A WESTERN ALASKAN TRANSECT TO EXAMINE INTERACTIONS OF CLIMATE, SUBSTRATE, VEGETATION, AND SPECTRAL REFLECTANCE: ATLAS GRIDS AT BARROW, ATQASUK, AND IVOTUK, ALASKA, 1998

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INTRODUCTION

The overall project addresses the effects on arctic vegetation of continental-scale gradients and regional-scale variation in substrate. This portion of the project is variation along a climate gradient in western Alaska that traverses three major phytogeographic subzones of the Tundra Zone: southern hypoarctic, northern hypoarctic, and arctic (Yurtsev 1994) (**Figure 1**). There are two primary goals:

- Examine transitions in the zonal plant communities, biomass, LAI, and NDVI along climate gradient from the coast to the foothills and
- Examine the effects of different geological substrates on these

In summer of 1998, we established 1-ha grids at six sites for intensive study of the and spectral properties. This poster presents general descriptions of the sites with selected from the 1998 surveys. More detailed studies of NDVI, LAI, and biomass at these sites others are planned for 1999. We will eventually relate this information to the work of other ATLAS investigators who are examining climate, soils, snow properties, and fluxes at the same sites.

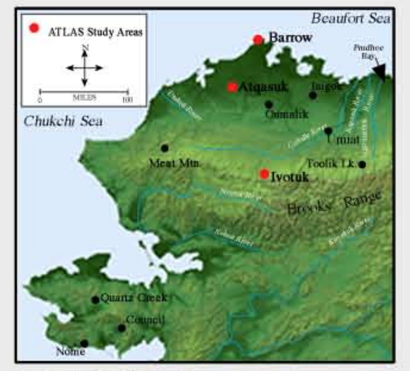

Figure 1. Location map.

Figure 2. Barrow gird (coastal acidic tundra). This grid is located east of the CMDL site near Oechel's Barrow flux tower. It is located on a fairly homogenous flat residual surface (unaffected by thaw-lake processes). Most of the surface is either featureless or has flat-centered ice-wedge polygons. The primary plant community is ***Saxifraga cernua–Carex aquatilis*** (Elias, Short et al. 1996). This type commonly occurs on moderately drained, zonal sites near the coast. This moist tundra type is dominated by graminoids (*Alopecurus alpinus, Carex aquatilis, Dupontia fisheri, Eriophorum angustifolium, Poa arctica*), forbs (*Cardamine pratensis, Cerastium jenisejense, Chrysosplenium tetrandrum, Petasites frigidus, Saxifraga cernua, S. hirculis, S. hieracifolia, S. nelsoniana, Stellaria laeta*), and mosses (*Oncophorus wahlenbergii, Polytrichastrum alpinum, Polytrichum strictum* and *Sarmentypnum sarmentosum*). Prostrate and semi-erect willows (*Salix rotundifolia, S. planifolia* ssp. *pulchra*) are common in some areas. The unit is approximately equivalent to Type 7 (Walker 1977) and Noda IV (Webber 1978). The phenology of the vegetation was insufficiently advanced at Barrow to sample a relevé or determine the percentage cover of plant species.

Figure 3. Atqasuk grid (sandy acidic tussock tundra). This grid is located on a broad flat stabilized sandy plain near the west end of the Atqasuk runway. The site is typical of residual surfaces unaffected by thaw-lake processes in the sand region of the Arctic Coastal Plain. The site is notable for its total lack of any nonsorted circles (frost scars). This is typical of tussock tundra in the sand region, but very unusual elsewhere on the Arctic Coastal Plain. The lack of cryoturbation promotes a leached soil and species-poor vegetation. The dominant community is tussock tundra with small tussocks (<15 cm high), (**Relevé A-1, *Ledum palustre* ssp. *decumbens–Eriophorum vaginatum***). Only six vascular species were recorded in the relevé of this site (*Eriophorum vaginatum, Ledum palustre* ssp. *decumbens, Vaccinium vitis-idaea, Cassiope tetragon, Pedicularis lapponica, and Carex bigelowii*). The moss canopy is poorly developed (*Aulacomnium turgidum, Dicranum elongatum, Oncophorus wahlenbergii, Polytrichum strictum, Sphagnum compactum*). Lichens are common between the tussocks, but are generally in poor condition. Common lichen species include *Alectoria nigricans, Bryocaulon divergens, Cladonia stygia, Cetraria cucullata, C. laevigata,* and *Ochrolechia frigida* . This community type is equivalent to Unit 8 of Map 2 of (Komárková and Webber 1980). In slightly moister areas, *Carex bigelowii* is the dominant sedge.

Figure 4. Ivotuk-1 grid (shrubby acidic tussock tundra). This grid is located on a gentle (4˚) east-facing slope (shoulder to midslope) of a very old (mid-Pleistocene?) outwash deposit. The shrubby tussock tundra is typical of many acidic sites on broad slopes in the region and is considered the zonal vegetation for the Ivotuk region. The site has numerous nonsorted circles and a few weakly developed water tracks. The dominant vegetation is a shrubby version of tussock tundra with abundant dwarf and low shrubs (*Betula nana, Salix planifolia* ssp. *pulchra, Ledum palustre* ssp. *decumbens, Rubus chamaemorus, Vaccinium uliginosum, V. vitis-idaea)* (**Relevé I-1A, *Betula nana* ssp. *exilis-Eriophorum vaginatum***) The height of many of the willows and dwarf birch exceeds 40 cm. The moss canopy includes *Aulacomnium turgidum, Dicranum spadiceum, Hylocomium splendens, Pleurozium schreberi, Sphagnum girgensohnii, S. lenense,* and *S. warnstorfii*). The vegetation is broadly equivalent to the acidic *Sphagno–Eriophoretum vaginati* (Walker et al. 1994) described from Toolik Lake and elsewhere on the Arctic Slope, but it is shrubbier. The nonsorted circles are acidic and have a plant community dominated by the crustose liverwort *Anthelia juratzkana,* and the rushes *Juncus biglumis,* and *Luzula arctica* (**Relevé I-1B, *Anthelia juratzkana–Luzula arctica***)

Figure 5. Ivotuk-2 grid (shrub tundra, water track complex). This grid has several plant communities associated with a small water-track complex on a gentle (4-6˚) east-facing slope. The plant communities span the transition from tussock tundra to shrubby water tracks. There are also small areas of nonacidic tundra with nonsorted circles. The best developed portions of the water tracks are in areas marginal to the actual tracks with flowing water. These have the plant community ***Eriophorum angustifolium–Salix planifolia* ssp. *pulchra***) (**Relevé I-2A**). This community has tall willows exceeding 80 cm tall, and a fairly rich understory consisting of *Eriophorum angustifolium, Pedicularis langsdorfii, Petasites frigidus, Polemonium acutiflorum, Pyrola grandiflora, Rubus chamaemorus, Saxifraga nelsoniana, Stellaria laeta,* and *Valeriana capitata.* The common mosses include *Aulacomnium palustre, Calliergon stramineum, Dicranum angustum, D. elongatum, Hylocomium splendens, Plagiomnium ellipticum, Sanionia uncinata, Sphagnum girgensohnii, S. teres,* and *Tomentypnum nitens.* This community is equivalent to the *Eriophorum angustifolium–Salix pulchra* community described from Toolik Lake (Walker et al. 1994). Stable areas marginal to the water tracks have deep moss carpets with a dwarf birch community (**Relevé I-2B, *Rubus chamaemorus–Betula nana***). This community is equivalent to the *Sphagno-Eriophoretum vaginati betuletosum nanae* subass. described from Toolik Lake (Walker et al. 1994). The central portion of water tracks with flowing water have a community with relatively few shrubs and are usually dominated by *Eriophorum angustifolium,* (**Relevé I-2C, *Eriophorum angustifolium–Salix planifolia* ssp. *pulchra***).

Figure 6. Ivotuk-3 (moist nonacidic tundra complex). This grid contains a complex of nonacidic tundra types that is associated with a small flat limestone outcrop. The outcrop is about a 2-m high terrace. It includes dry tundra on the outcrop, a shallow nonacidic snowbed downslope of the outcrop, and an area of gelifluction lobes and flarks (small ponds between the gelifluction lobes) that is associated with wetter soils downslope of the snowbed. Drier portions of the grid that are unaffected by the snow drift have nonsorted stripes and abundant nonsorted circles. The dominant vegetation is moist nonacidic tundra associated with the gelifluction lobes (**Relevé I-3A, *Dryas integrifolia–Carex bigelowii***) This tundra is equivalent to the *Dryado integrifoliae–Caricetum bigelowii equisetosum arvensis* subassociation described from Toolik Lake (Walker et al. 1994). This horsetail-rich variation of nonacidic tundra often occurs downslope of snowbeds on circumneutral mesic uplands and hillslopes in association with fine calcium-rich soils. Common plants include *Arctous rubra, Carex bigelowii, C. membranacea, Dryas integrifolia, Equisetum arvense, E. scripoidea, Eriophorum triste, Kobresia sibirica, Papaver macounii, Parrya nudicaulis, Pedicularis arctoeuropea, Pedicularis capitatum, Polygonum viviparum, Pyrola grandiflora, Salix arctica, S. reticulata* , *Thalictrichum alpinum.* The moss carpet is dominated by *Tomentypnum nitens, Hylocomium splendens, Catescopium nigritum, Meesia uliginosum, Orthothecium chryseum, Aulacomnium acuminatum, A. turgidum, Dicranum spadiceum, D. acutifolium* and numerous liverworts (e.g., *Ptilidium ciliare, Lophozia jurensis, L. ventricosa, Tritomaria quiquedentata*). The flarks have abundant algae *Nostoc commune* and a variety of mosses.

The dry nonsorted stripes have a complex of vegetation communities. The most common community is a dry forb-rich nonacidic tundra, (**Relevé I-3B *Novosieversia–Dryas integrifolia***) This community is dominated by *Dryas integrifolia* and is rich in other vascular plants (32 recorded species). An unusual aspect of this type compared to nonacidic tundra in the Toolik Lake region is the abundance of *Kobresia myosuroides.* This may be a good analog for Beringian steppe tundra found in the guts of Pleistocene grazers and areas on the Seward that were buried by tephra (Goetcheus and Birks, 1999 in press). The nonsorted circles on the stripes (**Relevé I-3C, *Saxifraga oppositifolia–Pertussaria dactylina***) are relatively barren and are dominated by *Saxifraga oppositifolia, Carex capillaris,* and a wide variety of lichens (e.g., *Pertussaria* spp., *Lecanora epibryon, Flavocetraria* spp., *Thamnolia* spp., *Ochrolechia frigida*).

Figure 7. Ivotuk-4 grid (mossy acidic tussock tundra). This grid has homogeneous acidic tussock tundra with abundant *Sphagnum* moss (**Relevé I-4, *Sphagnum lenense–Eriophorum vaginatum***). This unit is similar to Ivotuk 1, but has dwarf shrubs less than 25 cm tall, few nonsorted circles (<1% cover), abundant *Sphagnum* moss in the intertussock spaces, and is species poor (10 vascular plants in Relevé I-4). The unit is common on old uplands sites that lack input of nutrients from upslope. The dominant dwarf shrubs are *Ledum palustre* ssp. *decumbens* and *Rubus chamaemorus* with less amounts of *Betula nana* and *Vaccinium vitis-idaea.* The dominant mosses are *Sphagnum lenense* on the sides of tussocks, *S. balticum* between the tussocks and in depressions, and *Warnstorfia fluitans* in the deepest depressions covering stablized frost scars.

APPROACH AND RESULTS

The focus is on **zonal** vegetation, which occurs on stable mesic sites unaffected by extremes soil moisture, snow, or other site factors, and which best reflects the regional climate.

During the summer of 1998, six 100 x 100-m grids were surveyed along a climatic transect Barrow to Ivotuk (**Figure 1**). Three of these (**Barrow**, **Atqasuk**, and **Ivotuk-1**; **Figures 2-4**) represent the zonal vegetation within the three phytogeographic subzones. **Ivotuk-2 (Figure 5)** is a shrub-tundra site typical of well-watered hill slopes in the southern hypoarctic. **Ivotuk-3 (Figure 6)** is representative of nonacidic vegetation occurring on limestone outcrops in the subzone. This is of special interest because of the importance of calcium-rich tundras to ecosystems [Walker, 1998; Walker, 1999]. **Ivotuk-4 (Figure 7)** is a moss-rich tussock tundra site representative of relatively nutrient-poor sites that are topographically from input of nutrients. Two additional sites will be surveyed at Oumalik in 1999 on a nonacidic loess site and an acidic upland.

Information on complete plant-species composition and soils were obtained from 10x10-m (**relevés**) within the grids. Plant species data from Atqasuk and Ivotuk relevés are presented in a sorted table to emphasize differences in the species composition on acidic and substrates (**Table I**). Site factors and soil information were collected from the same plots, and a summary of selected site factors and soil information parameters are shown in **Table II**.

Accurate measurement of plant-species cover was determined using and optical point (Buckner sampler). Plant species were recorded at 4 points at each grid point (484 total points) the top and bottom of the plant canopy. These data are summarized according to plant types in **Table III**. Moss depth, tussock height, and canopy height were also recorded at point (**Table II**). Barrow was not sampled during 1998 because of the early phenological of the plant cover when the site was visited in late June. This site will be sampled in July 1999.

Clip harvests were collected from ten 10 x 50 cm plots within each grid for biomass (**Table V**). Three soil cores were collected from the same plots for belowground biomass.

Vegetation at sites I-2, I-3 and I-4 were mapped from oblique 35-mm color aerial photographs. The view of the sites was converted to a vertical view using ENVI and Photoshop software adjusting the distance between all grid points to be equal (**Figure 8**). Plant communities were recorded at 121 grid points in each grid, and this information was used to create a land-cover classification.

DISCUSSION AND CONCLUSIONS

Trends along the climate gradient: Data from Barrow and Oumalik are needed to draw conclusions regarding the effects of climate gradient. These data will be obtained in 1999 and compared with similar data from Kuparuk River Basin.

Effects of substrate differences:

∑ **Species richness:** There is much greater species richness (total species number) on moist nonacidic sites (59 taxa) compared to moist acidic sites (mean of 35 taxa). The sites nutrient-poor soils (A-1 and I-4) had the fewest species (30 and 33 respectively). numbers are very similar to richness numbers from the Kuparuk River basin (Walker, et al. 1999).

∑ **Species overlap:** There is very little overlap of species occurring in moist acidic and nonacidic sites. *Cassiope tetragon, Bistorta bistortoides* and *Eriophorum vaginatum* were the only species of the 32 species occurring at both substrates; there were 17 vascular taxa occurring only on the nonacidic substrates. There were vascular taxa that occurred only on the acidic substrates. This is also consistent with observations (Walker et al. 1999 in press, Walker et al. 1994).

∑ **Canopy structure:** Moist nonacidic tundra has less cover of low shrubs and erect shrubs (8.4% vs. 65.3% cover), but greater cover of prostrate dwarf shrubs *Dryas integrifolia* and *Salix reticulata*) (26.5% vs. 0%). It also has shorter plant canopies (17 vs 24 cm). Tussock graminoids (*Eriophorum vaginatum*) are much more common in the acidic tundra (23.6% cover vs. 4% in nonacidic tundra). In nonacidic tundra, there is much cover of forbs (5.8% vs. 1.9%) and horsetails (3.4% vs. 0).

∑ **Biomass:** There was much higher aboveground biomass in the moist acidic tundra (618 g) compared to moist nonacidic tundra (340 g m). This is consistent with biomass data on acidic and nonacidic sites at Sagwon, Alaska (Walker et al. 1999 in press). There is also much belowground biomass in the acidic tundra (369 g vs. 63 g m²). Most of the difference is due to greater biomass of erect shrubs in the acidic tundra (data not shown). Biomass of belowground (nongreen) mosses is also much greater in the acidic

∑ **Cryoturbation and active layer:** Nonsorted circles and stripes cover about 19.8% of the nonacidic site, but these are confined to the drier portion of the grid. Nonsorted circles uncommon in the portion of the grid with solifluction features. Nonsorted circles cover 4.1% of the acidic site. This is considerably greater than that observed in other acidic sites the Kuparuk River basin (Bockheim, et al. 1998). Early-July thaw was much deeper at nonacidic site (54 cm vs. 27 cm in the inter-hummock spaces). This is not consistent observations from the Kuparuk basin (Nelson, et al. 1998). There was a total absence of scars (nonsorted circles) on the acidic sandy soils at the Atqasuk site. Frost scars were also uncommon at I-4. These two were the sites with fewest species, shallowest thaw, short plant canopies. Sandy soils were not encountered in the Kuparuk River basin and was ubiquitous throughout the basin on loess-derived soils.

∑ **Relevance to landscape evolution and Beringian** The absence of cryoturbation in sandy areas and on older landscapes could be very important for limiting recycling of calcium and other nutrients to the soil surface horizons, and promoting development of deep organic layers. The finding of abundant *Kobresia myosuroides* on these moist nonacidic sites suggest that these sites may be good analogues for vegetation covered much of Beringia during the Pleistocene. Landscape evolution likely has nonacidic tundra areas to peaty tussock tundra in the Pleistocene. The finding of modern analogues has special relevance to the history of megafauna and man on the Slope (Kunz and Mann, 1997).

ACKNOWLEDGMENTS

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Table I. Atqasuk and Ivotuk relevé data, summer 1998. Braun-Blanquet cover-abundance scores: r=rare, 1 or 2 occurrences; +=several occurrences, but <1% cover; 1=1-10% cover; 2=10-25% cover; 3=25-50%; 4=50-75%; 5=75-100%. Dark colors delineate possible characteristic taxa for groups of associations; lighter colors show taxa preferential and single-occurrence taxa. Undefined taxa have greater than 25% cover. Mosses and lichens were identified by Dr. Olga Afonina and Dr. Michael Zhurbenko, Komarov Botanical Institute, St. Petersburg, Russia.

Plant community / Species	Acidic tussock tundra	Shrub tundra	Non-acidic tundra
[illegible]			

Table II. Site factors for grids. For tussock height, canopy height, and moss depth, n=121 points. Barrow will be sampled in 1999.

Site	Surficial Geology	Surficial Geomorphology	Topographic Position	Slope (deg.)	Aspect (deg.)	Plant communities (% of grid pts)	Soil Units	Thaw Depth (cm ± s.d., n=10)	Site Moisture	Vol. soil moisture, top mineral horizon (%)	Tussock height (cm)	Canopy height (cm)	Moss depth (cm)
Barrow	Marine sands and gravels	Flat centered polygons	Flat	0	-	Mainly Saxcer-Caraqua	Pergelic Cryaquept, acid	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Atqasuk 1	Eolian sand	Featureless	Flat	0	-	Ledpal-Erivag: 78% Ledpal-Carbig: 20% Ledpal-Rubcha: 2%	Pergelic Cryaquept, acid	Between tussocks: 15 ± 2 Tussocks: 21	Mesic	0.42	9 ± 3	10 ± 4	2.5 ± 1.1
Ivotuk 1	Glaciofluvial deposits	Frost scars	Mids sideslope	4	80	Betnan-Erivag: 83% Betnan-Carbig: 13% Anthjur-Luzarc: 4%	Ruptic Pergelic Cryaquept, acid and Histic Pergelic Cryoquept, acid	Between tussocks: 36 ± 11 tussocks: 42 ± 4 Frost scar: 51	Mesic to subhygric; Hygric in depressions	0.46	24 ± 7	29 ± 8	3.7 ± 2.9
Ivotuk 2	Glaciofluvial deposits	Well-developed hillslope water tracks	Lower side slope and drainage channels	5	120	Betnan-Erivag: 34% Eriang-Salpla: 29% Rubcha-Betnan: 16% Nonacidic tundra: 8% Others: 13%	Pergelic Cryoquept, acid and Histic Pergelic Cryoquept, acid	Eriang-Salpla: 27 ± 3 Rubcha-Betnan: 25 ± 4 Calstr-Eriang: 37 ± 12	Eriang-Salpla: Mesic to subhygric Rubcha-Betnan: Mesic Calstr-Eriang: hygric	0.4	15 ± 7	42 ± 17	4.7 ± 2.5
Ivotuk 3	Hill slope colluvium from small limestone outcrop	Gelifluction features and flarks; Sorted and non-sorted stripes, and frost scars	Mid-sideslope	6	145	Dryint-Carbig-Equarv: 49% Dryint-Carbig: 20% Novgla-Dryint: 11% Lecepi-Dryint: 7% Calstr-Noscom: 6% Others: 7%	Pergelic Cryaquept, nonacid; Pergelic Cryoboroll; and Ruptic Pergelic Cryaquept, nonacid	Dryint-Carbig-Equarv: 54 ± 10 Flarks: 35 ± 8 Novgla-Dryint: >80	Dryint-Carbig-Equarv: Mesic to subyhgric	0.34	17 ± 10	14 ± 7	2.4 ± 1.3
Ivotuk 4	Glaciofluvial deposits	Featureless, less than 20% frost scars	Hill crest or shoulder	2	98	Sphlen-Erivag: 100%	Pergelic Cryaquept	Intertussock: 39 ± 3 Tussock: 53 ± 3	Mesic to subhygric	0.38	19 ± 6	21 ± 6	3.7 ± 2.6

Table III. Cover of plant functional types. Barrow, Atquasuk, and Ivotuk grids. Values are percent of 484 points in each grid.

TOP OF PLANT CANOPY (% COVER)

Plant functional types	Barrow Coastal acidic	Atqasuk Acidic tussock	Ivotuk-1 Shrubby acidic tussock	Ivotuk-2 Shrub tundra	Ivotuk-3 Moist nonacidic	Ivotuk-4 Mossy tussock
Low deciduous shrubs	0	0	21.3	56.8	0.4	3.4
Erect dwarf deciduous shrubs	0	0.6	5.6	0.4	3.6	9.6
Erect dwarf evergreen shrubs	0	13.8	20.7	8.1	4.4	19.4
Prostrate and semi-erect dwarf deciduous shrubs	8	0	0	0	11.4	0
Prostrate and semi-erect dwarf evergreen shrubs	0	0	0	0	15.1	0
Forbs	8.5	3.1	1.9	4.5	5.8	0
Horsetails	0	0	0	0	3.4	0
Tussock graminoids	0	45.7	23.6	15.5	0.0	49.1
Nontussock graminoids	51.7	8.9	12.8	4.6	24.9	0
Lichens	6.8	10.7	0.8	0.4	4.0	0.6
Nonsphagnoid bryophytes	10.8	6.4	5.2	5.2	15.3	4.9
Sphagnoid bryophytes	0	0.6	3.5	1	0.0	10.8
Algae	0	0	0	0	0.6	0
Litter	9.7	10.1	3.5	3.1	10.0	1.8
Soil and rocks	1.1	0	1	0.4	0.2	0.3
Other	2.3	0.2	0	0	0.2	0
water	1.1	0	0	0	0.4	0
	100	100.1	100.1	100	99.7	99.9

BOTTOM OF PLANT CANOPY (% COVER)

Plant functional types	Barrow Coastal acidic	Atqasuk Acidic tussock	Ivotuk-1 Shrubby acidic tussock	Ivotuk-2 Shrub tundra	Ivotuk-3 Moist nonacidic	Ivotuk-4 Mossy tussock
Low deciduous shrubs	0	0	2.5	15.1	0	0.3
Erect dwarf deciduous shrubs	0	0	0.6	0.2	0	0.6
Erect dwarf evergreen shrubs	0	7.8	2.1	0.2	0.6	0.3
Prostrate and semi-erect dwarf deciduous shrubs	5.7	0	0	0	0.2	0
Prostrate and semi-erect dwarf evergreen shrubs	0	0	0	0	1.5	0
Forbs	13.6	8.8	0.2	0.2	0.0	0
Horsetails	0	0	0	0	0.0	0
Tussock graminoids	0	10.5	16.5	11.6	0.0	36.7
Nontussock graminoids	8.5	1	5.1	3.9	0.8	0
Lichens	10.2	25.2	3.7	1.8	6.9	1.2
Nonsphagnoid bryophytes	30.1	6.4	32.8	49.6	77.1	8.3
Sphagnoid bryophytes	0	1.7	12.6	10.3	0.0	42.9
Algae	0	0	0	0	0.6	0
Litter	24	38	20.4	5.4	11.0	9.3
Soil and rocks	1.7	0	1.9	0	0.2	0.3
Other	2.3	0.2	0	0.2	0.0	0
water	3.4	0	1.4	1.4	1.0	0
	99.5	99.6	99.8	99.9	100.0	99.9

Table IV. Biomass along the Barrow to Ivotuk transect. Numerators are aboveground values, and denominators are belowground values. Numbers in parentheses are production. Production values are shown for only Barrow in parentheses (g m-2 y-1).

BIOMASS (g m-2)

	Barrow-zonal (Webber 1978)	Atqasuk-zonal (Komarkova and Webber 1980)	Ivotuk-1 Zonal, shrubby, acidic tussock tundra (Copass et al., this study) (10 samples)	Ivotuk-2 Willow shrub tundra (Copass et al., this study) (4 samples)	Ivotuk-2 Birch shrub tundra (Copass et al., this study) (2 samples)	Ivotuk-2 Zonal, shrubby, acidic tussock tundra (Copass et al., this study) (5 samples)	Ivotuk-3 Moist nonacidic tundra (Copass et al., this study) (9 samples)	Ivotuk-3 Dry nonacidic tundra (Copass et al., this study) (3 samples)	Ivotuk-4 Mossy acidic tussock tundra (Copass et al., this study) (10 samples)
Vascular plants	47/996 (45/142)	208/47	444/191	733/160	1000/96	410/442	159/21	143/21	205
Bryophytes	40 (12)	97/29	168/178	255/272	220/192	334/221	180/42	137/42	230
Lichens	5 (0.5)	184/18	6	0	0	0	1	42	5
TOTAL	92/996 (58/142)	489/94	618/369	988/432	1220/388	744/663	340/63	322/63	440

Vegetation Maps of Ivotuk Grids

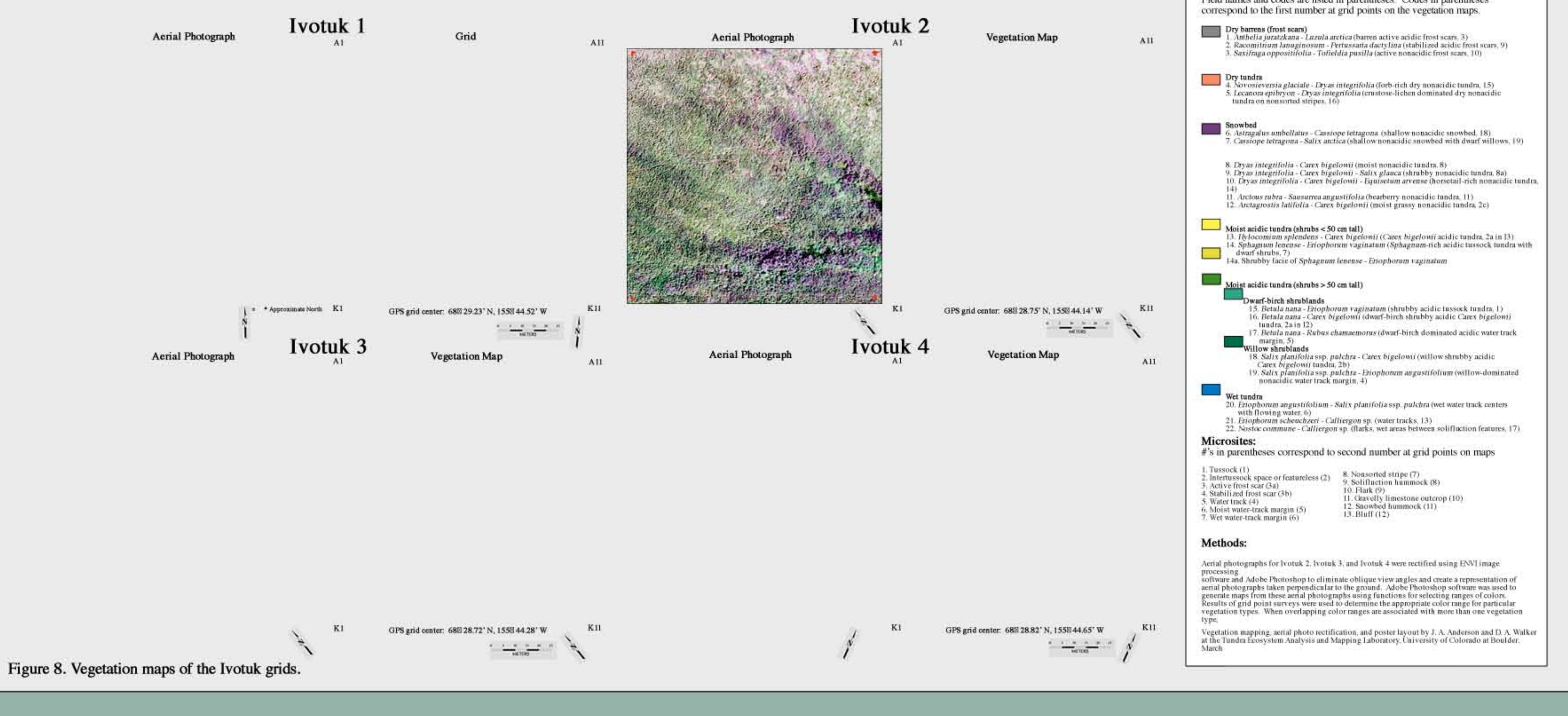

Figure 8. Vegetation maps of the Ivotuk grids.

IVOTUK CAMP AND VICINITY

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