Vegetation in the vicinity of the Toolik Field Station, Alaska

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The maps presented are components of the Arctic Geobotanical Atlas (http://www.ArcticAtlas.org/).

Explanation

Overview

This publication contains a group of vegetation maps at three scales in the vicinity of the Toolik Field Station, Alaska, which is an arctic research facility run by the Institute of Arctic Biology at the University of Alaska Fairbanks. The maps are intended to support research at the field station. The front side of this map sheet contains a vegetation map and ancillary maps of a 751-km^2 region surrounding the upper Kuparuk River watershed, including the Toolik Lake and the Imnavait Creek research areas, as well as portions of the Dalton Highway and Trans-Alaska Pipeline from the northern end of Galbraith Lake to Slope Mountain. The reverse side shows more detailed vegetation maps of the 20-km^2 research area centered on Toolik Lake and a 1.2-km^2 intensive research grid on the south side of Toolik Lake (red rectangles on Map A). All the maps are part of a hierarchical geographic information system (GIS) and the Web-based *Arctic Geobotanical Atlas* (http://www.arcticatlas.org/). The atlas also includes other map themes for all three areas and a previously published hierarchy of maps of the Imnavait Creek area (Walker et al. 1989; Walker and Walker 1996) (black rectangles on Map A). Photos and explanations of the geobotanical mapping units and the supporting field data and metadata can also be found on the website.

Maps of the Upper Kuparuk River Region

The upper Kuparuk River region has terrain typical of the Southern Foothills of the Brooks Range, including landscapes affected by three major glacial events. Map A shows the vegetation of the upper Kuparuk River region at 1:63,360-scale. Other maps show a false-color infrared satellite image (Map B), glacial geology (Map C), surficial geomorphology (Map D) and Normalized Difference Vegetation Index (NDVI)/biomass (Map E) - all at 1:225,000-scale. Maps A and C were derived from a geobotanical map of the region. The base map for the geobotanical map was a 1:25,000-scale black-and-white orthophoto-topographic map that was prepared especially for this project by Vexcel Corp., Denver, CO in 1994 from stereo pairs of 1:60,000-scale, 9 x 9-inch color-infrared aerial photographs that were obtained by NASA in 1982. The base map was prepared without ground-control points, but was registered as closely as possible to the 1:63,360 USGS map of the region. Vegetation and other geobotanical features were mapped by photo-interpretation onto 1:25,000-scale enlargements of the 1982 NASA aerial photographs. The minimum mapping unit was approximately 0.6 ha (1/8" at 1:25,000-scale). No formal accuracy assessment was performed, but 320 of the map polygons representing 3.2% of the total map polygons, and about 16% of the total map area were checked on the ground during helicopter-assisted transects in 1994. Geobotanical variables coded for each map polygon included: primary vegetation, secondary vegetation, tertiary vegetation, landform, surface deposit, primary surficial geomorphology and secondary surficial geomorphology. Secondary and tertiary types are subdominant types that cover more than 30% of a map polygon. The geobotanical map was made using methods and legends specially developed for northern Alaska (Walker et al. 1980, 1986, 1989). The GIS was developed following the integrated terrain-unit mapping approach (Dangermond and Harnden 1990). The resulting geobotanical maps were presented at conferences in 1996 (e.g., Walker et al. 1996) but remained unpublished until now. In 2007 the map boundaries were modified to register with a recent digital elevation model (DEM) of the Kuparuk River region (Nolan 2003) and the 1989 Système Probatoire d'Observation de la Terre (SPOT) image of the region (Map B). The legends were also modified to better fit the hierarchy of other maps in the *Arctic Geobotanical Atlas*.

Map A: Vegetation

The vegetation of the region was studied and mapped as part of the Arctic Long-Term Ecological Research (LTER) project at Toolik Lake and the Department of Energy R4D (Response, Resistance, Resilience and Recovery of vegetation from Disturbance) project at Imnavait Creek (Walker et al. 1994, Walker and Walker 1996). Fifty-seven plant communities and land-cover types were recognized during the mapping of the upper Kuparuk River region and are designated by the numeric GIS codes in the second column of the legend. These were grouped into the 14 physiognomic map units shown on Map A, which are compatible with the Circumpolar Arctic Vegetation Map (CAVM Team 2003) and the Alaska Arctic Tundra Vegetation Map (Raynolds et al. 2005).

Map B: False-Color Infrared Satellite Image

The French SPOT satellite data (20-m resolution) were obtained on 28 July 1989 and provides a view of the mapped region from space. The false-color infrared image shows more densely vegetated areas as brighter red tones. When compared with the glacial geology map (Map C), the older Sagavanirktok-age glacial landscapes have few lakes and redder tones indicating more dense vegetation, and the younger Itkillik-age glacial surfaces that have more lakes and grayer colors. The image data were also used to produce the NDVI/biomass map (Map E).

Map C: Glacial Geology

This map shows a simplified version of Thomas Hamilton's glacial geology map of the upper Kuparuk River region (Hamilton 2003). The glacial history of the region affects a wide variety of landscape and ecosystem properties, including topographic variation, abundance of lakes, plant production, soil carbon, spectral reflectance, biodiversity, trace-gas fluxes and heat flux of these landscapes. Glacial deposits within the upper Kuparuk River region are assigned to Sagavanirktok (middle Pleistocene, about 780-125 kya), Itkillik I (late Pleistocene, about 120-50 kya) and Itkillik II (late Pleistocene, about 25-11.5 kya) glaciations of the central Brooks Range glacial succession (Hamilton 2003). The legend units are arranged approximately from oldest to youngest.

Map D: Surficial Geomorphology

The surfaces of the landscapes in the Toolik Lake region have been modified by a variety of geomorphological processes including alluviation (movement of material by water), colluviation (movement of material by gravity) and periglacial processes (freezing and permafrost-related phenomena). Many of the surface forms have been described for the Imnavait Creek region (Walker and Walker 1996). Common surficial geomorphological features within the mapped area include sorted and nonsorted circles (frost boils), turf hummocks, gelifluction lobes and terraces, water tracks, high- and low-centered ice-wedge polygons, wetland features (strangmoor, aligned hummocks, palsas) and thermokarst features.

Map E: NDVI and Plant Biomass

NDVI is an index of vegetation greenness that can be linked to plant biomass and other biophysical properties of the vegetation, such as CO_2 and photosynthesis. The NDVI = (NIR – R)/(NIR + R), where NIR and R are the spectral reflectance values of the near-infrared (790-890 nm) and red (610-680 nm) bands, respectively. This map is derived from the same SPOT data as Map B. It is modified from an earlier version (Shippert et al. 1995) using more recent biomass information (Walker et al. 2008 in press). Water and barrens are generally displayed as black. Dry tundra and sparsely vegetated areas are displayed in gray. Vegetation density increases with darker shades of green.

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A: Upper Kuparuk River Region Vegetation

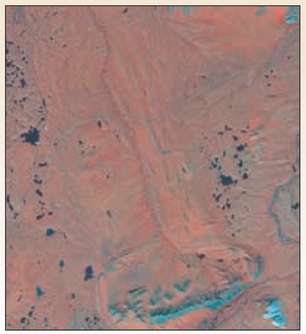
Physiognomy	Plant Communities (GIS codes)	Typical Microsites	Area (ha)	% of Map
Barren				
1. Anthropogenic barren	Roads, gravel pads and pipeline pads. (Disturbances are overlaid on pre-disturbance vegetation, so area of anthropogenic barrens are not included in the total area of the map.)	Barren roads, gravel construction pads, airstrips and gravel mines.	(270)	(0.4)
2. Lichens on rocks	Lichen communities on rocks, including *Cetraria nigricans-Rhizocarpon geographicum* (12).	Bedrock and xeric blockfields.	1,009	1.3
3. Partially vegetated barren	Complexes of vegetation with rock or soil on scree slopes (11), river gravels and other barrens (14), partially vegetated alpine areas (13) and areas dominated by nonsorted circles (15). Dominant plant communities include: *Saxifraga oppositifolia-Saxifraga eschscholtzii* (131); *Epilobium latifolium-Castilleja caudata* (141); revegetated gravel pads with *Festuca rubra* (142); *Anthelia juratzkana-Juncus biglumis* (15).	Partially vegetated barrens.	1,805	2.4
Moist graminoid tundra				
4. Tussock-sedge, dwarf-shrub, moss tundra	Moist acidic tussock-tundra complexes dominated by graminoids (31, 311). Dominant plant communities include *Eriophorum vaginatum-Sphagnum* (31) and *Carex bigelowii-Sphagnum* (3111).	Mesic to subhygric, stable, acidic (pH < 5.5) sites with shallow to moderate snow. Flat areas and gentle slopes.	29,020	38.7
5. Nontussock-sedge, dwarf-shrub, moss tundra	Moist nonacidic tundra complexes (32). Dominant plant communities include: *Carex bigelowii-Dryas integrifolia* (321), *Carex bigelowii-Dryas integrifolia* (subtypes *Equisetum arvense* (322) and *Salix glauca* (324)), *Eriophorum vaginatum-Tomentypnum nitens* (323) and *Carex bigelowii-Sphagnum*, subtype *Cassiope tetragona* (3113). Also includes a few other graminoid-dominated communities, including: *Festuca altaica-Poa glauca* (disturbed thermokarst areas) (325), *Deschampsia caespitosa-Carex saxatilis* (drained lakes) (326), *Carex podocarpa-Salix chamissonis* (snowy streamsides) (515).	Mesic to subhygric, nonacidic (pH > 5.5) sites with shallow to moderate snow. Flat areas and gentle slopes. Also miscellaneous graminoid-dominated sites including deep-snow stream margins, landslides and some rocky drained-lake basins.	13,153	17.5
Wet graminoid tundra and water				
6. Sedge, moss tundra (poor fens)	Nutrient-poor fen wetland complexes (41). Dominant plant communities include: Lower microsites: *Eriophorum scheuchzeri-Sphagnum orientale* (412) and *Eriophorum angustifolium-Sphagnum* (413). Raised microsites: *Sphagnum lenense-Salix fuscescens* (411).	Subhydric to hydric, acidic (pH < 4.5). Poor fens, meadows in colluvial basins.	1,934	2.6
7. Sedge, moss tundra (fens)	Nutrient-rich fen wetland complexes (4, 42). Dominant plant communities include: Lower microsites: *Carex aquatilis-Carex chordorrhiza* (422) and *Eriophorum angustifolium-Carex aquatilis* (423). Raised microsites: *Trichophorum caespitosum-Tomentypnum nitens* (421) and *Carex bigelowii-Tomentypnum nitens*.	Subhydric to hydric, nonacidic (pH > 4.5). Water tracks, stream margins, fens, flarks on solifluction slopes.	1,160	1.5
8. Water and herbaceous marsh	Unvegetated water (6) and/or aquatic vegetation in lakes and streams. Dominant plant communities include: *Arctophila fulva-Hippuris vulgaris* and *Sparganium hyperboreum-Hippuris vulgaris* (43).	Hydric. Lakes, ponds and streams.	1,593	2.1
Prostrate-shrub tundra				
9. Prostrate dwarf-shrub, forb, fruticose-lichen tundra (acidic)	Dry acidic tundra complexes (21). Dominant plant communities include : *Dryas octopetala-Selaginella sibirica* (211), *Arctous alpina-Salix phlebophylla* (212); and lichen tundra *Cladonia arbuscula-Stereocaulon tomentosum* (215).	Xeric to xeromesic, acidic, wind blown to shallow winter snow cover. Ridge tops, exposed slopes, dry river terraces.	5,818	7.8
10. Prostrate dwarf-shrub, sedge, forb, fruticose – lichen tundra (nonacidic)	Dry nonacidic tundra complexes. *Dryas integrifolia-Oxytropis nigrescens* (24) and *Dryas integrifolia-Astragalus umbellatus* (22).	Xeromesic to mesic, nonacidic. Includes a wide variety of drier nonacidic habitats, including stable river terraces and nonsorted stripes on slopes.	895	1.2
11. Hemi-prostrate dwarf-shrub, fruticose-lichen tundra	Deeper snowbed complexes (23). Dominant plant communities include: *Cassiope tetragona-Carex microchaeta* (231), *Cassiope tetragona-Dryas integrifolia* (232); and *Salix rotundifolia-Sanionia uncinatus* (233).	Subxeric to mesic, acidic to nonacidic, with deep snow. Snowbeds.	2,164	2.9
12. Hemi-prostrate and prostrate dwarf-shrub, forb, moss, fruticose-lichen tundra	Dry tundra with shallow snowbeds mainly on stripe complexes. Dominant plant communities include: *Cassiope tetragona-Calamagrostis inexpansa* (214). Also includes dry areas with hemi-prostrate dwarf birch *Betula nana-Hierochloe alpina* (213).	Subxeric to mesic, acidic to nonacidic, somewhat-deeper-snow areas. Depressions on acidic ridge crests, dry glacial till and outwash; nonsorted stripes.	2,116	2.8
Erect-shrub tundra				
13. Dwarf- to low-shrub, sedge, moss tundra	Moist acidic tundra complexes dominated by shrubs. Includes shrubby tussock tundra and mainly dwarf-shrub tundra areas (3112). Dominant plant communities include: *Betula nana-Eriophorum vaginatum* (312) and *Salix pulchra-Carex bigelowii* (no code). Also acidic shrub tundra dominated by dwarf birch or willows. Dominant plant communities include: *Betula nana-Rubus chamaemorus* and *Salix pulchra-Sphagnum* (513)	Mesic to subhygric, moderate snow. Includes a wide variety of habitats with dwarf shrubs, including wet lower slopes, margins of upland water tracks, palsas and high-centered polygons.	9,045	12.1
14. Low to tall shrublands	Shrublands dominated by low and tall shrubs (5) including: 1. Shrublands along streams and water tracks dominated by diamond-leaf willow (*Salix pulchra*). Dominant plant communities include: *Salix pulchra-Eriophorum angustifolium* (511) and *Salix pulchra-Calamagrostis canadensis* (514). 2. Shrublands in riparian complexes (51) dominated by feltleaf willow (*S. alaxensis*) and lanate willow (*S. richardsonii*) (512); includes tall shrublands (5121) and low shrublands (5122). 3. Upland shrublands dominated by glaucous willow (*Salix glauca*) or alder (*Alnus crispa*) (52).	Mesic to subhydric, often with deep snow. Stream margins, upland water tracks and south-facing slopes.	5,344	7.1
Total (excluding roads and pads)			75,056 ha	100%

Gravel Mines · Roads · Pipeline · Trails · Streams · Water tracks · 200-m contours · 50-m contours

0 2 4 6 Kilometers
UTM Zone 6, NAD 1983

Vegetation mapping was performed in 1994 at 1:25,000 scale from 1982 NASA acquired base photography and is displayed at 1:63,360 scale. The extent of the mapped area is shown as a black rectangle on the location map to the left.

B: False-Color Infrared Image



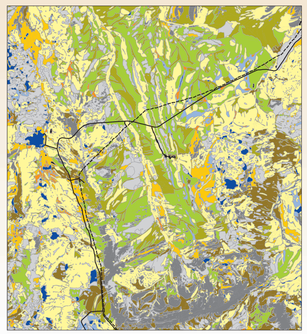
Interpretation:
This false-color infrared image displays vegetated areas as a gradient of red tones. The brightest red areas are densely vegetated shrublands; moderate red areas are generally well vegetated surfaces, often with tussock tundra, and the dull red to brownish areas are more sparsely vegetated including dry tundra, nonacidic tundra, and wet tundra. The darkest black to bluish black areas are water. The lightest areas are light-colored bedrock (dolomite or limestone) or light-colored gravel in roads and river floodplains. Lichen covered bedrock (mostly sandstone and conglomerates) is dark grayish green.

Source: SPOT imagery, 28 July 1989

C: Glacial Geology

- Bedrock
- Bedrock with discontinuous cover
- Drift of Sagavanirktok, undifferentiated
- Drift of Sagavanirktok, late advance
- Drift of Itkillik age, undifferentiated
- Drift of Itkillik Phase I
- Drift of Itkillik Phase II
- Drift of latest Itkillik readvance
- Outwash Sagavanirktok, late advance
- Outwash of Itkillik Phase I
- Outwash of Itkillik Phase II
- Outwash of latest Itkillik readvance
- Ice-contact deposits
- Active kettles
- Undifferentiated lacustrine deposits
- Undifferentiated gravel and beach deposits
- Undifferentiated colluvium
- Ice-rich silt deposits and colluvial basins
- Undifferentiated fan deposits
- Undifferentiated alluvium
- Roads
- Pipeline

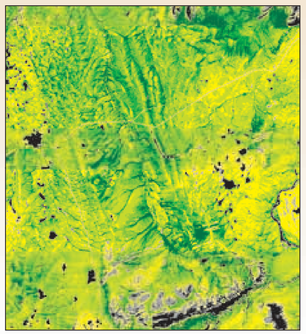
Source: simplified from Hamilton, 2003



D: Surficial Geomorphology

- Featureless
- Stony surfaces
- Non-sorted circles and/or stripes
- Gelifluction features (including lobes, terraces, turf hummocks)
- Well-developed hill-slope water tracks
- Indistinct hill-slope water tracks
- High- or flat-centered ice-wedge polygons and palsas
- Wetland surface forms (including low-centered polygons)
- Water (including thermokarsts and beaded streams)
- Irregular microrelief (glacial till, rolling relief, stream channels)
- Disturbed
- Roads
- Pipeline

Source: see vegetation map above, 1994



E: NDVI/Biomass

NDVI	Estimated Biomass (g/m^2)
< 0.14	0-25
0.14-0.32	26-75
0.33-0.40	76-150
0.41-0.45	151-300
0.46-0.48	301-500
0.49 - 0.51	501-1000
> 0.51	> 1000

0 2 4 6 8 10 Kilometers

Maps B-E displayed at 1:225,000 scale.

Source: SPOT imagery, 28 July 1989