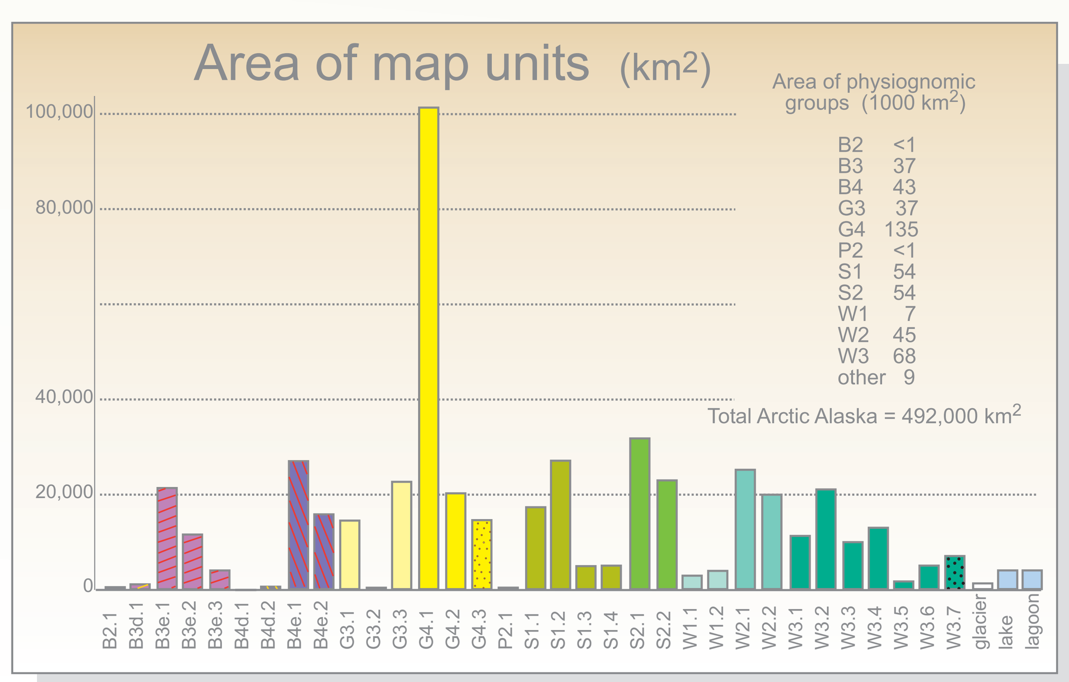












Dominant Vegetation

Barrens

B2 Barren complexes

B2.1 Lichen communities (comm. 74, see reverse side for plant community descriptions) on recent lava flows, complexed with unvegetated lava; in mosaic with areas not covered by lava (G3.3, comm. 75). Seward Peninsula, Subzone E.

B3d Acidic mountain complexes in Subzone D

B3d.1 Graminoid, prostrate dwarf-shrub communities (comm. 14) in complex with snowbed, talus slope and meadow communities, on frost-riven granite. St. Lawrence Island, Subzone D.

B3e Acidic mountain complexes in Subzone E

B3e.1 Prostrate dwarf-shrub, graminoid communities (comm. 35, 36) on acidic slopes, in complex with snowbeds (comm. 62, 63), talus slopes and meadow communities. Brooks Range, Subzone E.

B3e.2 Prostrate dwarf-shrub, lichen communities (comm. 39) on dry granitic slopes, in complex with snowbeds (comm. 64), talus slopes and meadow communities. Seward Peninsula and NW Alaska, Subzone E.

B3e.3 Erect dwarf-shrub, lichen communities (comm. 40) on dry acidic slopes, in complex with snowbeds, talus slopes and meadow communities. Kuskokwim Mtns., Subzone E.

B4d Non-acidic mountain complexes in Subzone D

B4d.1 Prostrate dwarf-shrub, forb, lichen communities (comm. 26) in complex with snowbeds (comm. 30, 31), talus slopes and meadow communities, on dry limestone slopes. York Mountains, Seward Peninsula, Subzone D.

B4d.2 Graminoid, dwarf-shrub communities (comm. 28), moist areas on Pleistocene lava. Kookooligit Range, St. Lawrence Island, Subzone D.

B4e Non-acidic mountain complexes in Subzone E

B4e.1 Prostrate dwarf-shrub, sedge communities (comm. 72) in complex with snowbeds (comm. 79, 80), talus slopes and meadow communities, on dry limestone slopes. Brooks Range, Subzone E.

B4e.2 Prostrate dwarf-shrub, forb, lichen communities (comm. 73) in complex with snowbeds (comm. 81), talus slopes and meadow communities, on dry limestone slopes. Seward Peninsula and NW Alaska, Subzone E.

Graminoid tundras

G3 Non-tussock graminoid tundras

G3.1 Non-tussock sedge, dwarf-shrub, moss communities (comm. 27) on mesic non-acidic loess. Northern Arctic Coastal Plain, Subzone D.

G3.2 Graminoid, prostrate dwarf-shrub, forb communities (comm. 18) on mesic areas. St. Lawrence Island, Subzone D.

G3.3 Non-tussock sedge, dwarf-shrub, forb, moss communities (comm. 75) on mesic non-acidic loess. Arctic Foothills of the Brooks Range and Seward Peninsula, Subzone E.

G4 Tussock graminoid tundras on non-sandy substrates

G4.1 Tussock-sedge, dwarf-shrub, moss communities (comm. 41) on mesic, acidic loess. Foothills of the Brooks Range and Seward Peninsula; ice-rich permafrost, Yukon -Kuskokwim Delta; and foothills of the Kuskokwim Mountains, Subzone E.

G4.2 Graminoid, dwarf-shrub communities, fire-controlled tussock-sedge communities, ranging from grass-dominated soon after fire (comm. 46), to communities similar to tussock tundra found to the north and south (comm. 41), to lichen-rich tundra long after fire (comm. 47). Seward Peninsula, Subzone E.

G4 Tussock graminoid tundras on sandy substrates

G4.3 Tussock-sedge, dwarf-shrub, moss communities (comm. 16) on sands, in complex with lakes and wet tundra (comm. 20). Northern Arctic Coastal Plain, Subzone E.

Prostrate-shrub tundras

P2 Prostrate dwarf-shrub tundras

P2.1 Prostrate dwarf-shrub lichen communities (comm. 15) on dry flats, slopes and ridges, with large areas of sedge, prostrate dwarf-shrub tundra (comm. 19). St. Matthew Island, Subzone D.

Erect-shrub tundras

S1 Erect dwarf-shrub tundras

S1.1 Erect dwarf-shrub communities (comm. 42) on mesic sites. Foothills of the eastern Brooks Range, Northern Alaska floristic province, Subzone E.

S1.2 Erect dwarf-shrub, lichen communities (comm. 48, 76) on mesic sites. Foothills of the western Brooks Range and mountains of the Seward Peninsula, Beringian Alaska floristic province, Subzone E.

S1.3 Erect and prostrate dwarf-shrub communities (comm. 49) on volcanic outcrops, commonly in complexes with rock outcrops and alder-dominated drainages (comm. 51). Yukon Delta, Nunivak Island, Subzone E.

S1.4 Erect dwarf-shrub, lichen communities (comm. 50), commonly in complexes with rock outcrops and alder-dominated drainages (comm. 51). Foothills of the Kuskokwim Mountains, Subzone E.

S2 Low-shrub tundras

S2.1 Low-shrub communities (comm. 44, 45) with open to closed canopies of willows or shrub birch, or open alder. Foothills of the Brooks Range, and valleys and foothills of the Seward Peninsula mountains and Kuskokwim Mountains, Subzone E.

S2.2 Low-shrub communities (comm. 51) with closed alder canopies in drainages and valleys, and at treeline. Foothills of the southern Brooks Range, Seward Peninsula mountains, and Kuskokwim Mountains, Subzone E.

Wetlands

W1 Wetlands in Subzone C

W1.1 Wet graminoid, moss communities (comm. 4) on wet acidic coastal areas, with moist communities (comm. 2,3) on higher microsites. Northern Arctic Coastal Plain, Subzone C.

W1.2 Wet graminoid, moss communities (comm. 10) on wet non-acidic coastal areas, with moist communities (comm. 9) on higher microsites. Northern Arctic Coastal Plain, Subzone C.

W2 Wetlands in Subzone D

W2.1 Wet sedge, moss communities (comm. 20) on wet acidic sites, with moist tussock-sedge, dwarf-shrub communities (comm. 16) on higher microsites. Northern Arctic Coastal Plain, northern Seward Penisula and St. Lawrence Island, Subzone D.

W2.2 Wet sedge, moss communities (comm. 29) on wet nonacidic sites, with moist communities (G3.1, comm. 27) on higher microsites. Northern Arctic Coastal Plain and northern coast of Seward Peninsula, Subzone D.

W3 Wetlands in Subzone E

W3.1 Wet sedge, moss communities (comm. 54) on wet acidic sites, with moist communities (G4.1, comm. 41) on higher microsites. Seward Peninsula and Selawik Basin, Subzone E.

W3.2 Wet sedge, moss communities (comm. 56) in complex with ponds, and drier lichen, ericaceous dwarf-shrub vegetation (S1.2, comm. 48). Central portions of the Yukon-Kuskokwim Delta, Subzone E.

W3.3 Wet sedge communities (comm. 57) in complex with shrub thickets (comm. 70) along rivers. Yukon-Kuskokwim Delta, Subzone E.

W3.4 Wet sedge, moss communities (comm. 59) in complex with lakes and drier tussock-graminoid, shrub communities (G4.1, comm. 41). Interior portions of the Yukon-Kuskokwim Delta, Subzone E.

W3.5 Wet sedge, prostrate dwarf-shrub communities (comm. 61) on wet acidic sites. Nunivak Island, Subzone E.

W3.6 Wet sedge, moss communities (comm. 77) on nonacidic sites, with moist communities (G3.3, comm. 75) on higher microsites. NW Alaska and Seward Peninsula, Subzone E.

W3 Saline wetlands in Subzone E

W3.7 Wet sedge communities (comm. 55) in slightly saline coastal areas. Areas of theYukon-Kuskokwim Delta periodically inundated by storm surges, Subzone E.

Glacier | Treeline | Riparian corridor

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