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A VEGETATION MAP OF AN AREA NEAR FAIRBANKS, ALASKA, BASED ON AN ERTS IMAGE

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16. Abstract

A vegetation map of a 3,200 km^2 area near Fairbanks, based on ERTS scene 1033-21011, is presented. Information from the scene, a reconstituted, simulated color-infrared, enlarged photographic print, was transferred to a U.S.G.S. 1:250,000 map by way of a tracing on a plastic overlay. Five colors were recognized on the scene and identified to vegetation types roughly equivalent to formations in the UNESCO classification: orange = Deciduous broad-leaved forest; gray = Evergreen needle-leaved forest; violet = Deciduous broad-leaved scrub; dull violet = Bog vegetation; light violet = Subarctic alpine tundra. Frequently these colors occurred as mosaics and blends, and 21 additional map units depict the phytocenologic interpretations of these. The map is an inventory of 26 broad vegetation types, a guide to the work necessary for a spatially and classificatorially more refined map, and an indication of the usefulness of ERTS imagery for economically mapping large areas.

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A VEGETATION MAP OF AN AREA NEAR FAIRBANKS, ALASKA, BASED ON AN ERTS IMAGE

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ABSTRACT

A vegetation map of a 3,200 km^2 area just west of Fairbanks, Alaska, drawn through use of an ERTS-1 image, scene no. 1033-21011, is presented. The map-area is phytocenologically diverse and is considered representative of much of interior Alaska. Vegetation information from the image, a reconstituted, simulated color-infrared, enlarged photographic print, was transferred to a U. S. Geological Survey topographic map in the 1:250,000 series by way of a tracing on a transparent plastic overlay.

Five colors were recognized on the image and identified to vegetation types roughly equivalent to formations in the recent UNESCO classification: orange = deciduous broad-leaved forest; gray = evergreen needle-leaved forest; violet = deciduous broad-leaved scrub; dull violet = bog vegetation; light violet = subarctic alpine tundra. Frequently these colors occurred mixed as mosaics and blends, and 21 additional map units were established to accommodate the corresponding phytocenologic interpretations.

The map is (a) an inventory of stands of 26 broad vegetation types, (b) a guide to the work necessary for a spatially and classificatorially more refined map, and (c) an indication that vegetation maps of a usefully large scale may be produced for large areas through use of ERTS imagery more efficiently than by conventional methods.

INTRODUCTION

Vegetation is a primary natural resource, and it is an indicator of other resources and environmental factors such as soils and climate. Most of the earth's land surface is covered by vegetation comprising a very large number of phytocenoses and numerous more broadly defined vegetation types. For the ecosystem oriented ecology and resource management now in vogue the vegetation component may serve as a practicable basis for ecosystem definition. Küchler (1967: 18) says "...the phytocenose is of such an essential and dominant significance that it usually expresses not only its own character but that of the entire ecosystem as well." The vegetation map is a comprehensive and readily usable form of the phytocenologic information basic to ecosystem studies and sound management programs. The description, classification and the conceptual and spatial delineation of vegetation types preparatory to mapping may constitute the lion's share of a phytocenologist's responsibilities.

The extent of scientific treatment of Alaskan vegetation is modest relative to the diversity and complexity of this resource in this large State, and it is especially limited in the face of current attention on land use planning and management. Any technological development facilitating vegetation study and inventory is therefore of some importance.

The first Earth Resources Technology Satellite, ERTS-1, launched July 23, 1972, shows promise for vegetation science in Alaska. Several studies based on ERTS multispectral imagery have already been presented by D. M. Anderson et al (1973), Anderson (1973), Anderson and Belon

(1973), and Anderson et al (1974). This work shows that an ERTS image enlarged to the desired scale is appropriate for delineating vegetation types, including rather narrowly defined phytocenoses at scales of 1:63,360 and larger. The present paper deals with the use of an ERTS-1 image for producing a 1:250,000 scale map depicting major vegetation types in an area near Fairbanks, Alaska (Figs. 1 and 2). Whereas the image is not reproduced here, discussions of spectral signatures, or colors, on it are presented as an indication of how a similar image might be used by others for vegetation interpretations and mapping. The present map is preliminary, pending (a) possible revision based on further aerial photograph and ground control, (b) refinement of the vegetation classification and (c) critical review by vegetation and land use scientists.

The map-area lies a few km west of Fairbanks, is approximately centered on a point at 64°46' N lat. X 148°31' W long., and is about 49 by 65 km, or 3,200 km^2 in size. It includes the Bonanza Creek Experimental Forest of the U. S. Forest Service, Murphy and Ester Domes, and segments of the Tanana River, the Nenana Highway and the Alaska Railroad. The topography is moderately diverse, with elevations from about 120 to 900 m, and a considerable variety of vegetation types occur here. These include lowland bogs and bog woodlands; upland bogs, bog woodlands, and broad-leaved and needle-leaved forests; a variety of scrubs; and, in a few local areas above about 750 m, subarctic alpine tundra. The interior Alaska part of the boreal forest biome seems to be well represented.

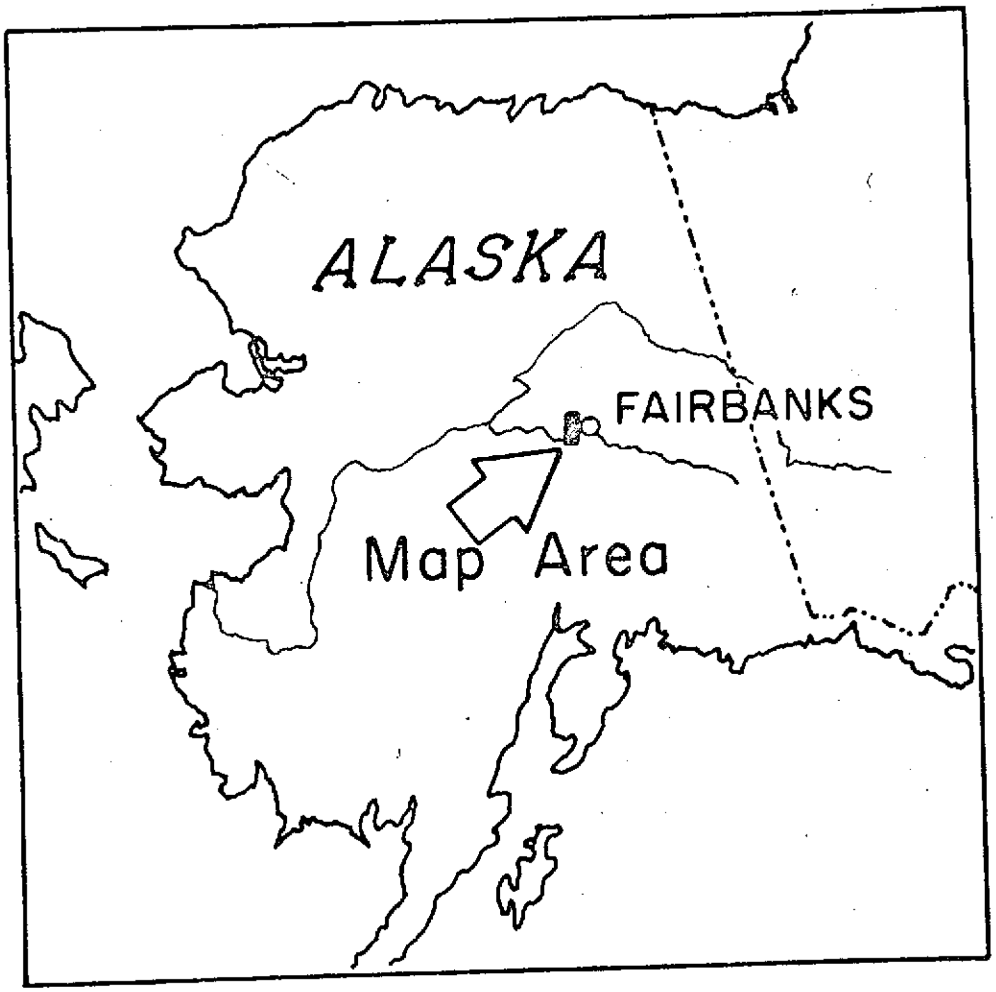
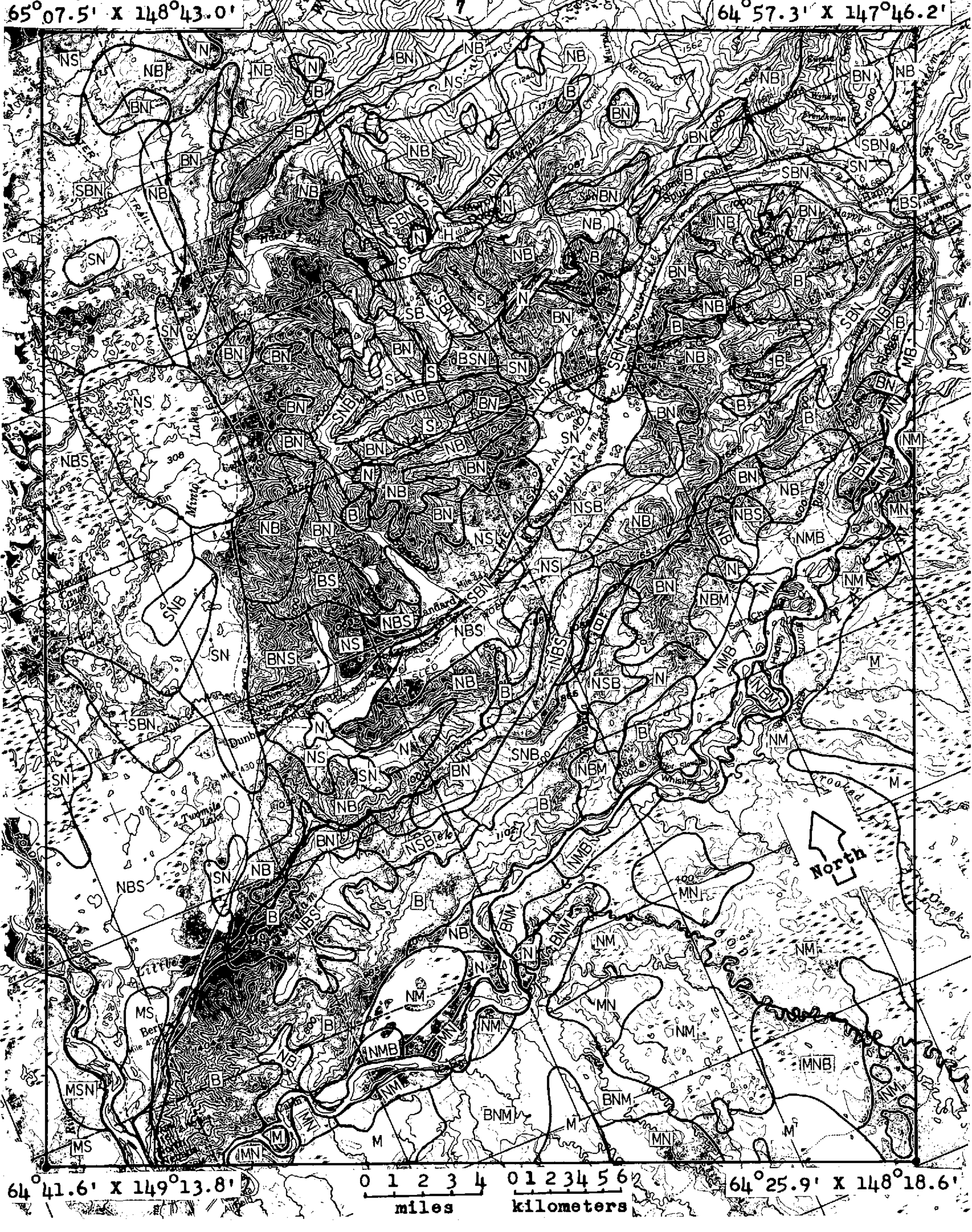


Figure 1. Map-area location.

Figure 2 (following page). Vegetation map of an area just west of Fairbanks, Alaska, based on ERTS-1 scene 1033-21011. Scale = 1:250,000. B = Deciduous broad-leaved forest, dominated by _Betula papyrifera_ and _Populus tremuloides_; N = Evergreen needle-leaved forest, dominated by _Picea glauca_ and _P. mariana_; S = Deciduous broad-leaved scrub, dominated by _Alnus_ spp. and _Salix_ spp.; M = Bog vegetation, dominated by various dwarf-shrubs, graminoids and bryophytes; and H = Alpine tundra, also dominated by dwarf-shrubs, graminoids and bryophytes, plus various forbs. In combination units, these vegetation types are indicated in order of decreasing importance. Unlabeled units are clouds.


65°07.5' X 148°43.0'
64°57.3' X 147°46.2'
64°41.6' X 149°13.8'
64°25.9' X 148°18.6'
0 1 2 3 4
miles
0 1 2 3 4 5 6
kilometers
North

METHODS

The image used for mapping is a photographic print made from the southeastern part of ERTS scene 1033-21011 in the photographic laboratory of the Geophysical Institute, University of Alaska. The print was produced in simulated color-infrared at a scale as close to 1:250,000 as possible by a process described by Anderson and Belon (1973).

The image was studied to discriminate color units, or units of different hue, intensity and brightness, to the extent that accuracy is possible with presumably normal color vision. Strong reflected light and transmitted light were tested, the former proving better. Five relatively pure colors were recognized: orange, gray, violet, dull violet and light violet. These colors occurred as units large enough feasibly to delineate and label at the 1:250,000 scale in a few places, but more frequently they occurred as mosaic components too small to delineate individually. Mosaics therefore were treated as map units. Blends of two and three colors were also recognized, and these too were treated as individual map units. A total of 26 different mappable color unit types were recognized, including the five pure colors and 21 blend and mosaic unit types.

Color units were delineated by drawing on a transparent plastic overlay of the image. The delineations were transferred over a light table to a U. S. Geological Survey map in the 1:250,000 series comprising parts of the Fairbanks and Livengood sheets.

It was assumed that colors on the ERTS image resulted chiefly from the spectral reflectance of vegetation, since vegetation is known to cover nearly the entire land surface in the map-area. This reflectance is that of the species or species groups contributing most to cover in the plant canopy. These are considered dominants, and vegetation type designations are made in terms of them. It was further assumed that different colors resulted from different vegetation types and that the mosaic of colors on the image was indicative of the mosaic of different stands of vegetation in the landscape. The colors and color combinations were identified to vegetation type through comparisons with aerial photographs and consideration of available ecological information and field knowledge of the map-area.

RESULTS AND DISCUSSION

The five more or less pure colors and the vegetation types they represent are listed below. Vegetation types are designated at the level of formation or subformation as defined by UNESCO (1973). The UNESCO formation or subformation each type is believed to represent is indicated by a number in a parenthesis.

Brief remarks regarding the dominant species are made, including some elementary information about their distributions on the topographic-moisture gradient as an aid in map interpretation. Elevation, slope, aspect and, in a general way, drainage can be determined by careful inspection of the background information on the map. In this manner phytocenoses dominated by one of two or more species with the same reflectance and appearance on the image may be located within the depicted, broad vegetation types. More thorough ecological information about the map-area and nearby similar areas was presented by Lutz (1956) and Viereck (1973) and several of the authors they cited.

Gray - Evergreen needle-leaved forest (62) and woodland (86). Map symbol N.

The dominant species are Picea glauca and P. mariana, white and black spruce. White spruce is much more frequently the dominant in spruce stands adjacent to rivers, on upland flat sites and on slopes of up to moderate steepness with a more or less southerly aspect. Black spruce is usually the dominant on lowland, flat and poorly drained sites and on slopes of a north or near-north aspect. Here the black spruce bog phytocenose, a woodland with a prominent understory of ericaceous shrubs and bryophytes, is frequent in addition to the forest type.

Orange - Deciduous broad-leaved forest (68) and some woodland (91). Map symbol B.

The dominant species are Populus balsamifera, P. tremuloides and Betula papyrifera, or balsam poplar, aspen and paper birch. As with the two evergreen species, large monospecific stands of these could not be distinguished on the image. However, poplar occurs in significant stands almost exclusively on floodplains near major streams. Aspen is important only on upland sites, particularly on the steeper southerly slopes. Paper birch as a stand dominant overlaps these species in physiographic range, although with low probability in the case of floodplains and the steepest south slopes. It is more frequently the deciduous forest dominant on upland flat sites and on slopes of most aspects up to moderate steepness. Aspen dominated stands are of widespread secondary importance in all upland areas except on north slopes. Stands characterized by mixtures of aspen and birch are common, but are indistinguishable on the image, and distinguishable with only low probability on the apparent topographic-moisture gradient, from monospecific stands.

Violet - Deciduous broad-leaved scrub (109). Map Symbol S.

The principal species are members of the genera Alnus, Salix and Betula, the alders, willows and shrub birches, none of which were distinguishable on the ERTS image. In the map-area, Alnus tenuifolia occurs as a stand dominant adjacent to major streams, especially on recent floodplains. Various willows also dominate on such sites. Large and monogeneric stands of willows occur on riparian sites and on various upland sites where former forest vegetation was removed by fire. Certain species of willow are dominant components of the earlier stages of post-fire succession. In some cases upland areas appearing otherwise suitable for forest vegetation but currently bearing deciduous broad-leaved scrub are locations of fires which occurred within the past few decades. Such areas are sometimes characterized by sharp, irregular and apparently non-physiographically related boundaries, revealed on the image by corresponding color breaks. The shrub birches, Betula glandulosa and B. nana, are less common as phytocenose dominants, occurring as such in the vicinity of treeline and in some lower elevation flat areas.

Light violet - Dwarf-shrub and moss tundra (191). Map symbol H.

This color was of limited distribution on the image, occurring only at and in the vicinity of the highest summit, Murphy Dome. It could probably have been seen on one or two other of the highest summits had these not been cloud-covered. The vegetation here is a tundra, characterized by several species of low growing woody plants, bryophytes, graminoids, lichens and occasional sparsely vegetated and bare rocky areas.

Dull violet - Bog vegetation (144). Map symbol M.

This rather broad vegetation type is extensive in the flat terrain south of the Tanana River and in the Minto Lakes area. The dominant plants are species of *Sphagnum* and other moss genera, *Carex* spp., *Eriophorum* spp. and a number of dwarf-shrub species.

These five colors appeared as pure units large enough to map in only a minor portion of the map-area, with the exception of orange, representing deciduous forest, which was moderately widespread (Fig. 2). In most cases they could be mapped at the 1:250,000 scale only as blends or mosaics. An additional 21 map units were established to accomodate these mixtures, which are believed to represent combinations of the vegetation types listed above. Gray-orange, for example, is believed to represent a vegetation comprising (a) a mosaic of relatively pure and separate stands of broad-leaved and needle-leaved trees or (b) a mixture with individuals of each group more or less evenly distributed throughout. The map unit symbol is NB, indicating that the needle-leaved component appears more important on the basis of the apparent strength of the gray color relative to orange. Gray-orange color units in which orange seemed stronger were interpreted as indicating that broad-leaved trees are more important in the vegetation. Here the map unit symbol is BN. Similarly, MNB designates a vegetation comprising a bog plant matrix with a black spruce component of low cover value and scattered stands of broad-leaved trees.

Colors and the color balance on the ERTS image used in this work seem to be peculiar to it. They are different from the colors on a transparency of the same scene obtained from ERTS User Services, National Aeronautics and Space Administration, whereon, for example, bright red instead of orange occurs. Colors are determined in part by the unique configuration of physical and chemical variables involved in image preparation. Therefore no two photographic products are apt to be quite the same, and the user will find it necessary to identify color units for himself and to establish the vegetation relationships.

CONCLUSIONS

This map and its preparation tends to confirm a conclusion from an earlier study involving a different vegetation, the subarctic tundra of the western Seward Peninsula, that ERTS imagery can enable the inventory and mapping of broadly defined vegetation types over large areas more efficiently than by the conventional use of aerial photographs (Anderson and Belon 1973). Although not a detailed map, it provides more classificatory and distributional information than any existing published map. It appears that a similar map for a larger part of interior Alaska could be produced in a few weeks, especially now that quality imagery is available for the region. A vegetation and land use map of the 19,000 km^2 Fairbanks North ~~Slope~~ Star Borough is now in preparation, based on several ERTS scenes. These include winter as well as summer scenes, as forest, woodland and scrub, and low vegetation are readily distinguished when the ground is snow covered. The present preliminary map will serve as a guide for obtaining the field and other information upon which the preparation of a revised and more nearly accurate map could be based (cf Küchler, 1967: 267; Anderson et al 1974).

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LITERATURE CITED

Anderson, D. M., W. K. Crowder, R. K. Haugen, T. L. Marlar, H. L. McKim and A. Petrone. 1973. An ERTS view of Alaska: Regional analysis of earth and water resources based on satellite imagery. Technical Report 241, U. S. Army Cold Regions Research and Engineering Laboratory, Hanover. 50 p + maps.

Anderson, J. H. 1973. Identification, definition and mapping of terrestrial ecosystems in interior Alaska. No. E74-10137, National Technical Information Service, Springfield. 16 p.

Anderson, J. H. and A. E. Belon. 1973. A new vegetation map of the western Seward Peninsula, Alaska, based on ERTS-1 imagery. No. E73-10305, National Techical Information Service, Springfield. 20 p.

Anderson, J. H., C. H. Racine and H. R. Melchior. 1974. Preliminary vegetation map of the Espenberg Peninsula, Alaska, based on an Earth Resources Technology Satellite image. Biological Papers of the

University of Alaska. In Press. MS 21 p + map.

Küchler, A. W. 1967. Vegetation mapping. Ronald Press, New York. 472 p.

Lutz, H. J. 1956. Ecological effects of forest fires in the interior of Alaska. Technical Bulletin 1133, U. S. Forest Service. 121 p.

Maugh, T. H. 1973. ERTS (II): A new way of viewing the earth. Science 180:171-173.

UNESCO. 1973. International classification and mapping of vegetation. No. 6, Ecology and Conservation Series. United Nations Educational, Scientific and Cultural Organization, Paris. 93 p + chart. (Available from Unipub, Inc., P. O. Box 433, New York 10016. $15.85.)

Viereck, L. A. 1973. Wild~~life~~fire in the taiga of Alaska. Quaternary Research 3:465-495.