420

SUSITNA HYDROELECTRIC PROJECT

ENVIRONMENTAL REPORT

TASK 7: ENVIRONMENTAL

PLANT ECOLOGY - 1980

MAY 1981

Prepared for:

ACRES

Prepared by:

Terrestrial
Environmental
Specialists, Inc.

ALASKA POWER AUTHORITY

ENVIRONMENTAL STUDIES ANNUAL REPORT 1980

SUBTASK 7.12 PLANT ECOLOGY STUDIES

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by

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SUMMARY

The vegetation/habitat types found in the Upper Susitna River Basin and the floodplain down to Talkeetna were described, classified, and mapped. Reconnaissance of many locations throughout the study area was made in summer 1980 to obtain information on species composition and community structure. Ocular estimates of the cover of each species in each layer of vegetation were made, and these data were used to classify the vegetation according to the system developed by Viereck and Dyrness (1980). High altitude (U2) color infrared photography and LANDSAT imagery were used to map the vegetation cover types. Maps were produced at the scales of 1:250,000 and 1:24,000 for the entire basin and direct impact areas, respectively. Additionally, the area extending 16 km in any direction from the proposed impoundment areas is in the process of being mapped at a scale of 1:63,360. A 1:24,000 scale map of apparent wetlands was also produced, based on the 1:24,000 scale vegetation map and the wetlands classification system (Cowardin et al. 1979) used by the U. S. Fish and Wildlife Service.

Results of reconnaissance surveys of the vegetation/habitat types show that at least 243 species in 130 genera and 55 families are present in the Upper Susitna River Basin. Of these 21 represented extensions of the previously known ranges of the species. Special effort was made to locate any species which are currently under review by the U. S. Fish and Wildlife Serivce for possible status as endangered or threatened. Although some potential habitats of these species were located, none of the species were found. Foot and helicopter surveys were also made of several lakes and ponds within the direct impact areas to determine the composition and structure of plant communities occurring in or near the water.

The major vegetation/habitat types found in the study area are low mixed shrub, woodland and open black spruce, sedge-grass tundra, mat and cushion tundra, and birch shrub. These vegetation/habitat types are typical of what is found covering vast areas of Alaska and northern Canada. Characteristically, these types are found on cold, wet soils

and exhibit slow or stunted growth. Less than 3% of the area is vegetated by deciduous or mixed conifer-deciduous forests which, by contrast, have more robust growth characteristics. Deciduous and mixed conifer-deciduous forests occur primarily along the Susitna River where soils are better drained and a longer growing season exists. Consequently, a large portion of deciduous and mixed forests found in the study area will be destroyed by the proposed impoundments. Other vegetation/habitat types -- mixed shrub, birch shrub, tall shrub, and spruce -- will also be lost by inundation, but in small degree relative to their availability across the entire Upper Susitna River Basin.

If that vegetation/habitat which is destroyed is found to have considerable importance as browse for moose, there may be some opportunity to create replacement browse supplies in adjacent areas either by burning or by clearing to stimulate regrowth of palatable shrubs. Generally speaking, however, losses of vegetation can not be mitigated. However, in those situations where the vegetation is only temporarily destroyed (eg: construction sites, roads, and borrow sites) revegetation by mulching and seeding with native species may quickly restore ground cover. Natural revegetation following fertilization also appears promising in mitigating temporary losses of vegetation.

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1 - INTRODUCTION

The overall objective of the Plant Ecology Studies is to map and characterize the vegetation/habitat types occurring in the areas to be affected by the proposed Susitna Hydroelectric Project, predict impacts that will result from the proposed facilities, and to provide preliminary mitigation options. Specifically, during 1980 our objectives were to produce preliminary vegetation maps and qualitative descriptions of each vegetation type mapped. Additionally, we were to survey the Upper Susitna River impact areas for plant species currently being reviewed by the U. S. Fish and Wildlife Service for protection under the Endangered Species Act of 1973.

2 - METHODS

2.1 - Definition of Study Area

The area of study during 1980 included all of the Upper Susitna River drainage and the floodplain of the Susitna River from Gold Creek to Talkeetna. Some portions of this area were studied more intensively than others. The scale at which the different areas were mapped is presented on Figure 1 and gives some indication of how the study effort was distributed; more attention was given to areas that were mapped at larger scales, since these are the areas of direct impact.

2.2 - Vegetation Cover/Habitat Mapping

Vegetation of the entire Upper Susitna River drainage (Figure 1) was mapped at a scale of 1:250,000. Vegetation adjacent to and within 16 km of the Upper Susitna River was mapped at a scale of 1:63,360. The vegetation within the proposed impact areas (i.e., impoundments, areas within 0.8 km of impoundments, floodplain from Portage Creek to Talkeetna, and borrow sites) was mapped at a scale of 1:24,000. The classification system developed by Viereck and Dyrness (1980) was utilized in the mapping effort.

Mapping at all three scales began with the entire Upper Susitna River drainage being subdivided into major physiographic regions by the interpretation of winter and summer LANDSAT imagery. Vegetation units on 1:120,000 scale high altitude (U-2) color infra-red (CIR) photography of representative areas of each physiographic region were then delineated and identified according to Viereck and Dyrness (1980). The 1:120,000 scale prints, with attached overlays, were then taken into the field and as many delineated vegetation units verified as possible; field checks were distributed across each of the major physiographic regions, with emphasis being placed on those vegetation types which were most difficult

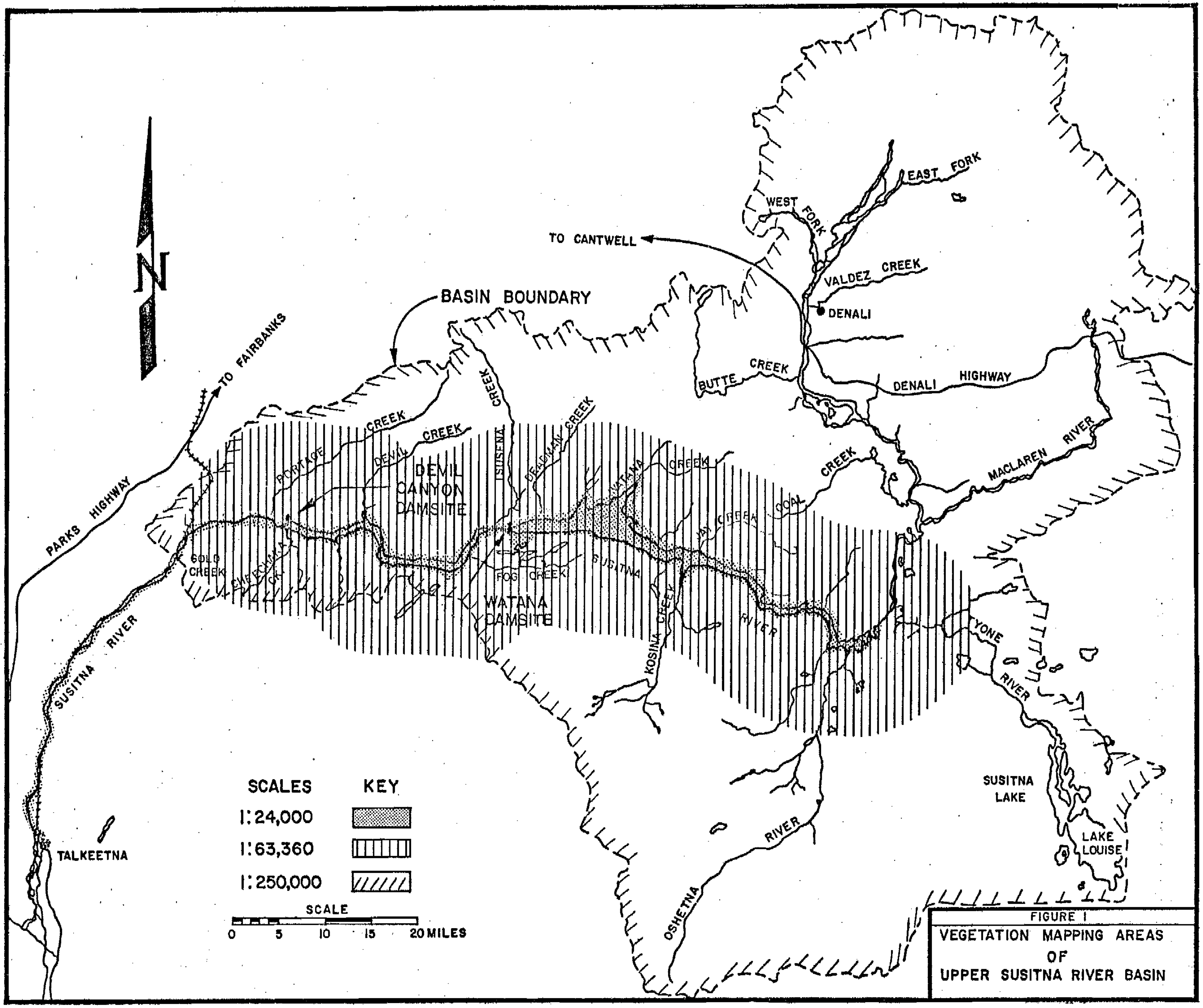

FIGURE 1
VEGETATION MAPPING AREAS OF UPPER SUSITNA RIVER BASIN

to interpret on aerial photography; helicopter availability also was a factor in determining which areas could be checked. Enlargements of the 1:120,000 scale CIR photography at the 1:24,000 and 1:63,360 scales were obtained as transparencies, and vegetation units were then redelineated on mylar overlays. The 1:250,000 scale mapping was done on an overlay of a summer LANDSAT image; in each case, field-checked copies of the 1:120,000 scale CIR prints were consulted for more accurate delineation of vegetation types. Experience gained during the summer in interpreting the tones and textures of CIR prints was also used in the remapping of the vegetation. Finally, overlay maps were traced on subdued positive transparencies of corresponding USGS topographic maps, thus producing final maps which could later be duplicated. The 1:63,360 scale map has not reached this final stage of completion.

2.3 - Qualitative Assessments

2.3.1 - Sampling Locations

Reconnaissance level surveys were made of each major vegetation type. Areas surveyed were selected based on the aerial photography. Some areas were chosen because we were unsure of what vegetation type was represented by certain colors and textures on the photographs. Others were selected because more sample points were needed in a particular vegetation type. The desired number of sample points in a vegetation type was based on extent of that type and on severity of impact from the Susitna Hydroelectric Project. In other words, more points were sampled in vegetation types of large extent and in the impoundment areas. The actual sample area was chosen because of its homogeneity. The size of an area sampled depended on the size of the homogeneous area, the number of people sampling the area, and the available time. The areas and types sampled during the 1980 field season (June, July, and August) are indicated on Table 1 and Figure 2.

Table 1

Vegetation/habitat types (and sample location numbers) sampled in Upper Susitna River Basin, 1980.

Vegetation/habitat Type	Sample Location Number[a]
Mat and cushion tundra	1-8
Sedge-grass tundra	9-10
Herbaceous tundra	11
Wet sedge-grass	12-14
Open black spruce	15-17
Woodland black spruce	18-22
Open white spruce	23-27
Woodland white spruce	28
Closed birch forest	29-32
Open birch forest	33-34
Closed balsam poplar	35-36
Open balsam poplar	37
Closed aspen	38
Closed mixed conifer-deciduous forest	39-41
Open mixed conifer-deciduous forest	42-49
Closed tall shrub	50-52
Open tall shrub	53
Low shrub	54-62
Willow shrub	63-64

[a] Sample locations are given in Figure 2.

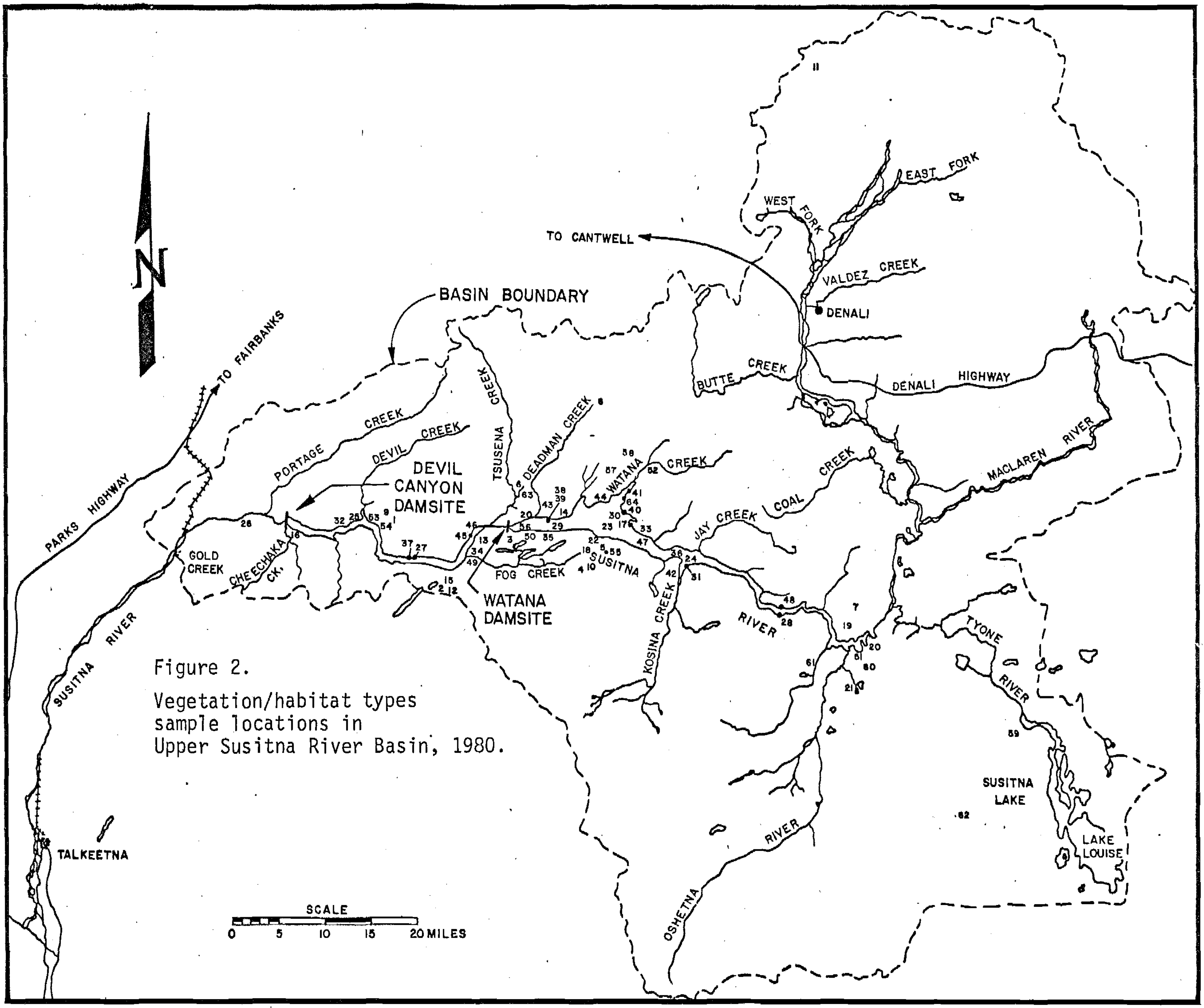

Figure 2.

Vegetation/habitat types sample locations in Upper Susitna River Basin, 1980.

2.3.2 - Vegetation Characteristics

Species composition and community structure information was collected at each area sampled. Ocular estimates were made of the cover of each plant species in each layer of vegetation. Cover is the vertical projection of living plant parts on the ground and is measured as a percentage of area covered. The ground layer consisted of all herbaceous species and all woody species less than 0.5 m tall. The shrub layer consisted of woody species taller than 0.5 m but less than 2.5 cm dbh (diameter breast height). Understory vegetation was woody species between 2.5 cm and 10.0 cm dbh. Overstory vegetation consisted of species larger than 10.0 cm dbh. "Shrub layer" refers to a layer of vegetation whereas the term "shrub" refers to the life form of woody species not considered trees such as *Betula glandulosa*, *B. nana*, *Alnus* spp., *Empetrum nigrum*, and others. Some tall shrubs such as *Alnus* may be taller than short trees such as *Picea mariana* which occurred scattered in wet areas. Hence, height is not a good distinguishing characteristic for these life forms in this vegetation.

A woody species could occur in any one or combination of layers in a given stand. Cover was also estimated for each layer of vegetation without regard to species. Cover values are not additive because of overlapping layers. In other words, if a species has 15% shrub layer cover and a 10% ground layer cover, its overall cover would be at least 15% but may be less than 25% if parts of the taller individuals occur above the shorter individuals. Similarly, the sum of the cover percentages in a stand may exceed 100%.

2.3.3 - Physical Characteristics

The objective of this portion of the qualitative assessment was to collect data that would describe characteristics of the physical environment which could be closely associated with the occurrence of a particular vegetation/wildlife habitat type. One person on the survey team was assigned to record the physical variables at each site where the vegetation was described. Elevation was determined from topographic maps or the altimeter of the helicopter. Degree of slope typical of the site was measured with an ABNEY level. Aspect was determined with the use of a compass and recorded in degrees. Position was also recorded with reference to elevational location of the site with respect to the land form on which it occurs (e.g. canyon site; mid, upper, or lower level; mountain top; etc.).

Soil pits were dug whenever time permitted, and the horizons of each described in terms of depth, texture, color, wetness, and structure. Texture and color were described in common soil classification terms. Wetness was recorded as saturated, wet, moist, or dry. The pits were dug to a depth of at least 30 cm or until frost or rock was encountered. Parent material was identified in each case. In addition, core samples of approximately 20 cm depth were taken from 5 to 8 locations within the site. The samples were placed in a common plastic bag, labelled, and sealed for later texture and chemical analysis. They were stored in a cool place.

2.3.4 - Wildlife Habitat

The focus of this part of the qualitative assessment was description of ungulate habitat values for each community/habitat type. Secondarily, record was made of presence or sign of other wildlife species, such as birds, small mammals, and bears.

Available browse, browse utilization, browse vigor, pellet groups, and comments relative to wildlife habitat were recorded. Specifics are discussed in the Plant Ecology Procedures Manual (p. 13).

2.3.5 - Wetlands

All land within the proposed impact areas was also classified according to Cowardin et al. (1979) into appropriate wetland classes. A map delineating wetland types was constructed using the vegetation/habitat maps following the same procedures given in Section 2.2. The only difference was that the vegetation units were replaced with appropriate wetland classes. This was done with little consideration of soil moisture conditions, since this information was mostly unavailable to us. Presence of steep slope and likely good drainage was interpreted to rule out classification as wetland in some cases where the vegetation cover did indicate the possibility of wetland. Obviously, this is a very risky procedure without actual soils data for interpretation.

Foot surveys were made of several ponds and lakes and their peripheral wet areas within the impoundment areas and adjacent uplands. During the surveys, species composition, dominance and total cover (relative to amount of water) were estimated. Elevation, estimated rooting depth, and width of surrounding wetland were recorded. Surrounding wetland was limited by definition to the Lacustrine-Limnetic-Emergent Wetland-Vascular wetland class of Cowardin et al. (1979). Many of the remaining ponds and lakes, not surveyed on foot, were examined by helicopter overflights to ensure similarity among ponds and to search for new species.

2.4 - Endangered and Threatened Species

No plant species are presently officially listed for Alaska by federal or state authorities as endangered or threatened, however, 37 are currently under review by the U. S. Fish and Wildlife Service (USF&WS 1980). Most of these species were also discussed by Murray (1980). The general habitat requirements and occurrence of these plant species were known from previous taxonomic and ecological studies in Alaska and from information on the Alaskan flora by Hulten (1968). Following a review of this information and contact with local experts, 10 species that could possibly occur in the phytogeographic region of the Upper Susitna River were identified. Potential habitat for these species was then selected for closer investigation.

In August 1980, a helicopter and foot survey was made of each of the selected areas. Special attention was given to micro sites where the species in question might occur. Since calophytic species could possibly occur, soils having free carbonates were located by using geologic maps which indicated calcareous rock materials and by testing with 10% hydrochloric acid.

3 - RESULTS AND DISCUSSION OF BASELINE STUDY

3.1 - Introduction

During summer 1980, preliminary maps and descriptions of vegetation/habitat types were constructed for approximately 4 million acres of forest, shrub and tundra lands in the Upper Susitna River Basin. Vegetation/habitat information includes descriptions of flora, threatened and endangered species, physical site characteristics, wetlands, and aquatic species.

3.2 - General Description of Study Area

The Upper Susitna River Basin is located in the Pacific Mountain physiographic division in southcentral Alaska (Joint Federal-State Land Use Planning Commission for Alaska 1973). The Susitna River drains parts of the Alaska Range on the north and parts of the Talkeetna Mountains on the south. Many areas along the east-west portion of the river, between the confluences of Portage Creek and the Oshetna River, are steep and covered with conifer, deciduous, and mixed conifer and deciduous forests. Flat benches occur at the tops of these banks and usually contain low shrub or woodland conifer communities. Low mountains rise from these benches and are covered by sedge-grass tundra and mat and cushion tundra.

The southeastern portion of the study area between the Susitna River and Lake Louise is characterized by extensive flat areas covered with low shrubland and woodland conifer communities which are often intermixed and difficult to distinguish in the field or on aerial photographs because of intergradations. The area along the Susitna River between the Maclaren River and the Denali Highway is covered with woodland and open spruce stands. Farther east the area has more low shrubland cover. The Clearwater Mountains north of the Denali Highway have extensive tundra vegetation. The floodplain of the Susitna River north of the

Denali Highway has woodland spruce and willow stands. The Alaska Range contains most of the permanent snowfields and glaciers in the study area.

The steep portions and some adjacent areas along the east-west portions of the river are considered in the closed spruce-hardwood forest type of Viereck and Little (1972), the moderately high mixed evergreen and deciduous forest map unit of Spetzman (1963), and the upland spruce hardwood forest of the Joint Federal-State Land Use Planning Commission of Alaska (1973). This type of vegetation is found mainly along rivers in the southcentral and interior regions of the state.

The benches bordering the east-west portion of the river and the area around the Maclaren River are classified as moist tundra in all three of the previously mentioned maps. This moist tundra classification includes herbaceous meadows as well as shrub dominated areas. These areas occur around the Brooks Range, on the Seward Peninsula, and near the Killuck Mountains.

The extensive flats in the lower Oshetna River and Lake Louise areas are considered open, low growing spruce forests by Viereck and Little (1972), low mixed evergreen and deciduous forests by Spetzman (1963), and lowland spruce-hardwood forests by the Joint Federal-State Land Use Planning Commission of Alaska (1973). Viereck and Little's (1972) description appears most appropriate since the area is covered primarily by spruce stands with treeless bogs. This type generally occurs just above the closed spruce-hardwood stands (Viereck and Little 1972) or the bottomland spruce poplar stands (Joint Federal-State Land Use Planning Commission of Alaska 1973).

The vegetation along the lower mountains and the lower slopes of the higher mountains was classified as alpine tundra by Viereck and Little (1972) and the Joint Federal-State Land Use Planning Commission (1973) and barren and sparse dry tundra by Spetzman (1963). Some of these areas were mapped as rock while other areas were mapped as sedge-grass tundra or mat and cushion tundra in this study, whereas the previous maps included the rock in the alpine tundra. Some areas which were mapped as rock do have some important pioneering species growing in crevices, but the plants provided neglible ground cover. This vegetation grows on mountains throughout the state.

3.3 - Floristics

Table 2 contains a preliminary list of plant species which have been tentatively identified from the Upper Susitna River Basin. There are 243 vascular plant species occurring in 130 genera in 55 families. Some collected specimens have yet to be identified and others need to be verified by experts in the field. This is particularly true for the *Carex* and *Salix* genera. The families which contained the most species were Compositae, Salicaceae, Rosaceae, Gramineae, Cyperaceae, and Ericaceae. The Salicaceae family was also important from the standpoint of canopy cover, wildlife usage, and pioneering on gravel bars, whereas the Compositae contributed relatively minor cover. The genus *Salix* contained 17 species, tentatively, while *Carex* had 10 species and *Saxifraga* had 9 species.

Seven genera of lichen which included at least 11 species were identified while five taxa of mosses were identified. More extensive work on lichens and mosses will likely identify many more species of mosses and lichens.

3.4 - Preliminary Vegetation/Habitat Type Maps

The two vegetation/habitat maps that have been produced to date are the 1:250,000 scale (Figure 3 - see back packet) and 1:24,000 scale (Figure 4 - see accompanying map). The 1:63,360 scale map is currently nearing completion.

It should be noted that there is seldom a distinct line of demarcation between vegetation/habitat types when viewed on aerial photographs or in

Table 2

Preliminary list of plant species, identified during summer 1980 in Upper Susitna River Basin.[a]

Pteridophyta	
Aspidiaceae	
Dryopteris dilatata (Hoffm.) Gray	Shield fern
Dryopteris fragrans (L.) Schott	Fragrant shield-fern
Gymnocarpium dryopteris (L.) Newm.	Oak-fern
Athyriaceae	
Cystopteris fragilis (L.) Bernh.	Fragile-fern
Cystopteris montana (Lam.) Bernh.	Mountain fragile-fern
Woodsia alpina (Bolton) S. F. Gray	Alpine woodsia
Equisetaceae	
Equisetum arvense L.	Meadow horsetail
Equisetum fluviatile L. ampl. Ehrh.	Swamp horsetail
Equisetum pratense L.	Meadow horsetail
Equisetum silvaticum L.	Woodland horsetail
Equisetum variegatum Schleich.	Variegated scouring-rush
Isoetaceae	
Isoetes muricata Dur.	Quillwort
Lycopodiaceae	
Lycopodium alpinum L.	Alpine clubmoss
Lycopodium annotinum L.	Stiff clubmoss
Lycopodium clavatum L.	Running clubmoss
Lycopodium complanatum L.	Ground cedar
Lycopodium selago L. ssp. *selago*	Fir clubmoss
Gymnospermae	
Cupressaceae	
Juniperus communis L.	Common juniper
Pinaceae	
Picea glauca (Moench) Voss	White spruce
Picea mariana (Mill.) Britt., Sterns & Pogg.	Black spruce

Monocotyledoneae

Cyperaceae

Carex aquatilis Wahlenb.	Water sedge
Carex bigelowii Torr.	Bigelow sedge
Carex capillaris L.	Hairlike sedge
Carex concinna R. Br.	Low northern sedge
Carex filifolia Nutt.	Thread-leaf sedge
Carex limosa L.	Shore sedge
Carex loliacea L.	Sedge
Carex membranacea Hook.	Fragile sedge
Carex podocarpa C. B. Clarke	Short-stalk sedge
Carex rhynchophysa C. A. Mey.	Sedge
Carex spp.	Sedge
Eriophorum angustifolium Honck.	Tall cottongrass
Eriophorum scheuchzeri Hoppe	White cottongrass
Eriophorum vaginatum L.	Tussock cottongrass
Trichophorum caespitosum (L.) Hartm.	Tufted clubrush

Gramineae

Agropyron sp.	Wheatgrass
Agrostis scabra Willd.	Tickle grass
Agrostis sp.	Bent grass
Alopecurus alpinus Sm.	Mountain foxtail
Arctagrostis latifolia (R. Br.) Griseb.	Polargrass
Calamagrostis canadensis (Michx.) Beauv.	Bluejoint
Calamagrostis purpurascens R. Br.	Purple reedgrass
Danthonia intermedia Vasey	Timber oatgrass
Deschampsia atropurpurea (Wahlenb.) Scheele[b/]	Mountain hairgrass
Deschampsia caespitosa (L.) Beauv.	Tufted hairgrass
Festuca altaica Trin.	Fescue grass
Festuca rubra L. Coll.	Red fescue
Hierochloe alpina (Swartz) Roem. & Schult.	Alpine holygrass
Hierochloe odorata (L.) Wahlenb.	Vanilla grass
Phleum commutatum Gandoger	Timothy
Poa arctica R. Br.	Arctic bluegrass
Poa palustris L.	Bluegrass
Trisetum spicatum (L.) Richter	Downy oatgrass

Iridaceae

Iris setosa Pellas	Wild iris

Juncaceae	
Juncus arcticus Willd.	Arctic rush
Juncus castaneus Sm.	Chestnut rush
Juncus drummondii E. Mey.	Drummond rush
Juncus mertensianus Bong.	Mertens rush
Luzula campestris (L.) DC. ex DC. & Lam.[b]	Woodrush
Luzula confusa Lindeb.	Northern woodrush
Luzula multiflora (Retz.) Lej.	Woodrush
Luzula parviflora (Ehrh.) Desv.	Small-flowered woodrush
Luzula tundricola Gorodk.	Tundra woodrush
Luzula wahlenbergii Rupr.	Wahlenberg woodrush
Liliaceae	
Lloydia serotina (L.) Rchb.	Alp lily
Streptopus amplexifolius (L.) DC.	Cucumber root
Tofieldia coccinea Richards	Northern asphodel
Tofieldia pusilla (Michx.) Pers.	Scotch asphodel
Veratrum viride Ait.	Helebore
Zygadenus elegans Pursh	Elegant death camas
Orchidaceae	
Platanthera convallariaefolia (Fisch.) Lindl.	Orchis family
Platanthera hyperborea (L.) Lindl.	Orchis family
Potamogetomaceae	
Potamogeton epihydrous Raf.	Nuttall pondweed
Potamogeton filiformis Pers.	Filiform pondweed
Potamogeton gramineus L.	Pondweed
Potamogeton perfoliatus L.	Clasping-leaf pondweed
Potamogeton robbinsii Oakes	Robbins pondweed
Sparganiaceae	
Sparganium angustifolium Michx.	Narrow-leaved burreed
Dicotyledoneae	
Araliaceae	
Echinopanax horridum (Sm.) Decne. & Planch.	Devil's club

Betulaceae[c/]

Alnus crispa (Ait.) Pursh	American green alder
Alnus sinuata (Reg.) Rydb.	Sitka alder
Betula glandulosa Michx.	Resin birch
Betula nana L.	Dwarf arctic birch
Betula occidentalis Hook.	Water birch
Betula papyrifera Marsh.	Paper birch

Boraginaceae

Mertensia paniculata (Ait.) G. Don	Tall bluebell
Myosotis alpestris F. W. Schmidt	Forget-me-not

Callitrichaceae

Callitriche hermaphroditica L.	Water starwort
Callitriche verna L.	Vernal water-starwort

Campanulaceae

Campanula lasiocarpa Cham.	Mountain harebell

Caprifoliaceae

Linnaea borealis L.	Twin-flower
Viburnum edule (Michx.) Raf.	High bush cranberry

Caryophyllaceae

Minuartia obtusiloba (Rydb.) House	Alpine sandwort
Silene acaulis L.	Moss campion
Stellaria sp.	Starwort
Wilhelmsia physodes (Fisch.) McNeill	Merckia

Compositae

Achillea borealis Bong.	Yarrow
Achillea sibirica Ledeb.	Siberian yarrow
Antennaria alpina (L.) Gaertn.	Alpine pussytoes
Antennaria monocephala DC.	Pussytoes
Antennaria rosea Greene	Pussytoes
Arnica amplexicaulis Nutt. ssp. prima Maguire	Arnica
Arnica frigida C. A. Mey.	Arnica
Arnica lessingii Greene	Arnica
Artemisia alaskana Rydb.	Alaska wormwood
Artemisia arctica Less.	Wormwood
Artemisia tilesii Ledeb.	Wormwood
Aster sibiricus L.	Siberian aster
Erigeron humilis Graham	Fleabane daisy
Hieracium triste Willd.	Woolly hawkweed
Petasites frigidus (L.) Franch.	Arctic sweet coltsfoot
Petasites sagittatus (Banks) Gray	Arrowleaf sweet coltsfoot

Senecio atropurpureus (Ledeb.) Fedtsch.	Ragwort
Senecio lugens Richards.	Ragwort
Senecio sheldonensis Pors.	Sheldon groundsel
Solidago multiradiata Ait.	Northern goldenrod
Taraxacum sp.	Dandelion

Cornaceae

Cornus canadensis L.	Bunchberry

Crassulaceae

Sedum rosea (L.) Scop.	Roseroot

Cruciferae

Cardamine bellidifolia L.	Alpine bittercress
Cardamine pratensis L.	Cuckoo flower
Cardamine umbellata Greene	Bittercress
Draba nivalis Liljebl.	Rockcress
Draba stenoloba Ledeb.	Rockcress

Diapensiaceae

Diapensia lapponica L.	Diapensia

Elaeagnaceae

Shepherdia canadensis (L.) Nutt.	Soapberry

Empetraceae

Empetrum nigrum L.	Crowberry

Ericaceae

Andromeda polifolia L.	Bog rosemary
Arctostaphylos alpina (L.) Spreng.	Alpine bearberry
Arctostaphylos rubra (Rehd. & Wilson) Fern.	Red-fruit bearberry
Arctostaphylos uva-ursi (L.) Spreng.	Bearberry
Cassiope tetragona (L.) D. Don	Four angle mountain heather
Ledum decumbens (Ait.) Small[c/]	Northern Labrador tea
Ledum groenlandicum Oeder	Labrador tea
Loiseleuria procumbens (L.) Desv.	Alpine azalea
Oxycoccus microcarpus Turcz.	Swamp cranberry
Rhododendron lapponicum (L.) Wahlenb.	Lapland rosebay
Vaccinium caespitosum Michx.	Dwarf blueberry
Vaccinium uliginosum L.	Bog blueberry
Vaccinium vitis-idaea L.	Mountain cranberry

Fumariaceae

Corydalis pauciflora (Steph.) Pers.	Few-flowered corydalis

Gentianaceae

Gentiana glauca Pall.	Glaucous gentian
Gentiana propinqua Richards.	Gentian
Menyanthes trifoliata L.	Buckbean
Swertia perennis L.	Gentian

Geraniaceae

Geranium erianthum DC.	Northern geranium

Haloragaceae

Hippuris vulgaris L.	Common marestail

Leguminosae

Astragalus aboriginum Richards.	Milk-vetch
Astragalus alpinus L.[b]	Milk-vetch
Astragalus umbellatus Bunge	Milk-vetch
Hedysarum alpinum L.	Alpine sweet-vetch
Lupinus arcticus S. Wats.	Arctic lupine
Oxytropis maydelliana Trautv.	Maydell oxytrope
Oxytropis nigrescens (Pall.) Fisch.	Blackish oxytrope
Oxytropis viscida Nutt.	Viscid oxytrope

Lentibulariaceae

Pinguicula villosa L.	Hairy butterwort
Utricularia vulgaris L.	Common bladderwort

Myricaceae

Myrica gale L.	Sweet gale

Nymphaceae

Nuphar polysepalum Engelm.	Yellow pond lily

Onagraceae

Epilobium angustifolium L.	Fireweed
Epilobium latifolium L.	Dwarf fireweed
Epilobium palustre L.	Swamp willow-herb

Orobanchaceae

Boschniakia rossica (Cham. & Schlecht.) Fedtsch.	Poque

Polemoniaceae

Polemonium acutiflorum Willd.	Jacob's ladder

Polygonaceae

Oxyria digyna (L.) Hill	Mountain sorrel
Polygonum bistorta L.	Meadow bistort
Polygonum viviparum L.	Alpine bistort
Rumex arcticus Trautv.	Arctic dock
Rumex sp.	Dock

Portulacaceae

Claytonia sarmentosa C. A. Mey.	Spring-beauty

Primulaceae

Dodecatheon frigidum Cham. & Schlecht.	Northern shooting star
Primula cuneifolia Ledeb.	Wedge-leaf primrose
Trientalis europaea L.	Arctic starflower

Pyrolaceae

Pyrola grandiflora Radius	Large-flower wintergreen
Pyrola minor L.	Lesser wintergreen
Pyrola secunda L.	One-sided wintergreen

Ranunculaceae

Aconitum delphinifolium DC.	Monkshood
Anemone narcissiflora L.	Anemone
Anemone parviflora Michx.	Northern anemone
Caltha leptosepala DC.	Mountain marsh-marigold
Ranunculus confervoides (E. Fries) E. Fries	Water crowfoot
Ranunculus nivalis L.	Snow buttercup
Ranunculus occidentalis Nutt.	Western buttercup
Ranunculus pygmaeus Wahlenb.	Pygmy buttercup
Ranunculus sp.	Buttercup
Thalictrum alpinum L.	Arctic meadowrue
Thalictrum sparsiflorum Turcz.	Few-flower meadowrue

Rosaceae

Dryas drummondii Richards.	Drummond mountain-avens
Dryas octopetala L.	White mountain-avens
Geum rossii (R. Br.) Ser.	Ross avens
Luetkea pectinata (Pursh) Ktze.	Luetkea
Potentilla biflora Willd.	Two-flower cinquefoil
Potentilla fruticosa L.	Shrubby cinquefoil
Potentilla hyparctica Malte	Arctic cinquefoil
Potentilla palustris (L.) Scop.	Marsh cinquefoil
Rosa acicularis Lindl.	Prickly rose
Rubus arcticus L.	Nagoon berry
Rubus chamaemorus L.	Cloudberry
Rubus idaeus L.	Raspberry
Rubus pedatus Sm.	Five-leaf bramble
Sanguisorba stipulata Raf.	Sitka burnet
Sibbaldia procumbens L.	Sibbaldia
Sorbus scopulina Greene	Western mountain ash
Spiraea beauverdiana Schneid.	Beauverd spirea

Rubiaceae

Galium boreale L.	Northern bedstraw
Galium trifidum L.	Small bedstraw

Salicaceae[c/]

Populus balsamifera L.	Balsam popular
Populus tremuloides Michx.	Quaking aspen
Salix alaxensis (Anderss.) Cov.	Feltleaf willow
Salix arbusculoides Anderss.	Littletree willow
Salix arctica Pall.	Arctic willow
Salix barclayi Anderss.	Barclay willow
Salix brachycarpa Nutt.	Barren-ground willow
Salix fuscescens Anderss.	Alaska bog willow
Salix glauca L.	Grayleaf willow
Salix lanata L. subsp. richardsonii (Hook) A. Skwortz.	Richardson willow
Salix monticola Bebb	Park willow
Salix novae-angliae Anderss.	Tall blueberry willow
Salix phlebophylla Anderss.	Skeletonleaf willow
Salix planifolia Pursh ssp. planifolia	Diamondleaf willow
Salix planifolia Pursh ssp. pulchra (Cham.) Argus	Diamondleaf willow
Salix polaris Wahlenb.	Polar willow
Salix reticulata L.	Netleaf willow
Salix rotundifolia Trautv.	Least willow
Salix scouleriana Barratt	Scouler willow
Salix sp.	Willow

Santalaceae

Geocaulon lividum (Richards.) Fern.	Sandalwood

Saxifragaceae

Boykinia richardsonii (Hook.) Gray	Richardson boykinia
Leptarrhena pyrolifolia (D. Don) Ser.	Leather-leaf saxifrage
Parnassia palustris L.	Northern Grass-of-Parnassus
Ribes triste Pall.	Red currant
Saxifraga bronchialis L.	Spotted saxifrage
Saxifraga davurica Willd.	Saxifrage
Saxifraga foliolosa R. Br.	Foliose saxifrage
Saxifraga hieracifolia Waldst. & Kit.	Hawkweed-leaf saxifrage
Saxifraga lyallii Engler	Red-stem saxifrage
Saxifraga oppositifolia L.	Purple mountain saxifrage
Saxifraga punctata L.	Brook saxifrage
Saxifraga serpyllifolia Pursh	Thyme-leaf saxifrage
Saxifraga tricuspidata Rottb.	Three-tooth saxifrage

Scrophulariaceae

Castilleja caudata (Pennell) Rebr.	Pale indian paintbrush
Pedicularis capitata Adams	Capitate lousewort
Pedicularis kanei Durand	Kane lousewort
Pedicularis labradorica Wirsing	Labrador lousewort
Pedicularis parviflora J. E. Sm. var. parviflora	Lousewort
Pedicularis sudetica Willd.	Lousewort
Pedicularis verticillata L.	Whorled lousewort
Veronica wormskjoldii Roem. & Schult.	Alpine speedwell

Umbelliferae

Angelica lucida L.	Wild celery
Heracleum lanatum Michx.	Cow parsnip

Valerianaceae

Valeriana capitata Pall.	Capitate valerian

Violaceae

Viola epipsila Ledeb.	Marsh violet

Nonvascular Plant Species

Lichens

Cetraria cucullata (Bell.) Ach.
Cetraria islandica (L.) Ach.
Cetraria nivalis (L.) Ach.
Cetraria richardsonii Hook.
Cetraria spp.
Cladonia alpetris (L.) Rabenh.
Cladonia mitis Sandst.
Cladonia rangiferina (L.) Web.
Cladonia spp.
Dactylina arctica (Hook.) Nyl.
Nephroma spp.
Peltigera spp.
Stereocaulon paschale (L.) Hoffm.
Thamnolia spp.

Mosses

Climacium sp.
Hypnum spp. and other feather mosses
Paludella squarrosa (Hedw.) Brid.[d]
Polytrichum spp.
Ptilium crista-castrensis (Hedw.) DeNot.
Sphagnum spp.
Rhacomitrium spp.

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a/ Vascular plant species nomenclature according to Hulten (1968) except where noted. Lichen nomenclature according to Thomson (1979). Moss nomenclature according to Conard (1979).

b/ Nomenclature according to Welsh (1974).

c/ Nomenclature according to Viereck and Little (1972).

d/ Nomenclature according to Crum (1976).

the field. The delineation of vegetation/habitat types does, therefore, require constant judgment as to the boundaries of each type. Another important factor that should be considered in using the maps is that there is a smallest mappable unit for each scale map. The smallest units which can be mapped for the 1:250,000 scale and 1:24,000 scale maps are approximately 16 hectares and 4 hectares, respectively. Some mapping units on the larger scale maps (1:24,000 and 1:63,360) are more specific than those on the smaller scale (1:250,000) but most are the same. The main differences resulted by eliminating complexes and delineating the forested areas by dominant tree species on the larger scale maps. Smaller areas could be delineated on the larger scale maps.

The Viereck and Dyrness (1980) preliminary classification was used for the mapping and offered a standard nomenclature which other studies on the Susitna project could also use and have reproducible results. Level III names were used in most cases. However, Level IV names were used for forested areas on the 1:24,000 and 1:63,360 maps. In most cases the key presented by Viereck and Dyrness (1980) was adequate for classification only at Levels I through III, presumably because the classification is preliminary and lacks sufficient information to consistently identify vegetation at Levels IV and V. Also, U-2 aerial imagery is not consistently interpretable at lower hierarchical levels in this preliminary classification. For these reasons, Level III was used.

The vegetation types which occurred, their total hectares, and the percent of area covered are reported in Table 3 (1:250,000) and Table 4 (1:24,000 scale maps); Table 4 gives the hectares and percentages for each reservoir. The Devil Canyon and Watana dam locations with pool elevations of 457 meters (1500 feet) and 671 meters (2200 feet), respectively were assumed in these area determinations.

Level I types (which are based predominantly on life forms) that occurred in the Upper Susitna River Basin were Forest, Tundra, and Shrubland (Table 3). Forest communities were those with at least 10% cover by tree species regardless of how tall the individual trees were. Shrubland communities had at least 25% cover of erect to decumbent shrubs but

Table 3

Hectares and percentage of total area covered by vegetation/habitat types on 1:250,000 scale map (Figure 3).

	Hectares	Percent of Total Area
Total Vegetation	1,387,607	85.08
Forest	348,232	21.35
Conifer	307,586	18.86
Woodland spruce	188,391	11.55
Open spruce	118,873	7.29
Closed spruce	323	0.02
Deciduous	1,290	0.08
Open birch	968	0.06
Closed birch	323	0.02
Mixed	39,355	2.41
Open	23,387	1.43
Closed	15,968	0.98
Tundra	394,685	24.20
Wet sedge grass	4,839	0.30
(Mesic) sedge grass	184,358	11.30
Herbaceous alpine	807	0.05
Mat and cushion	65,001	3.99
Mat and cushion/sedge grass	139,680	8.56
Shrubland	644,690	39.53
Tall shrub	129,035	7.91
Low shrub	515,655	31.62
Birch	33,549	2.06
Willow	10,645	0.65
Mixed	471,461	28.91
Unvegetated	243,392	14.92
Water	39,840	2.44
Lakes	25,162	1.54
Rivers	14,678	0.90
Rock	113,712	6.97
Snow and ice	89,841	5.51
Total Area	1,630,999	100.00

Table 4

Hectares of different vegetation types to be impacted compared with total hectares of those types in the entire Upper Susitna River Basin. Number in parentheses is the percent of the vegetation type as found in the entire Upper Basin.

	Impoundments		Borrow Areas					Upper Susitna River Basin
	Devil Canyon	Watana	A	C	D	F	H	
Woodland spruce	162 (0.09)	4766 (2.53)	228 (0.12)	77 (0.04)	15 (0.01)		227 (0.12)	188,391
Open spruce	862 (0.73)	3854 (3.24)	48 (0.04)	7 (0.01)			125 (0.11)	118,873
Open birch	73 (7.54)	318 (32.85)						968
Closed birch	470[a/]	491[a/]			1[a/]			323
Open conifer-deciduous	300 (1.28)	1329 (5.68)			19 (0.08)	9 (0.04)	94 (0.40)	23,387
Closed conifer-deciduous	758 (4.75)	869 (5.44)			2 (0.01)			15,968
Open balsam poplar	7[b/]							
Closed balsam poplar	10[b/]	2[b/]						
Wet sedge-grass	12 (0.25)	100 (2.07)	6 (0.12)		1 (0.02)			4,839
Mat and cushion tundra			78 (0.12)					65,001[c/]
Tall shrub	19 (0.01)	580 (0.45)	18 (0.01)	23 (0.02)	8 (0.01)			129,035
Birch shrub	58 (0.17)	474 (1.41)	18 (0.05)	92 (0.27)	73 (0.22)			33,549
Willow	16 (0.15)	55 (0.52)					7 (0.07)	10,645
Low mixed shrub	6 (+)	785 (0.15)	101 (0.02)	113 (0.02)	109 (0.02)	55 (0.01)	46 (0.01)	471,461
Lakes	1 (+)	47 (0.22)	3 (0.01)			1 (+)		21,162
Rivers	835 (5.69)	2106 (14.35)		10 (0.07)		6 (0.04)		14,678
Rock	14 (0.01)	63 (0.06)			1 (+)			113,712
Total areas	3603 (0.22)	15839 (0.97)	500 (0.03)	322 (0.03)	228 (0.01)	71 (+)	499 (0.03)	1,211,992

a/ Hectares of closed birch are apparently greater in the impact areas than for the entire basin, because the basin was mapped at a much smaller scale, and many of the closed birch stands did not appear at that scale.

b/ Balsam poplar stands were too small to be mapped at the scale of which the Upper Susitna River Basin was mapped.

c/ Total hectares of mat and cushion tundra are much greater than this, but many hectares were mapped as a complex with sedge-grass tundra.

were not located above or beyond the tree limit. Tundra stands were those communities found above or beyond the limit of trees and were dominated by shrub or herbaceous species.

Figure 3 illustrates the general overall distribution of different vegetation/habitat types, and Table 3 gives rough percentages for cover by each type. However, it should be remembered that much detail is lost at the relatively small scale of Figure 3. Figure 4, on the other hand, is larger scaled and allows inclusion of more detail, but it covers only a limited portion of the Upper Susitna River Basin, namely, the impact areas. Consequently, Table 4 is constructed to provide some indication of the cover of vegetation/habitat types within the impact areas relative to the total cover of those types across the entire basin. As alluded to above, however, there are some problems with this approach. For example, because closed birch forests were often too small to be delineated at the smaller scale (Figure 3), but were circumscribable at the larger scale (Figure 4), there is an apparent discrepancy in the total number of hectares of that type when computed from each map.

Overall, however, Figure 3 does give a fair description of the distribution and relative abundance of each vegetation/habitat type. Conifer forests cover approximately 19% of the basin. They occupy a wide range of sites, from the flood plains to the mountains, but they seldom occur above 975 m elevation.

Deciduous forests -- birch, aspen, and balsam poplar -- and mixed conifer - deciduous forests are much more restricted in distribution and together cover only 2.5% of the area. As can be seen from Figure 3, these vegetation/habitat types are found primarily on south facing slopes below 700 m elevation and in the Susitna River Valley below Devil Canyon. Balsam poplar stands, in particular, are found only on the flood plain (Figure 4).

Tundra vegetation/habitat types are generally located above or beyond the limit of forests. Approximately 24% of the basin is covered with tundra (Table 3). Roughly half of the tundra is dominated by mesic or wet sedge-grass vegetation/habitat types (Table 3). These generally occur in the mountainous regions of the basin (Figure 3). Closely associated with the mesic sedge-grass type is the mat and cushion tundra (Figure 3). Mat and cushion tundra and complexes of mat and cushion/sedge-grass tundra represent most of the remaining tundra situations (Table 3).

Shrubland is the largest overall group of vegetation/habitat types occurring in the Upper Susitna River Basin, covering almost 40% of the total area (Table 3). Thirty percent is covered by shrub birch and willow. These vegetation/habitat types are found at intermediate and low elevations throughout the basin, but primarily on the broad flat areas in the central, southern, and northeastern portions of the basin (Figure 3). Tall shrub, dominated by alder, is the other principle component of the shrubland, occupying approximately 8% of the basin. As can be seen from Figures 3 and 4, this type is found in steep terrain throughout the basin, and in large expanses at the western end of the basin near Portage Creek.

Unvegetated areas (15% of the total area) consist primarily of rock, snow, and ice, which are common at the highest elevations (i.e. the mountain types).

3.5 - Preliminary Vegetation/Habitat Type Descriptions

3.5.1 - Forest Types

Forest vegetation/habitat types were located at the lower elevations of the study area. The average elevation of sampled areas was 523 m. This type was divided according to the dominant tree types (conifer, deciduous, or mixed) and then by tree crown cover percent. Deciduous and conifer types had at least 75% of the tree cover provided by deciduous or conifer trees, respectively. The woodland type had between 10% and 25% tree cover and was only observed for conifer stands. Open stands contained 25% to 50% tree cover while closed stands had over 50% tree cover. The boundary percentage between open and closed types was chosen as 50% rather than the 60% that Viereck and Dyrness (1980) used since it was easier to estimate on the aerial photography and in the field. Field estimates were performed best from the air because the Venetian blind effect of the trees caused overestimates from the ground.

Conifer, deciduous, and mixed stands were observed in the field with open canopies while only deciduous and mixed stands with closed canopies were located in the field. One closed conifer area appeared on the aerial photography in the Lake Louise area but was not field checked. All forested stands had almost complete vegetation cover with 80% to 95% ground layer cover.

Spruce stands were dominated by white spruce (Picea glauca) or black spruce (Picea mariana) and contained a well-developed ground layer which accounted for most of the vegetation cover (Tables 5 and 6). Overstory provided almost one-fourth cover in open stands but was almost negligible in the woodland stands. Open stands contained trees at least several meters tall while woodland stands were usually a collection of scattered, stunted trees. Hence, open spruce had more overstory cover than woodland spruce. Shrub layer provided more cover in the woodland stands than in open stands (Tables 5 and 6).

Feather mosses covered as much ground as the trees in the open spruce stands (Table 5). Low shrubs, such as crowberry (Empetrum nigrum), northern Labrador tea (Ledum decumbens), bog blueberry (Vaccinium uliginosum), and mountain cranberry (Vaccinium vitis-idaea) accounted for much of the woody ground layer. Important herbaceous species included bluejoint (Calamagrostis canadensis)

Table 5

Cover percentages for total vegetation, vertical strata, and plant species in open conifer vegetation/habitat type[a] in Upper Susitna River Basin in summer 1980.

Category		Average Cover (%)[b]
Total vegetation		98
Overstory (>10 cm dbh)		24
Picea glauca	White spruce	24
Picea mariana	Black spruce	2
Understory (2.5 - 10 cm dbh)		10
Picea glauca	White spruce	3
Picea mariana	Black spruce	2
Shrub layer (>0.5 m tall, <2.5 cm dbh)		5
Picea glauca	White spruce	1
Picea mariana	Black spruce	3
Ground layer (≤0.5 m tall)		94
Mosses, unidentified		11
Feather mosses	Feather moss	29
Ptilium spp.		13
Empetrum nigrum	Crowberry	6
Ledum decumbens	Northern Labrador tea	5
Vaccinium uliginosum	Bog blueberry	7
Vaccinium vitis-idaea	Mountain cranberry	6
Equisetum arvense	Meadow horsetail	6
Equisetum silvaticum	Woodland horsetail	8
Linnaea borealis	Twinflower	8
Picea mariana	Black spruce	1
Calamagrostis canadensis	Bluejoint	14

[a] Number of areas sampled was 9.

[b] Includes only those species with at least 5% cover in any one area sampled.

Table 6

Cover percentages for total vegetation, vertical strata, and plant species in woodland conifer vegetation/habitat type[a/] in Upper Susitna River Basin in summer 1980.

Category		Average Cover (%)[b/]
Total vegetation		99
Overstory (>10 cm dbh)		1
Picea glauca	White spruce	
Understory (2.5 - 10 cm dbh)		12
Picea mariana	Black spruce	11
Shrub layer (>0.5 m tall, <2.5 cm dbh)		17
Picea mariana	Black spruce	15
Ground layer (≤0.5 m tall)		93
Feather mosses	Feather moss	5
Sphagnum spp.	Sphagnum moss	62
Empetrum nigrum	Crowberry	8
Ledum decumbens	Northern Labrador tea	5
Ledum groenlandicum	Labrador tea	5
Vaccinium uliginosum	Bog blueberry	23
Equisetum silvaticum	Woodland horsetail	10
Rubus arcticus	Nagoon berry	15
Rubus chamaemorus	Cloudberry	5
Picea mariana	Black spruce	3
Carex bigelowii	Bigelow sedge	7
Carex spp.	Sedge	6

a/ Number of areas sampled was 6.

b/ Includes only those species with at least 5% cover in any one area sampled.

and horsetails (Equisetum spp.). Open spruce stands were usually found on slopes or flatlands along the rivers at elevations averaging 487 m.

Woodland spruce stands had sphagnum mosses (Sphagnum spp.) as the most important species providing ground cover (Table 6). All woodland stands that were visited were black spruce. This vegetation/habitat type was usually found on the relatively level benches where soils were poorly drained. Average elevation of sampled areas was 620 m. Usually these trees were too small to qualify for the overstory layer, which requires trunks with >10 cm dbh. Maximum heights were less than 2 m in some areas. Important ground layer species included sedges (Carex spp.), woodland horsetail (Equisetum silvaticum), and low shrubs similar to those found in the open spruce stands. Slightly over 30 identified species were encountered in the woodland spruce vegetation/habitat type.

Woodland spruce sites graded into boggy areas where tree cover might be less than 10% and the vegetation resembled muskegs. Low birch shrub stands and woodland spruce were frequently difficult to distinguish in the field because birch stands sometimes had scattered trees which sometimes produced almost 10% cover. The small size of trees created similar textures on the aerial photography for woodland spruce and low birch shrub sites. These areas were difficult to distinguish on the photographs since they had similar colors (dark gray) and textures.

The structure of the layers for open black and white spruce stands was similar except that white spruce stands contained more overstory, a reflection of the generally larger size of white spruce trees (Tables 7 and 8). These units were mapped only on the 1:24,000 and 1:63,360 scale maps. The overstory in open white spruce stands was less variable among stands than was the overstory in black spruce stands. Maximum overstory heights of trees in open black spruce types varied from about 5 to 11 m while white spruce

Table 7

Cover percentages for total vegetation, vertical strata, and plant species in open black spruce vegetation/habitat type[a] in Upper Susitna River Basin in summer 1980.

Category		Average Cover (%)[b]
Total vegetation		96
Overstory (>10 cm dbh)		14
Picea glauca	White spruce	13
Picea mariana	Black spruce	5
Understory (2.5 - 10 cm dbh)		10
Picea glauca	White spruce	4
Picea mariana	Black spruce	5
Shrub layer (>0.5 m tall, <2.5 cm dbh)		7
Picea mariana	Black spruce	8
Salix spp.	Willow	2
Ground layer (<0.5 m tall)		93
Mosses, unidentified		34
Feather mosses	Feather moss	30
Cladonia spp.		7
Empetrum nigrum	Crowberry	14
Ledum decumbens	Northern Labrador tea	14
Vaccinium uliginosum	Bog blueberry	10
Vaccinium vitis-idaea	Mountain cranberry	15
Equisetum silvaticum	Woodland horsetail	12
Salix spp.	Willow	7
Picea mariana	Black spruce	4

a/ Number of areas sampled was 3.

b/ Includes only those species with at least 5% cover in any one area sampled.

Table 8

Cover percentages for total vegetation, vertical strata, and plant species in open white spruce vegetation/habitat type[a] in Upper Susitna River Basin in summer 1980.

Category		Average Cover (%)[b]
Total vegetation		100
Overstory (>10 cm dbh)		35
Picea glauca	White spruce	35
Understory (2.5 - 10 cm dbh)		11
Picea glauca	White spruce	3
Alnus sinuata	Sitka alder	6
Shrub layer (>0.5 m tall, <2.5 cm dbh)		4
Picea glauca	White spruce	1
Alnus crispa	American green alder	4
Rosa acicularis	Prickly rose	3
Ground layer (≤0.5 m tall)		94
Feather mosses	Feather moss	30
Ptilium spp.		24
Equisetum arvense	Meadow horsetail	11
Equisetum silvaticum	Woodland horsetail	6
Linnaea borealis	Twinflower	15
Betula glandulosa	Resin birch	6
Rosa acicularis	Prickly rose	5
Calamagrostis canadensis	Bluejoint	23

a/ Number of areas sampled was 5.

b/ Included only those species with at least 5% cover in any one area sampled.

stands reached heights of 20 m. Most of the black spruce tree cover was contained in the shrub layer while the white spruce cover was concentrated in the overstory layer. Black spruce stands contained low shrubs such as crowberry, northern Labrador tea, bog blueberry, and mountain cranberry in the ground layer, while prickly rose (Rosa acicularis) and bluejoint (Calamagrostis canadensis) were the most important ground layer species in open white spruce. Twin-flower (Linnaea borealis) was fairly important in the white spruce stands, but was not observed in the black spruce stands, possibly reflecting a preference for better-drained soils. Thirty to 35 identified species were encountered in each of these mapping units.

White spruce sites usually had better-drained soils than black spruce sites. Viereck (1970) reported that moss developed in white spruce stands and acted as an insulating layer on the soils. The soils became colder and permafrost developed. Black spruce was better adapted to cold soils than white spruce, so it replaced white spruce. As the permafrost develops and the soil became more poorly drained, black spruce vegetation was replaced by bog vegetation. Hence, vegetation in black spruce stands resembled bog or muskeg vegetation while the associated species in white spruce stands were more closely related to earlier deciduous successional stands. Apparently woodland black spruce and bogs alternate in temporal and spatial succession (Drury 1956). Observations in the Upper Susitna River Basin, particularly around Fog Lakes and Lake Louise, seemed to support this.

Viereck (1970) reported northern Labrador tea, Labrador tea (Ledum groenlandicum), bog blueberry, mountain cranberry, and sphagnum and feather mosses to be important species in black spruce stands along the Chena River in interior Alaska. These were also important in the Upper Susitna River Basin. However, crowberry, nagoonberry, and woodland horsetail were important in black spruce stands in our study but were not reported along the Chena River by Viereck (1970).

Meadow horsetail (Equisetum arvense) and feather mosses provided significant amounts of cover in white spruce stands along the Chena River (Viereck 1970) and in the Upper Susitna River Basin but bluejoint, twinflower, and Ptilium crista-castrensis were apparently more important along the Susitna River than along the Chena. Hettinger and Janz (1974) reported that feather mosses were important in the ground layer of white spruce stands in northeastern Alaska, which agreed with our results. However, they found crowberry to be an important species, but this accounted for less than 2% cover in the Susitna stands.

Among black spruce stands, those occupying significant slopes (8 - 10°) appeared to be more productive of browse species, and in fact, had noticeably greater use by moose. Browse production was low relative to other vegetation, but it had incurred heavy use, suggesting such stands may be important areas for cover during severe weather. Open black spruce stands on the flats were generally very poor in terms of forage production, but some caribou sign was present. Skoog (1968) considered this type to represent a good supply of terrestrial forage lichens for caribou in winter.

Deciduous forest vegetation usually had a greater overstory cover than spruce stands, possibly because an individual tree had more foliage cover. These types were restricted mostly to the steep banks and floodplain along the river. Elevations averaged 582 m with closed stands occurring at average elevations of 560 m and open stands at 625 m. They had almost complete vegetation cover and a well-developed ground layer. The overstory layer in closed stands covered almost three-fourths of the area but only about three-eighths in open stands (Tables 9 and 10). Overstory was sometimes 15 m tall. Neither the shrub layer nor the understory layer was of major importance. Important woody species in the ground layer in both types included crowberry, northern Labrador tea, bog blueberry, and mountain cranberry. Open stands appeared to have more woody cover in the ground layer than did the closed

Table 9

Cover percentages for total vegetation, vertical strata, and plant species in closed deciduous forest (birch and balsam poplar) vegetation/habitat type[a] in Upper Susitna River Basin in summer 1980.

Category		Average Cover (%)[b]
Total vegetation		99
Overstory (>10 cm dbh)		76
Picea glauca	White spruce	4
Betula papyrifera	Paper birch	54
Populus balsamifera	Balsam poplar	20
Understory (2.5 - 10 cm dbh)		7
Picea glauca	White spruce	3
Betula papyrifera	Paper birch	4
Populus balsamifera	Balsam poplar	1
Shrub layer (>0.5 m tall, <2.5 cm dbh)		5
Picea glauca	White spruce	2
Betula papyrifera	Paper birch	4
Populus balsamifera	Balsam poplar	1
Ground layer (≤0.5 m tall)		90
Ptilium spp.		26
Polytrichum spp.		5
Empetrum nigrum	Crowberry	9
Ledum decumbens	Northern Labrador tea	15
Vaccinium uliginosum	Bog blueberry	20
Vaccinium vitis-idaea	Mountain cranberry	10
Equisetum silvaticum	Woodland horsetail	5
Cornus canadensis	Bunchberry	38
Populus balsamifera	Balsam poplar	1
Calamagrostis canadensis	Bluejoint	19
Gymnocarpium dryopteris	Oak-fern	10
Mertensia paniculata	Tall bluebell	6

a/ Number of areas sampled was 4.

b/ Includes only those species with at least 5% cover in any one area sampled.

Table 10

Cover percentages for total vegetation, vertical strata, and plant species in open birch deciduous forest vegetation/habitat type[a/] in Upper Susitna River Basin in summer 1980.

Category		Average Cover (%)[b/]
Total vegetation		99
Overstory (>10 cm dbh)		38
Picea glauca	White spruce	3
Betula papyrifera	Paper birch	38
Understory (2.5 - 10 cm dbh)		6
Picea glauca	White spruce	1
Betula papyrifera	Paper birch	6
Shrub layer (>0.5 m tall, <2.5 cm dbh)		5
Picea glauca	White spruce	2
Betula papyrifera	Paper birch	2
Ground layer (≤0.5 m tall)		95
Polytrichum spp.		10
Ledum decumbens	Northern Labrador tea	20
Ledum groenlandicum	Labrador tea	12
Vaccinium uliginosum	Bog blueberry	30
Vaccinium vitis-idaea	Mountain cranberry	26
Cornus canadensis	Bunchberry	11
Rosa acicularis	Prickly rose	5
Picea glauca	White spruce	3

a/ Number of areas sampled was 2.

b/ Includes only those species with at least 5% cover in any one area sampled.

stands. Closed stands had more herbaceous components such as bunchberry (Cornus canadensis), bluejoint, and oak-fern (Gymnocarpium dryopteris). Approximately 16 identified species were encountered in open deciduous forest types while about 31 were found in closed deciduous forests.

Closed deciduous stands were further separated on the larger scale maps according to the dominant species: balsam poplar (Populus balsamifera) and paper birch (Betula papyrifera). Closed balsam poplar (Populus balsamifera) generally occurred on islands in the river or flat areas alongside the river. It was usually the first tree successional stage in vegetation development on alluvial deposits. The trees provided about three-fourths cover (Table 11). The ground layer was well developed and included bunchberry, crowberry, northern Labrador tea, bog blueberry, and mountain cranberry. These areas contained about 14 species which were encountered and identified.

Closed paper birch (Betula papyrifera) stands occurred on steep, usually south-facing slopes. The vertical layer structure is similar to the closed balsam poplar stands: three-fourths overstory, a well-developed ground layer, and relatively unimportant shrub and understory layers (Table 12). The most important ground layer species were bunchberry, bog blueberry, bluejoint, and oak-fern. Approximately 25 species were encountered and identified.

Closed trembling aspen (Populus tremuloides) stands were usually found on the upper portions of dry, south-facing slopes. These areas were rarely large enough to sample and were not large enough to map. The general structure was similar to other closed deciduous stands in that there were a well-developed overstory and and ground layer but insignificant shrub and understory layers (Table 13).

Hettinger and Janz (1974) reported mountain cranberry and bluejoint as major species in birch forest stands in northeastern Alaska,

Table 11

Cover percentages for total vegetation, vertical strata, and plant species in closed balsam poplar forest vegetation/habitat type[a/] in Upper Susitna River Basin in summer 1980.

Category		Average Cover (%)[b/]
Total vegetation		99
Overstory (>10 cm dbh)		
Picea glauca	White spruce	80
Populus balsamifera	Balsam poplar	75
Understory (2.5 - 10 cm dbh)		5
Populus balsamifera	Balsam poplar	5
Shrub layer (>0.5 m tall, <2.5 cm dbh)		10
Populus balsamifera	Balsam poplar	5
Ground layer (≤0.5 m tall)		85
Ptilium spp.		20
Polytrichum spp.		5
Empetrum nigrum	Crowberry	30
Ledum decumbens	Northern Labrador tea	40
Vaccinium uliginosum	Bog blueberry	40
Vaccinium vitis-idaea	Mountain cranberry	20
Cornus canadensis	Bunchberry	40
Populus balsamifera	Balsam poplar	1
Spiraea beauverdiana	Beauverd spiraea	5

a/ Number of areas sampled was 1.

b/ Includes only those species with at least 5% cover in any one area sampled.

Table 12

Cover percentages for total vegetation, vertical strata, and plant species in closed birch deciduous forest vegetation/habitat type[a/] in Upper Susitna River Basin in summer 1980.

Category		Average Cover (%)[b/]
Total vegetation		99
Overstory (>10 cm dbh)		73
Picea glauca	White spruce	8
Betula papyrifera	Paper birch	68
Understory (2.5 - 10 cm dbh)		9
Picea glauca	White spruce	5
Betula papyrifera	Paper birch	3
Shrub layer (>0.5 m tall, <2.5 cm dbh)		3
Picea glauca	White spruce	1
Betula papyrifera	Paper birch	3
Ground layer (≤0.5 m tall)		95
Ptilium spp.		15
Polytrichum spp.		5
Vaccinium uliginosum	Bog blueberry	15
Vaccinium vitis-idaea	Mountain cranberry	5
Equisetum silvaticum	Woodland horsetail	10
Cornus canadensis	Bunchberry	16
Calamagrostis canadensis	Bluejoint	38
Gymnocarpium dryopteris	Oak-fern	20
Mertensia paniculata	Tall bluebell	10

a/ Number of areas sampled was 2.

b/ Includes only those species with at least 5% cover in any one area sampled.

Table 13

Cover percentages for total vegetation, vertical strata, and plant species in closed aspen deciduous vegetation/habitat type[a] in Upper Susitna River Basin in summer 1980.

Category		Average Cover (%)[b]
Total vegetation		99
Overstory (>10 cm dbh)		80
Betula papyrifera	Paper birch	5
Populus tremuloides	Trembling aspen	80
Understory (2.5 - 10 cm dbh)		5
Betula papyrifera	Paper birch	5
Populus tremuloides	Trembling aspen	5
Shrub layer (>0.5 m tall, <2.5 cm dbh)		5
Picea glauca	White spruce	5
Betula papyrifera	Paper birch	5
Betula glandulosa	Resin birch	5
Rosa acicularis	Prickly rose	5
Salix spp.	Willow	5
Populus tremuloides	Trembling aspen	5
Ground layer (≤0.5 m tall)		85
Ptilium spp.		5
Polytrichum spp.		5
Ledum decumbens	Northern Labrador tea	20
Vaccinium uliginosum	Bog blueberry	10
Linnaea borealis	Twinflower	5
Cornus canadensis	Bunchberry	80
Mertensia paniculata	Tall bluebell	5
Epilobium angustifolium	Fireweed	5
Geocaulon lividum	Sandalwood	5
Spiraea beauverdiana	Beauverd spiraea	5
Vaccinium vitis-idaea	Mountain cranberry	10
Betula nana	Dwarf arctic birch	5
Viburnum edulis	Highbush cranberry	5
Lycopodium annotinum	Stiff clubmoss	5
Lycopodium clavatum	Running clubmoss	5

a/ Number of areas sampled was 1.

b/ Includes only those species with at least 5% cover in any one area sampled.

which was in agreement with the Susitna results. However, feather-mosses and alder shrubs which they also found to be important, were insignificant in the Susitna area. The undergrowth in the Susitna stands was taller than that pictured in Hettinger and Janz's (1974) publication. The Susitna stands contained bunchberry, northern Labrador tea, Labrador tea, and bog blueberry as important species which were not considered important in the other study. Both studies reported that birch stands occurred on disturbed sites with southern exposures.

The mixed conifer deciduous vegetation/habitat types had overstory cover intermediate between that for spruce stands and that for deciduous stands. Elevations for mixed conifer deciduous forests averaged 466 m with closed stands having a mean elevation near 425 m and open stands occurring around 482 m. Most of the larger stands occurred on slopes downstream from Tsusena Creek. These were probably successional stands which developed as spruce trees replaced deciduous trees. All observed stands were mixtures of paper birch and white spruce, but other types might exist. Cover in these vegetation/habitat types was almost complete with a well-developed ground layer containing important amounts of bluejoint, bunchberry, woodland horsetail, and Ptilium (Tables 14 and 15). Overstory cover in closed mixed stands was about 60% while that in open mixed stands was 38%. The height of the overstory was sometimes up to 20 m. The shrub layer was more important in the open stands, mostly as a result of tall blueberry willow (Salix novae-angliae). Bog blueberry was an important ground species in the open mixed stands. About 40 identified vascular plant species were encountered in open mixed stands while about 29 were found in closed mixed stands.

In general, the deciduous and the mixed conifer and deciduous forests appeared to represent a relatively poor forage resource for moose and caribou. This was particularly true in the closed stands. Steep slopes often associated with these types might be

Table 14

Cover percentages for total vegetation, vertical strata, and plant species in closed mixed conifer deciduous forest vegetation/habitat type[a/] in Upper Susitna River Basin in summer 1980.

Category		Average Cover (%)[b/]
Total vegetation		98
Overstory (>10 cm dbh)		60
Picea glauca	White spruce	33
Betula papyrifera	Paper birch	35
Understory (2.5 - 10 cm dbh)		8
Picea glauca	White spruce	3
Betula papyrifera	Paper birch	4
Shrub layer (>0.5 m tall, <2.5 cm dbh)		4
Picea glauca	White spruce	3
Ground layer (≤0.5 m tall)		88
Ptilium spp.		40
Empetrum nigrum	Crowberry	3
Vaccinium vitis-idaea	Mountain cranberry	8
Equisetum silvaticum	Woodland horsetail	24
Cornus canadensis	Bunchberry	13
Rubus arcticus	Nagoon berry	7
Calamagrostis canadensis	Bluejoint	30

a/ Number of areas sampled was 3.

b/ Includes only those species with at least 5% cover in any one area sampled.

Table 15

Cover percentages for total vegetation, vertical strata, and plant species in open mixed conifer deciduous forest vegetation/habitat type[a] in Upper Susitna River Basin in summer 1980.

Category		Average Cover (%)[b]
Total vegetation		100
Overstory (<10 cm dbh)		38
Picea glauca	White spruce	20
Betula papyrifera	Paper birch	12
Understory (2.5 - 10 cm dbh)		7
Picea glauca	White spruce	5
Betula papyrifera	Paper birch	1
Shrub layer (>0.5 m tall, <2.5 cm dbh)		17
Picea glauca	White spruce	2
Betula papyrifera	Paper birch	2
Salix novae-angliae	Tall blueberry willow	11
Ground layer (≤0.5 m tall)		79
Feather mosses	Feather mosses	18
Ptilium spp.		34
Empetrum nigrum	Crowberry	6
Ledum decumbens	Northern Labrador tea	6
Vaccinium uliginosum	Bog blueberry	16
Vaccinium vitis-idaea	Mountain cranberry	9
Equisetum silvaticum	Woodland horsetail	3
Cornus canadensis	Bunchberry	13
Picea glauca	White spruce	2
Calamagrostis canadensis	Bluejoint	11
Gymnocarpium dryopteris	Oak-fern	8

[a] Number of areas sampled was 8.

[b] Includes only those species with at least 5% cover in any one area sampled.

partially responsible for the low preference by ungulates as well. Natural records of browsing intensity, as indicated by the structure of paper birch suckers, suggested these types may incur heavy use in severe winters. Skoog (1968) stated that these types were little used by caribou at any time of the year. The frequency of berry-filled bear scats in this type in spring suggested it might be an important food resource for black bears as they come out of winter torpor. However, the open nature of the understory vegetation made sighting of fecal piles easier and positively biased comparison with other types.

Forested communities in the Upper Susitna River Basin were similar to those described by Viereck (1975). Black spruce generally occurred in wetter sites than white spruce while deciduous or mixed forests occurred on warmer sites. Closed forests occurred on warmer sites also. The drier of these closed sites were usually deciduous while the moister ones were mixed or dominated by spruce. Deciduous and mixed forest stands were considered earlier successional stages of the conifer stands (Viereck 1970, 1975, and Hettinger and Janz 1974).

Prickly rose was reported to be an important species in balsam poplar stands along the Chena River (Viereck 1970) and in northeastern Alaska (Hettinger and Janz 1974) as well as in white spruce stands along the Chena River (Viereck 1970). However, it accounted for less than 8% cover in open white spruce stands and less than 5% cover in the closed balsam poplar stands in the Upper Susitna River Basin.

3.5.2 - Tundra Types

Tundra communities usually occurred above the present limit of tree growth. Most of the well-vegetated communities occurred on flat to gently sloping areas while sparser vegetation occurred on steep or rocky terrain. Approximately 70 identified vascular plant species were encountered in these types. Four distinct subtypes occurred in areas large enough to map: wet sedge-grass tundra, mesic sedge-grass tundra, herbaceous alpine tundra, and closed mat and cushion tundra communities. Aspects of tundra vegetation/habitat types were variable.

Wet sedge-grass tundra communities occurred in wet, depressed areas with poor drainage at an average elevation of 587 m. They had almost complete total vegetation cover with most of it occurring in the ground layer (Table 16). Nineteen identified species were encountered. The most important herbaceous species were two species of sedge, especially water sedge (Carex aquatilis), bluejoint, and sphagnum as well as several other unidentified mosses. The shrub layer, when it was present, contained scattered individuals of willow (Salix spp.). Wet sedge-grass communities could potentially contain up to 10% cover of erect shrubs. There was usually a large amount of organic matter in these soils and sometimes there was a thick organic layer on top of mineral soil.

Mesic sedge-grass tundra generally occurred on rolling uplands with well-drained soils at an average elevation of 1372 m. In some areas the soils were well-developed, but in other areas the soil occurred as patches alternating with rocks. Nine identified species were encountered. Total vegetation cover was between half and three-fourths of the area (Table 17). All vegetation was low in the ground layer and usually less than 30 cm tall. Bigelow sedge (Carex bigelowii) was the most common species and accounted for almost half of the total vegetation cover.

Two types of herbaceous alpine tundra occurred in the Upper Susitna River Basin, although only one occurred in areas sufficiently large to map. The herb-sedge communities occurred at higher elevations near the glaciers, particularly the West Fork Glacier at an elevation of 1295 m, where there were gentle slopes of fairly well-drained soils which were relatively well developed. They were

Table 16

Cover percentages for total vegetation, vertical strata, and plant species in wet sedge-grass tundra vegetation/habitat type[a/] in Upper Susitna River Basin in summer 1980.

Category		Average Cover (%)[b/]
Total vegetation		99
Shrub layer (>0.5 m tall, <2.5 cm dbh)		13
Salix pulchra	Diamondleaf willow	8
Salix spp.	Willow	5
Ground layer (<0.5 m tall)		86
Mosses, unidentified		20
Sphagnum spp.	Sphagnum moss	22
Salix fuscescens	Alaska bog willow	5
Calamagrostis canadensis	Bluejoint	14
Carex aquatilis	Water sedge	38
Carex bigelowii	Bigelow sedge	23
Carex spp.	Sedge	

a/ Number of areas sampled was 3.

b/ Includes only those species with at least 5% cover in any one area sampled.

Table 17

Cover percentages for total vegetation, vertical strata, and plant species in mesic sedge-grass tundra vegetation/habitat type[a/] in Upper Susitna River Basin in summer 1980.

Category		Average Cover (%)[b/]
Total vegetation		65
Ground layer ($\leq$0.5 m tall)		65
Polytrichum spp.		5
Salix spp.	Willow	13
Carex bigelowii	Bigelow sedge	30
Carex spp.	Sedge	4

a/ Number of areas sampled was 2.

b/ Includes only those species with at least 5% cover in any one area sampled.

basically a mineral soil but contained about 5% organic matter. Some of the soil may have developed from loess blown from the glacier surface. Approximately 42 identified species were encountered in the one area that was visited. Vegetation cover was almost complete, but cover was dispersed evenly among the many species present so that no group of species dominated the area (Table 18). No estimates were made of cover because of the complexity of the vegetation. All vegetation occurred in the ground layer. The other type of herbaceous alpine community was found in small, isolated rocky areas that were too small to map or to sample. Small forbs and sometimes shrubs grew in the pockets of mineral soil imbedded between the rocks.

The fourth type of tundra community was the mat and cushion tundra which was found at higher elevations (1013 m) on dry, windy ridges. Vegetation covered about three-fourths of the area and was usually less than 20 to 30 cm tall (Table 19). Vegetation consisted predominantly of lichens and low mat-forming shrubs. Soils were shallow and coarse.

Diverse wildlife occupied the high elevation tundra communities in summer. Most obvious were caribou, black and brown bears, ptarmigan, hoary marmots, and arctic ground squirrels. Whimbrel pairs were frequently spotted here in early summer. Bear scats indicated over-wintered berries were the major attractant of bears in June although many squirrel dens were found which had been excavated by bears. Caribou were more frequently sighted in the sedge-grass tundra than in any other type. Skoog (1968) considered sedge-grass tundra to be important year-round range for caribou in this region. He considered mat and cushion tundra to be more important as a winter forage supply, since its wind swept condition generally kept it relatively snow-free.

Wet sedge-grass communities, more common below tree line, showed use by moose where browse was available. Otherwise, its importance was

Table 18

Plant species list in herbaceous alpine tundra in Upper Susitna River Basin in summer 1980.[a]

Category
Lycopodium alpinum
Polytrichum spp.
Salix polaris
Salix reticulata
Petasites frigidus
Rumex arcticus
Sanguisorba stipulata
Sedum rosea
Calamagrostis purpurascens
Carex bigelowii
Eriophorum angustifolium
Anemone narcissiflora
Diapensia lapponica
Luzula confusa
Luzula tundricola
Valeriana capitata
Aster sibiricus
Senecio atropurpeus
Saxifraga tricuspidata
Aconitum delphinifolium
Sibbaldia procumbens
Deschampsia caespitosa
Polygonum bistorta
Salix rotundifolia
Campanula lasiocarpa
Artemisia arctica
Myosotis alpestris
Cassiope tetragona
Lycopodium annotinum
Lycopodium selago
Boykinia richardsonii
Festuca rubra
Silene acaulis
Epilobium latifolium
Veronica wormskjoldii
Carex filifolia
Polemonium acutiflorum
Salix phlebophylla
Juncus sp.
Caltha leptosepala
Phleum commutatum
Equisetum sp.

[a] Number of areas sampled was 1.

Table 19

Cover percentages for total vegetation, vertical strata, and plant species in closed mat and cushion tundra vegetation/habitat type[a/] in Upper Susitna River Basin in summer 1980.

Category		Average Cover (%)[b/]
Total vegetation		78
Ground layer (<0.5 m tall)		78
Lichens, unidentified		14
Cladonia spp.		8
Empetrum nigrum	Crowberry	8
Ledum decumbens	Northern Labrador tea	7
Vaccinium uliginosum	Bog blueberry	8
Arctostaphylos spp.	Bearberry	7
Betula glandulosa	Resin birch	6
Betula nana	Dwarf arctic birch	10

a/ Number of areas sampled was 8.

b/ Includes only those species with at least 5% cover in any one area sampled.

more closely associated with wading birds and beaver, where topography allowed dam building. In many cases, the wet sedge-grass vegetation was likely the result of beaver activity.

3.5.3 - Shrubland Types

Shrubland vegetation/habitat types were the most prevalent types in the Upper Susitna River Basin. They generally occurred at higher elevations than forest communities but at lower elevations than tundra types. Most areas, particularly the low shrub, were found on extensive, fairly level benches at mid-elevations throughout the upper basin. Less extensive areas, usually tall shrub, were found on steep slopes above the river. Two main types were found: tall and low shrub with each being further divided into closed and open types by the percentage shrub cover. Approximately 65 identified species were encountered in this overall type. Aspects of the shrubland vegetation/habitat types were variable.

Tall shrub communities were dominated by alder (*Alnus sinuata*) and were found mostly on steep slopes above the river or sometimes above the flat benches with an average elevation of 573 m. Many of these stands were 2 to 4 m tall. Approximately 25 identified species were encountered in either the closed or open alder stands. Alder stands frequently occurred as stringers through other vegetation/habitat types along the slopes by the river. Many areas also contained alder as a ring around a mountain at a certain elevation or a strip along a river drainage as at Portage Creek. The closed stands had almost complete vegetation cover with the ground layer and understory each accounting for most of the cover (Table 20). Portions of some of these stands were like thickets. Alder provided the most cover with bluejoint and woodland horsetail accounting for most of the ground layer cover.

Only one open alder stand was visited, but it had less vegetation cover than the closed alder sites with most of the vegetation being

Table 20

Cover percentages for total vegetation, vertical strata, and plant species in closed tall alder vegetation/habitat type[a] in Upper Susitna River Basin in summer 1980.

Category		Average Cover (%)[b]
Total vegetation		96
Understory (2.5 - 10 cm dbh)		57
Alnus sinuata	Sitka alder	25
Alnus crispa	American green alder	32
Shrub layer (>0.5 m tall, <2.5 cm dbh)		38
Alnus sinuata	Sitka alder	28
Alnus crispa	American green alder	10
Ribes spp.	Currant	8
Ground layer (<0.5 m tall)		62
Equisetum silvaticum	Woodland horsetail	31
Ribes spp.	Currant	8
Alnus sinuata	Sitka alder	7
Calamagrostis canadensis	Bluejoint	35

a/ Number of areas sampled was 3.

b/ Includes only those species with at least 5% cover in any one area sampled.

in the understory layer (Table 21). Bluejoint was the most important ground layer species. White spruce was present in the overstory and understory. A mixture of alder with white spruce probably indicated that this was a successional stand.

Hanson's (1953) description of alder types was similar to those found in the Upper Susitna River Basin in that these thickets occurred on well-drained slopes and varied from 1- to 4-m tall. Bluejoint was a dominant ground layer species in many cases. Beauverd spiraea (Spiraea beauverdiana) and bog blueberry were also mentioned as important species. Hanson (1953) observed birch shrubs (Betula spp.) as an important species in alder stands, but the areas encountered along the Upper Susitna River Basin did not contain any observed birch shrubs. In contrast, the Susitna stands contained important quantities of woodland horsetail. Hettinger and Janz (1974) similarly observed that alder stands occurred on steeper slopes and older riparian sites.

Squirrel, hare, and moose signs were relatively prevalent in these stands. One alder stand located on a slope of the Susitna Canyon (R11E, T29N) was very heavily used by moose. Currant (Ribes spp.) appeared to be highly preferred browse in this stand. Willow was important browse in all stands, and certain individuals of American green alder (Alnus crispa) were heavily browsed.

Low shrub communities were found on the extensive relatively flat benches where soils were frequently wet and gleyed but usually lacking standing water (except for willow types). Average elevation was about 781 m. Over 40 identified species were encountered in this vegetation/habitat type. Subtypes included birch, willow, and a mixture of the two. Because of the gradations between the subtypes, descriptions were very general. Both open and closed stands had almost complete vegetation cover (Tables 22 and 23). The ground and shrub layers contributed similar amount of cover in closed stands while the ground layer provided most of the cover in the open communities. Shrub layer cover estimates might

Table 21

Cover percentages for total vegetation, vertical strata, and plant species in open tall alder vegetation/habitat type[a] in Upper Susitna River Basin in summer 1980.

Category		Average Cover (%)[b]
Total vegetation		85
Overstory (>10 cm dbh)		10
Picea glauca	White spruce	10
Understory (2.5 - 10 cm dbh)		45
Picea glauca	White spruce	5
Alnus sinuata	Sitka alder	40
Shrub layer (>0.5 m tall, <2.5 cm dbh)		10
Alnus sinuata	Sitka alder	10
Ground layer (≤0.5 m tall)		25
Linnaea borealis	Twinflower	5
Alnus sinuata	Sitka alder	5
Calamagrostis canadensis	Bluejoint	10

a/ Number of areas sampled was 1.

b/ Includes only those species with at least 5% cover in any one area sampled.

Table 22

Cover percentages for total vegetation, vertical strata, and plant species in closed low shrub vegetation/habitat type[a] in Upper Susitna River Basin in summer 1980.

Category		Average Cover (%)[b]
Total vegetation		93
Shrub layer (>0.5 m tall, <2.5 cm dbh)		42
Betula glandulosa	Resin birch	10
Salix pulchra	Diamondleaf willow	8
Ground layer (≤0.5 m tall)		52
Mosses, unidentified		17
Feather mosses	Feather moss	6
Empetrum nigrum	Crowberry	7
Ledum decumbens	Northern Labrador tea	18
Ledum groenlandicum	Labrador tea	4
Vaccinium uliginosum	Bog blueberry	8
Vaccinium vitis-idaea	Mountain cranberry	8
Arctostaphylos rubra	Red-fruit bearberry	6
Betula glandulosa	Resin birch	34
Betula nana	Dwarf arctic birch	9

a/ Number of areas sampled was 10.

b/ Includes only those species with at least 5% cover in any one area sampled.

Table 23

Cover percentages for total vegetation, vertical strata, and plant species in open low shrub vegetation/habitat type[a/] in Upper Susitna River Basin in summer 1980.

Category		Average Cover (%)[b/]
Total vegetation		100
Shrub layer (>0.5 m tall, <2.5 cm dbh)		17
<u>Betula glandulosa</u>	Resin birch	5
Ground layer ($\leq$0.5 m tall)		83
Feather mosses	Feather moss	13
<u>Ledum groenlandicum</u>	Labrador tea	5
<u>Vaccinium uliginosum</u>	Bog blueberry	15
<u>Betula glandulosa</u>	Resin birch	15
<u>Carex aquatilis</u>	Water sedge	43

a/ Number of areas sampled was 2.

b/ Includes only those species with at least 5% cover in any one area sampled.

be high because of problems in estimating cover from the ground, the same problem encountered in the forest types.

Birch shrub stands were usually dominated by resin birch (Betula glandulosa) about 1.0 m tall and contained several other species of low shrubs, especially northern Labrador tea. Mosses contributed an important amount of cover. In some stands, there was a buildup of soil and debris around the bases of each birch shrub clump creating a large amount of microrelief. Sometimes the stands were dense like a thicket while others had large openings between individual birch shrubs. Scattered black spruce occurred in some stands contributing almost 10% cover. Hence, low shrub and woodland black spruce stands were difficult to distinguish on the ground and on the aerial photography. The two species of birch shrub, resin (Betula glandulosa) and dwarf arctic birch (B. nana), were sometimes difficult to distinguish based on leaf shape and plant height. Viereck (1966) commented on this problem, also.

Willow stands were usually found in wetter areas, frequently with standing water. Water sedge was the important herbaceous species in these stands. Because of the wetness, these communities were usually less diverse than birch shrub stands. Willows frequently had soil and debris built up at their bases also with standing or running water in the troughs.

Birch shrub communities apparently received moderate use by moose most of the year. However, it was obvious that stands with more willow were preferred. Indeed, willow stands received greater use than any other vegetation type. Feltleaf willow (Salix alaxensis) and diamondleaf willow (S. planifolia) were heavily utilized in most areas.

Caribou sign were also frequent in birch communities. Skoog (1968) found that leaves of resin birch were important food for caribou in summer, and in winter, lichens were important. He found that caribou feed on willows in spring and fall and considered willow stands important to the ecology of caribou. We agree with this, but specify that this is apparently true only for stands found above the rim of the river canyon.

Low shrub vegetation/habitat types were common in northwestern (Hanson 1953) and northeastern Alaska (Hettinger and Janz 1974) as well as in the Upper Susitna River Basin. The most important associated species in the birch shrub stands was bog blueberry while mosses and lichens contributed large amounts of cover. Crowberry was also common in all three studies as well as Viereck's (1966) study on the Muldrow Glacier. The birch-willow type which Hanson (1953) described is 2 to 3 m or more tall, while Susitna birch-willow stands were usually less than 1.5 m tall. Birch shrub stands near the Muldrow Glacier in the Interior were 1.0 to 1.5 m tall (Viereck 1966), which was similar to the Susitna stands. Similar associated species included northern Labrador tea and bog blueberry (Hanson 1953 and Hettinger and Janz 1974). Mountain cranberry was important in northeastern Alaska and the Susitna area, but not in the northwestern part of the state.

3.5.4 - Herbaceous Types

Two herbaceous types also existed but were not described on field reconnaissance sheets. Grasslands dominated by bluejoint were present on level to sloping areas at lower elevations along the river and along the Portage Creek drainage. Herbaceous pioneer communities were present on gravel and sand bars that had recently become vegetated. These soils had little organic matter and often had a large amount of cobbles. Pioneer species included horsetails (*Equisetum* spp.), lupines (*Lupinus* spp.), and alpine sweetvetch (*Hedysarum alpinum*).

3.5.5 - Unvegetated Types

There are three classes of unvegetated areas depicted on the maps: water, rock, and snow and ice. Lakes and streams were included in the water category. Lakes were generally found along flat benches and ranged in size from small ponds to large lakes such as Big Lake. Rock was those areas of bedrock or deposited geologic materials which had little or no vascular vegetation growing on or in them. Rock occurred as outcroppings at high elevations or along steep cliffs along the river or as unconsolidated gravel in newly deposited river bars. Snow and ice include permanent snowfields and glaciers. Glaciers and permanent snowfields were most common at the northern end of the study area in the Alaska Range although some did occur near the southern boundary in the Talkeetna Mountains.

3.6 - Wetlands

3.6.1 - Identification and mapping of wetlands

Recently, the U. S. Fish and Wildlife Service adopted (USF&WS 1980) the wetland classification system described by Cowardin et al. (1979). The primary purpose of this classification is to provide a basis for conducting inventory and evaluation of wetland portions of ecosystems, so they can be managed more logically. The classification was not designed to define the jurisdiction of government agencies (USF&WS 1980). As Cowardin et al. (1979) state, "There is no single, correct, indisputable, ecologically sound definition of wetlands, primarily because of the diversity of wetlands and because the demarcation between dry and wet environments lies along a continuum".

With the above in mind, we attempted to use the classification of Cowardin et al. (1979) to map and classify the wetlands within the proposed impoundment areas and floodplain below the Devil Canyon dam site to Talkeetna. However, it was apparent that many of the wetland classes given by this classification could not be identified solely from aerial photography. Specifically, we could not classify riverine or most lacustrine systems without on-ground sampling of bottom and shore materials. Consequently, these were classified simply as lake, pond, river, or stream. Table 24 lists the wetland classes and corresponding vegetation types (from Viereck and Dyrness 1980) by the landscape that was actually mapped.

The map of wetlands (Figure 5, see accompanying maps) does not delineate all the wetlands occurring in the area, nor are the boundaries precise which are given. This is in part due to restrictions imposed by scale (many wetlands are smaller than what can be legibly mapped), but is also due to the fact that boundaries are graded and obscure, even when viewed from the ground. The Alaska District Corps of Engineers (1979) encountered the same problems when they attempted to map much of the wetlands of the same area in 1979. They concluded that detailed maps would have been "extremely difficult" to produce, because the wetlands are highly integrated with non-wetlands, and because plant species composition in wet and non-wetlands is similar, differing only in the quantities of individuals. Additionally, they, as we, found that many non-wetland areas can contain free water. This was especially true during the unusually wet summer of 1980.

3.6.2 - Vascular Aquatic Plants

3.6.2.1 - Introduction

The objective of this study was to assess the aquatic vascular plants growing within the adjacent to ponds and lakes in the area

Table 24

Vegetation and wetland classes found in the proposed Susitna impoundment and borrow areas.

Mapping Unit (Viereck & Dyrness 1980)	FWS Wetland Class (Cowardin *et al*. 1979)
Lakes, ponds	Lacustrine unconsolidate bottom, aquatic bed, unconsolidated shore
Rivers, streams	Riverine Upper Perennial rock bottom, unconsolidated bottom, rocky shore, unconsolidated shore
Wet sedge-grass	Palustrine or Lacustrine emergent
Low shrub	Palustrine scrub-shrub
Birch shrub	Palustrine scrub-shrub
Willow shrub	Palustrine scrub-shrub
Open black spruce	Palustrine forested
Woodland black spruce	Palustrine forested
Open white spruce	Palustrine forested
Closed white spruce	Palustrine forested
Open balsam poplar	Palustrine forested
Closed balsam poplar	Palustrine forested

of study. The area of study extended from Devil Canyon to the confluence of the Oshetna River. Selected ponds and lakes within the impoundment area as well as on the adjacent upland plateau areas were evaluated. Twenty-four lakes and ponds were assessed from the ground (Figure 6). Helicopter overflights were made of many of the remaining lakes and ponds in the area to ensure similarity among ponds and to search for new species.

During each ground stop the species growing within and adjacent to the body of water were recorded. Notes were kept on the types of species encountered (floating, submergent, etc.) and where the species commonly occurred (bank, shallows, deep water, etc.).

The species were divided into "true" aquatics and "bank" species. Although there is no good definition of aquatic plants, "true" aquatic plants are defined here as those growing directly in water or immediately adjacent to water. Species that dominated the banks or periphery of the ponds or that frequently occurred on floating mats were considered "bank" species. All the species recorded are considered hydrophytes.

For each species a subjective evaluation was made as to whether it was dominant, common, or sparse in each area in which it was found. Total estimated cover of aquatic vegetation (relative to the total amount of water), surrounding wetland width, and elevation were also recorded for each water body assessed.

The wetland area, as defined here, is primarily restricted to the wet sedge-grass tundra type presented in the vegetation/habitat cover maps, or the Lacustrine-Limnetic-Emergent Wetland-Vascular wetland class of Cowardin et al. (1979).

The Susitna River itself and its tributaries were not specifically assessed for aquatic plants. Because of the high velocity of the tributaries and the velocity and sediment load of the mainstream Susitna, they are nearly devoid of aquatic vascular plants.

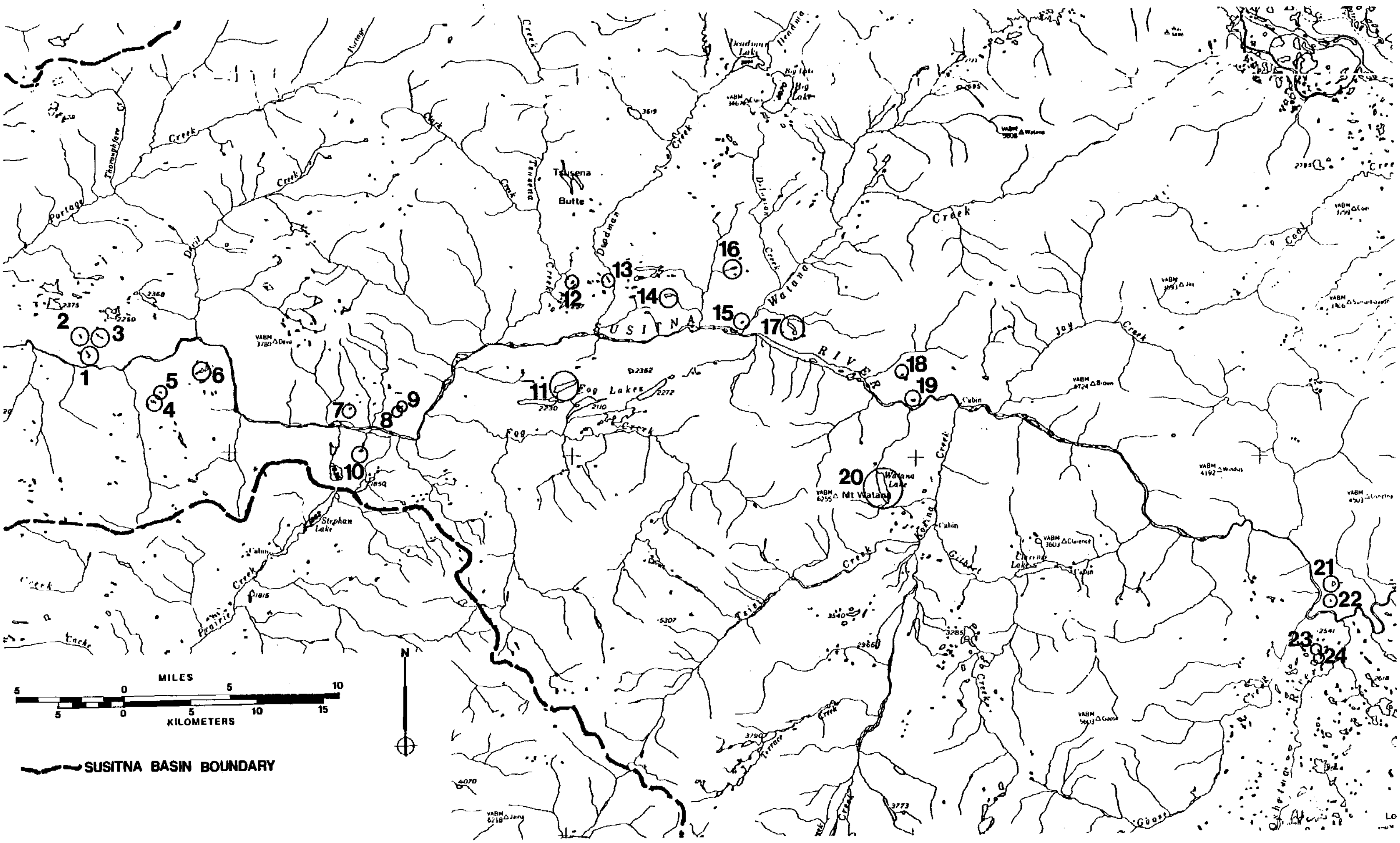


Figure 6

Locations of lakes and ponds surveyed for vascular aquatic plants in August 1980.

3.6.2.2 - Results and Discussion

There are very few ponds and lakes within the impoundment areas. Most of the water bodies occur on the upland plateau between the edge of the river canyon and the surrounding mountain. There are a countless number of lakes in the large flats of the Upper Susitna Basin, such as those in the southeastern portion of the upper basin in the Lake Louise area. Most of the lakes and ponds immediately adjacent to the impoundment area are classified according to Cowardin et al. (1979) as: Lacustrine-Limnetic-Unconsolidated Bottom or Aquatic bed; or Lacustrine-Littoral-Aquatic Bed or Unconsolidated Bottom.

The dominant "true" aquatic species of the water bodies were: horsetail (*Equisetum fluviatile*), bur reed (*Sparganium angustifolium*), sedge (*Carex aquatilis*), yellow pond lily (*Nuphar polysepalum*), mare's tail (*Hippuris vulgaris*), and bladderwort (*Utricularia vulgaris*) (Table 25).

Bur reed and yellow pond lily probably contributed more to total cover than all other species combined. Yellow pond lily, which is a submerged species with large floating leaves, was particularly prominent and formed vast beds in several water bodies. It did not occur along the edges of ponds, but appeared to grow best at depths ranging from 0.6 to 2.1 m. As a result, a band of yellow pond lily frequently occurred around the lake away from the shore in the area between the shallows and deep water. Bur reed, on the other hand, frequently dominated the shallows of the ponds which were about 0.15 to 0.60 m in depth. Horsetail, mare's tail, and bladderwort were also common in these shallows. Horsetail was common on rocky bottoms where little other vegetation occurred. Bladderwort appeared to be more prominent in shallows with a mud bottom or a bottom of organic matter.

Dominant "bank" or edge species included: horsetail, reed bent grass (*Calamagrostis canadensis*), cotton grass (*Eriophorum* spp.),

Table 25

Aquatic Plant Survey, Susitna Hydroelectric Project, August 1980

SPECIES	Pond or Lake (#)																							
"TRUE" AQUATICS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Climacium sp. -- Moss															d[a]				c					
Isoetes muricata -- Quillwort											s													
Equisetum fluviatile -- Horsetail	d	d	d					c										d				s		s
Sparganium angustifolium -- Bur reed	c	d	d	d			d			d	d	c	d	c		c	d	s			s	c	c	c
Potamogeton sp. -- Pondweed (narrow-leaved)		c					c	s																
Potamogeton sp. -- Pondweed (broad-leaved)								s										s				c		d
Potamogeton Robbinsii -- Pondweed																				d				
Potamogeton filiformis -- Pondweed																			s		s			
Eriophorum spp. -- Cotton grass																		s						
Carex aquatilis -- Sedge	d	d			c	c		d	d								c	d						
Nuphar polysepalum -- Yellow pond lily		c				d	d	d	d	d	c	d	d	d		d	c		d		d	d	d	d
Ranunculus confervoides -- Buttercup		c		d		d		s		s					s	s								
Potentilla palustris -- Marsh fivefinger										s														
Callitriche verna -- Water starwort															d									
Hippuris vulgaris -- Mare's tail							c			c	s				d		c		c		s	s		s
Menyanthes trifoliata -- Buckbean																							s	
Utricularia vulgaris -- Bladderwort											c	d		c		c	d	d			s		s	d

a. d=dominant, c=common, s=sparse

Table 25 (Cont')

SPECIES	Pond or Lake (#)																						
"BANK" SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
															(a)									
Sphagnum spp. -- Sphagnum moss															c	d							d	
Equisetum fluviatile -- Horsetail		d	d					d		s														
Woodsia sp. -- Woodsia												s												
Calamagrostis canadensis -- Reed bent grass				d	d			d		c							c							s
Eriophorum spp. -- Cotton grass				d	d	c			d			d	d	c				s			d		c	
Carex sp. -- Sedge						d							d								d			
Carex aquatilis -- Sedge		d	d	d	d	d	d	d	d	d		d	s	d	d	d	d	d		d	d	d	d	
Carex rhyncophysa -- Sedge			s														c							
Iris setosa -- Iris		s																						
Salix sp. -- Willow					c							s												s
Potentilla palustris -- Marsh fivefinger				c	d		c	c		d		c			c	d	c	s	s			c	d	c
Andromeda polifolia -- Andromeda					c																			
Menyanthes trifoliata -- Buckbean		s						c		c			d								s		c	

a. d=dominant, c=common, s=sparse

Table 25 (Cont.')

	Pond or Lake (#)																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Total Cover (%)	<1	<5	– (b)	0-1	–	–	10-20	<5	–	0-5	0-1	1-5	1-2	80-90	80-100	50-60	1-5	0-1	5-10	40-50	15	20-30	20-35	10-20
Surrounding Wetland Width (Meters)	0	2-3	–	3-6	6-9	3-6	3-6	2-9	–	15-30	0-3	15-25	3-5	15-30	15-25	30-45	3-15	1-2	2-3	0	6-9	12-15	3-6	2-3
Elevation (Feet)	1950	1700	2300	2300	2180	2180	2800	1950	1950	1975	2300	2280	2410	2340	1850	2300	2060	2750	1800	3000	2250	2560	2575	2560

b. data not recorded

sedge (Carex aquatilis), marsh fivefinger (Potentilla palustris) and buckbean (Menyanthes trifoliata). Sedge probably contributed more to total cover than all other edge species combined. It was the prevalent species of the pond shallows from about 0 - 0.3 m in depth, along the pond periphery, and also on floating mats, which were sometimes present.

The same species were encountered in many of the water bodies of the area. The one exception was the aquatic vegetation of Watana Lake. This lake was dominated solely by pondweed (Potamogeton Robbinsii). This pondweed is a submerged rooted aquatic species that grew in water from about 1.2 to 2.4 m in depth. Hulten (1968) reports that this species is known from his area of study, but it has only been collected once at Summit. Welsh (1974) indicates that it is known from southcentral Alaska, but evidently rare. The reason for the lack of other vascular plants in Watana Lake and the presence of Potamogeton Robbinsii is not understood; although at 914 m elevation, this lake had the highest elevation of any water body assessed.

Total cover of aquatic vegetation and the width of the surrounding emergent wetland area varied from pond to pond (Table 25). Total cover appeared to vary depending upon the proportionate amount of open water (in general, more than 2.1 m in depth) to shallow water present in each pond. The higher the percent of shallow water the greater the area that sufficient light could penetrate to the bottom and, as a result, the higher the cover of aquatic plants. This trend is valid in general, although lakes and ponds above 945 m in elevation usually had sparse aquatic vegetation cover regardless of the bottom morphology. Rocky substrate and rock ledges also appeared to limit the amount of aquatic vegetation cover.

The amount of associated emergent wetland area, which was dominated by sedge and other common bank species, appeared to be related to surrounding topography, bottom morphology and the age of the water body. Steep slopes or topographic relief around the water body limited the amount of associated emergent wetland. Ponds in depressions in relatively flat terrain had a well developed associated wetland around them. Organic matter developed as the water bodies became older and probably increased the periphery area dominated by emergent wetlands. A floating mat of vegetation was sometimes a part of the associated emergent wetland. These mats developed over a layer of water and were dominated by sedge, sphagnum moss, and common bank species.

A summary of the dominant aquatic species and factors influencing their location in and around many of the water bodies in the Upper Susitna Basin is presented in Figure 7. The existence and size of each zone indicated varies from pond to pond, although the general trends of the area are presented.

3.7 - Endangered, Threatened, Rare, and Noteworthy Species

3.7.1 - Endangered, Threatened, and Rare Species

No plant species are presently officially listed for Alaska by federal or state authorities as endangered or threatened, however 37 species are currently under review by the U. S. Fish and Wildlife Service (USF&WS 1980) for possible protection under the Endangered Species Act of 1973. A recent publication by Murray (1980) discusses the habitat, distribution, and key traits of most of these species.

A list of species (Table 26) extracted from Murray (1980) was believed to be the most likely plants of this category to be found in the Susitna River drainage, and in the landscape modified by the construction of the proposed dams and hydroelectric power plants. Since the upper reaches of the drainage were expected to be the least impacted, the major portion of the survey was devoted to the

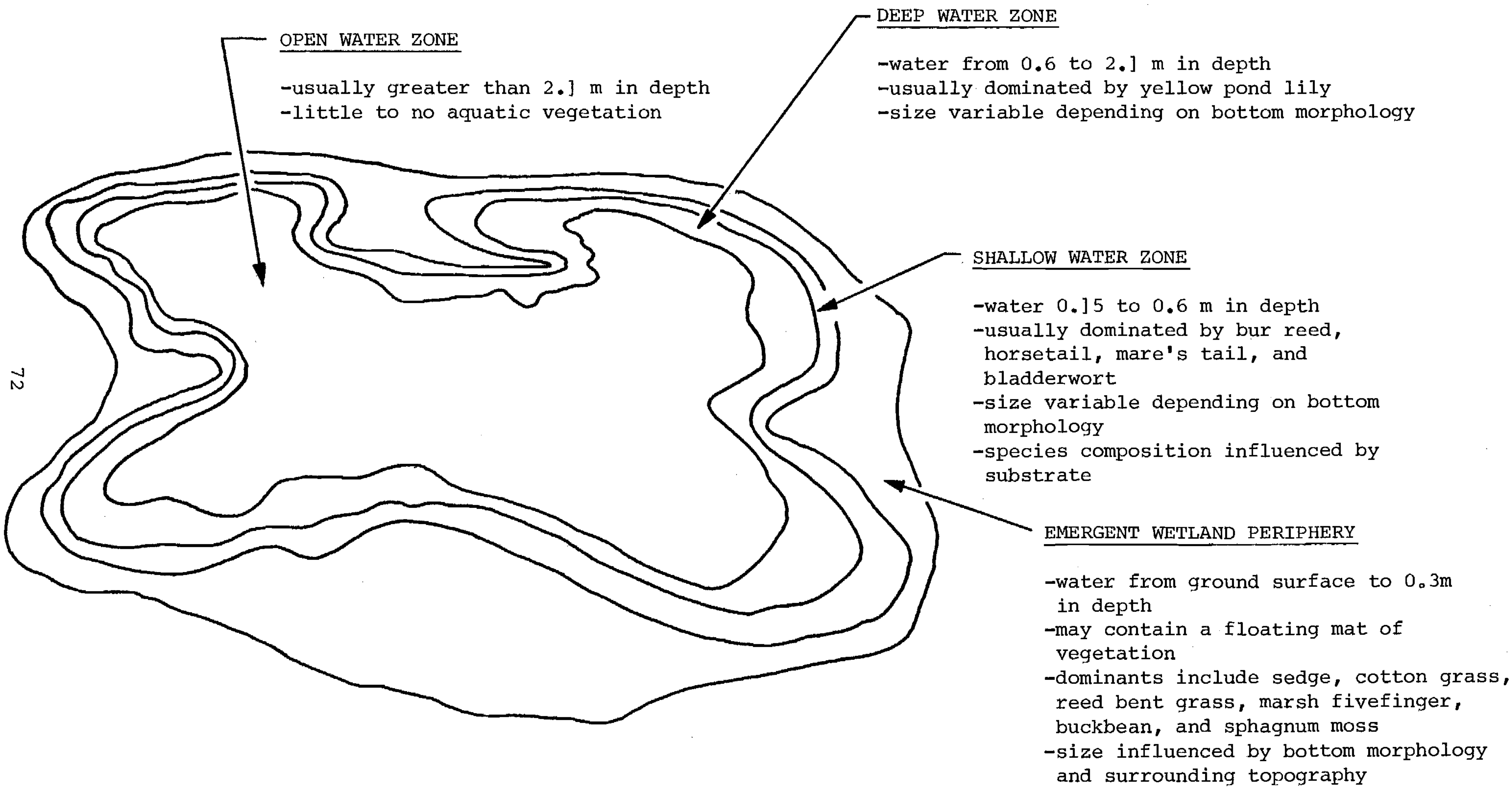


FIGURE 7

A SCHEMATIC REPRESENTATION OF THE DOMINANT VEGETATION ASSOCIATED WITH MANY OF THE LAKES AND PONDS OF THE UPPER SUSITNA BASIN.

Table 26

List of endangered and threatened plant species[a/] sought in the August 1980 survey.

Species and Habitat	Unofficial Status[b/]
Smelowskia pyriformis Drury & Rollins North American endemic calcareous scree, talus, in upper Kuskikwim R. drainage	Threatened species
Aster yukonensis Cronq. North American endemic river banks, dry streambeds, river delta sands and gravels Kluane Lake, Koyukuk River.	Endangered species
Montia bostockii (A. E. Porsild) S. L. Welsh North American endemic wet, alpine meadows, St. Elias Mtns., Wrangell Mtns.	Endangered species
Papaver alboroseum Hult. Amphi-Beringian well-drained alpine tundra, Wrangell Mtns., St. Elias Mtns. Cook Inlet lowlands, Alaska Range	Endangered species
Podistera yukonensis Math & Const. North American endemic S. facing rocky slopes, grasslands at low elevations, Eagle area, Yukon border	Endangered species
Smelowskia borealis (Greene) Drury & Rollins var. villosa North American endemic alpine calcareous scree, Mt. McKinley Park, Alaska Range	Endangered species
Taraxacum carneocoloratum Nels. North American endemic alpine rocky slopes, Alaska Range, Yukon Olgilvie Mtns.	Endangered species
Other Endangered Species Possibilities:	
Cryptantha shackletteana	Upper Yukon River
Eriogonum flavum var. aquilinum	Eagle, Alaska
Erysimum asperum var. angustatum	Upper Yukon River

a/ Species information and status from Murray (1980).

b/ All species, except Papaver alboroseum, are under review by the U.S. Fish & Wildlife Service for possible protection under the Endangered Species Act of 1973.

study of potential habitats in and around the impoundments. The general habitat requirements and occurrence of these plant species were known from a previous taxonomic and ecological study in Alaska, and from information given by Hulten (1968).

Field searches were made in potential habitats in August 1980. The late date of the survey may have made the detection of the species difficult although all are perennials, and the late vegetative stages should have still been present in the phytomass.

The field survey was conducted in three main areas: 1) the upper drainage basin, alpine areas near the Susitna and West Fork Glaciers, 2) the lowlands of the upper drainage basin, Maclaren and Tyone Rivers, ridges, terraces, and periglacial features, and 3) the lower drainage, outcrops, and promontories along the Susitna River near Watana Creek, Kosina Creek; and gravel bars in the river bed.

As several of the endangered species and the only threatened species (Smelowskia pyriformis) favored well-drained, rocky or scree slopes, this habitat was surveyed in the steep valleys adjacent to the Susitna and West Fork Glaciers, Figure 8. Typical alpine tundra vegetation prevailed on most of the scree slopes studied.

A helicopter and foot survey was made of the upper basin of the Susitna drainage and its tributaries. These rivers meander widely in this area and are re-working glacial-fluvial deposits. There are numerous lakes and ox-bow ponds, and periglacial features are abundant. Well-drained, sandy and gravelly ridges and terraces in this area would provide suitable habitat for several of the species being sought (Table 24). None of the endangered and threatened plant species were found in the upper basin lowland survey which was not exhaustive in extent considering the large area involved. Additional field work may be justified in this area.

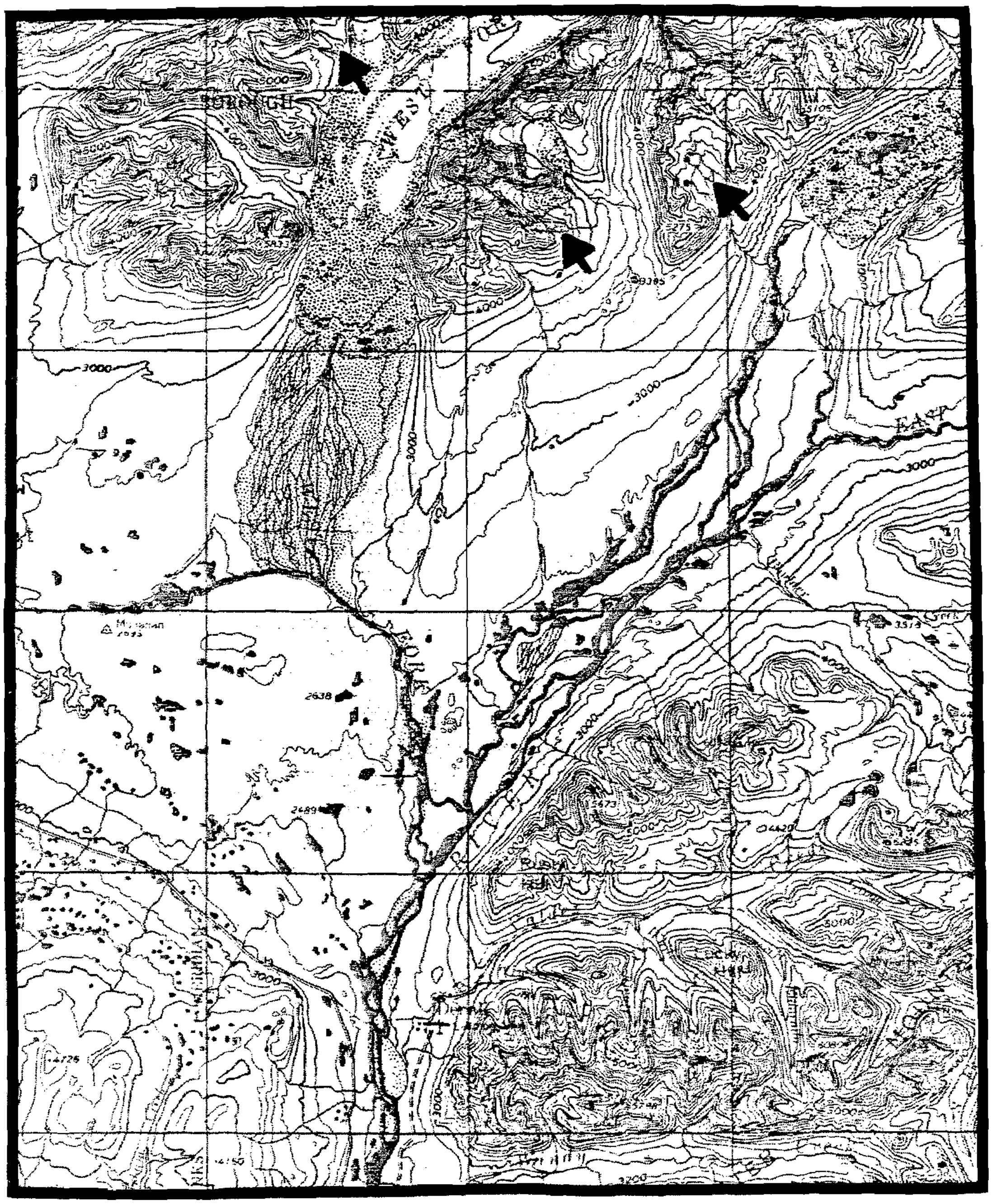


Figure 8
Areas surveyed for threatened and endangered species in the Susitna-West Fork Glacier area.

The major portion of the endangered and threatened plant survey was conducted in the Susitna River drainage adjacent to and upstream from the Watana Camp site to the confluence of the Susitna River and the Oshetna River. A trip was made downstream as far as Devil Canyon and two large gravel bars within the river bed were surveyed. These gravel bars are rather vigorously eroded and the vegetation is primarily confined to the dense growth of spruce, hardwoods, shrubs, and grasses on the stable, elevated portion of the bar. Few invader species were observed on bare gravel and silt.

Since several of the species being sought were recognized calciphiles, calcareous rock materials were surveyed from geologic maps of the area. Field tests were made with 10% hydrochloric acid which indicates by effervescence the presence of free carbonates. The included maps (Figures 8 and 9) show the locations of the outcrops surveyed in the Watana Creek-Oshetna River area with calcareous outcrops being indicated, and the alpine areas surveyed.

Three calcareous areas were found in the survey, one of which was indicated on the geologic maps consulted. The first calcareous area encountered was on the northwest slopes of Mt. Watana at an altitude of approximately 1128 m. An outlier ridge with light colored rock outcrops in this area and a report of marine fossils in the area made it a likely habitat for calciphilic species. The light gray rocks on this ridge gave a positive test for carbonates and two recognized calciphiles were found in the area, Saxifraga oppositifolia and Rhododendron lapponicum. None of the plant species on the endangered or threatened list were found.

The second calcareous outcrop encountered in the survey of potential habitats in which the endangered and threatened species might be found was located on the south side of the Susitna River, just east of the confluence of Kosina Creek and the Susitna River. A series of low, grey domes occur on the westfacing slope of an unnamed prominence at an elevation of 1006 m (Figure 9). These

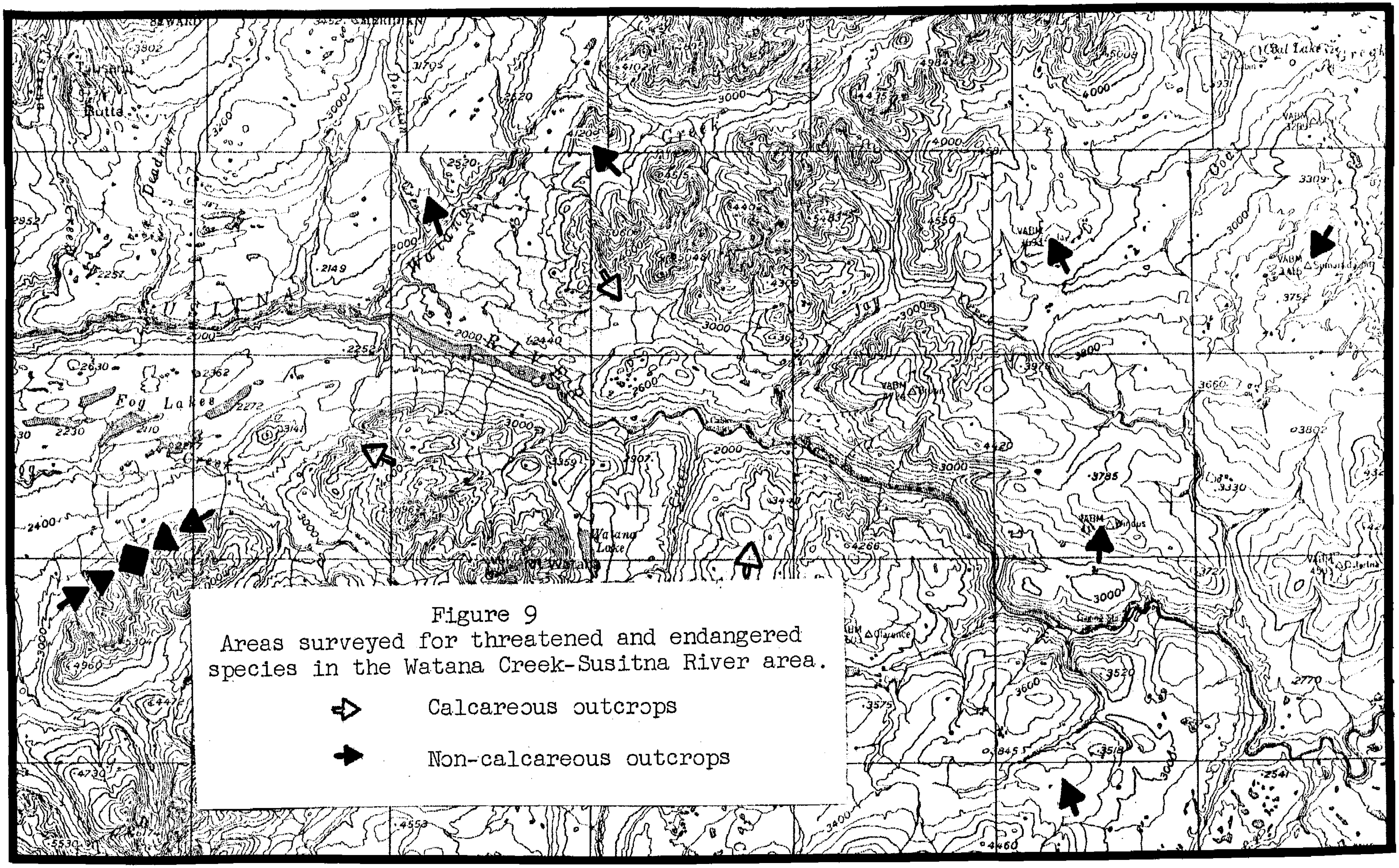


Figure 9
Areas surveyed for threatened and endangered species in the Watana Creek-Susitna River area.

Calcareous outcrops

Non-calcareous outcrops

domes of calcareous rock were apparently distinct from the main mass of rocks composing the main peak which was acidic by test. The Kosina Creek calcareous area had several calciphilic species such as Saxifraga oppositifolia and Rhododendron lapponicum. A sterile collection of Taraxacum was collected adjacent to the largest calcareous dome and it is the only potential representative of the threatened and endangered species group encountered in the 1980 survey. A third calcareous prominence was encountered in the survey of peaks in the middle Susitna River drainage. This area is on the north side of the Susitna River, on the west side of Watana Creek, approximately 7.24 km west of the creek at an altitude of 671 m. No threatened species were observed on the gravelly domes in this area.

In summary, the only plant species observed and collected during 1980 which could have belonged to any of the endangered or threatened taxa was a collection of Taraxacum made near Kosina Creek on calcareous rocks and soils. This site was at an elevation of 1006 m, and is far above any possible impact from the impoundments.

3.7.2 - Noteworthy Species

Twenty-one vascular plant species were encountered during the summer of 1980 in the Upper Susitna River basin which were outside the ranges indicated by Hulten (1968) (Table 27). Some of these species may have been reported in the area in the 12 years since Hulten's publication. Some of these range extensions are the result of more intensive botanical surveys in the area while some may represent an actual enlargement of the range for some species.

Because the Upper Susitna River drainage is not extremely well-represented in existing plant collections, range extensions, and some new records may be expected from any botanical surveys in the area. The Upper Susitna River drainage may represent a unique

Table 27

Vascular plant species in the Upper Susitna River Basin which are outside their range as reported by Hulten (1968).

Equisetum fluviatile
Lycopodium selago ssp. selago
Lycopodium complanatum
[a] Picea mariana
Carex filifolia
Danthonia intermedia
Luzula wahlenbergii
Veratrum viride
Plantanthera convallariaefolia
Plantanthera hyperborea
Echinopanax horridum
Senecio sheldonensis
[a] Myrica gale
Ranunculus occidentalis
Potentilla biflora
[a] Rubus idaeus
Rubus pedatus
Galium triflorum
Pedicularis kanei kanei
Pedicularis parviflorus
Potamogeton robbinsii

[a] Viereck and Little (1972) include the Upper Susitna River Basin in the range of this species.

phytogeographic region in that the lowlands habitats of the Cook Inlet and Talkeetna River valley extend into the upper basin of the Susitna drainage and make contact with the arctic-alpine habitats and flora of the Alaska Range. Alpine habitats close to maritime locations in central Alaska have unique assemblages of plant species, especially those called the amphi-Beringian floristic element. A representative example of this floristic type may be seen at Hatcher Pass in the Talkeetna Mountains.

Two of these species represent significant range extensions: Senecio sheldonensis and Danthonia intermedia. S. sheldonensis had not previously been reported in the state except possibly in the Skagway area (Hulten 1968). Our specimen was collected in a mesic midgrass community in August near upper Portage Creek, but has not yet been verified. There is at least one other informal report of the species occurring in the study area. Welsh (1974) reports that the species occurs in the southern Yukon and northern British Columbia.

Danthonia intermedia was found in August in the grass portion of a mosaic of low birch and grass communities in the low shrub areas between the Maclaren River and the Denali Highway. Previous recordings of the species occurred near the upper end of Cook Inlet and the Skagway area (Hulten 1968). Moreover, the only other representative of the genus in the state, D. spicata, has only been reported from near Ketchikan. This would represent a significant extension of the genus although D. intermedia was found in only the one location in our study area. Welsh (1974), on the other hand, reports the occurrence of D. intermedia in southcentral Alaska with no specific locations mentioned.

Potamogeton robbinsii, a submerged rooted aquatic was found in Watana Lake. There has been limited collection of this species in Alaska. Hulten (1968) reports it from his area of study, but it has only been collected once at Summit. Welsh (1974) indicates that it is known from southcentral Alaska, but evidently rare.

The distribution of Picea mariana should also be noted since Hulten (1968) includes areas north and south of the Upper Susitna River in the range, but does not include the study area. Viereck and Little (1972), however, do include the Susitna drainage in their distribution map. This tree is one of the most common species in the study area.

Most other species on the list represent only slight range extensions. Most of these are extensions to the north (more inland) from their previous observations. Plantanthera hyperborea and Myrica gale extensions include sites between areas that were previously included in the range. Potentilla biflora and Pedicularis kanei Durand kanei extensions were south of the previously reported range. Both of these species were found on calcareous outcroppings (Kosina Creek and Mt. Watana, respectively) while looking for endangered species. These species are probably more adapted to the drier environment associated with the interior or with calcareous outcroppings in the Upper Susitna River Basin.

4 - IMPACT ASSESSMENT

4.1 - Construction Impacts

Assuming the plan developed by the U. S. Army Corps of Engineers (1978), it is obvious that the major impact of the Susitna Hydroelectric Project on vegetation will be the elimination of area from different vegetation/habitat types. The hectares of each vegetation/habitat type to be impacted are presented in comparison with the total hectares of those types in the entire Upper Susitna River Basin (Table 4).

If proposed maximum pool elevations are required, the Devil Canyon (1500 ft elevation) and Watana (2200 ft elevation) reservoirs will inundate 3603 and 15,885 ha of area respectively; 2753 and 13,669 ha, respectively, are vegetated (Table 4). A total of 18,109 ha of vegetation will be lost if all borrow areas (outside the impoundment areas) are also totally utilized. Borrow sites may eventually be revegetated, however. The 18,109 ha of impacted vegetation represents roughly 1.2% of the total vegetated area in the Upper Susitna River Basin.

Assuming maximum impact in the impoundment and borrow areas, the vegetation/habitat types which will be lost (and the apparent % each is of the total available in the entire basin) are presented in Table 4. As discussed in Section 3.4 Preliminary Vegetation/Habitat Type Maps, problems created by comparing maps of two different scales resulted in apparent percentages of overlap which are highly inflated for the comparison of birch forests in the impact areas with that of their availability in the overall basin. However, it can safely be said that birch forests will be substantially impacted by the project, relatively more so than any other vegetation/habitat type. The only other types which would receive relatively substantial impact are open and closed conifer-deciduous forests and open and closed balsam poplar stands.

The access road or railroad will destroy an additional 150-300 ha of vegetation, depending on the route selected, and assuming access is from one direction only and 30 m wide roadbed. Three-hundred hectares is roughly equal to 0.02% of the vegetation in the entire basin. The primary vegetation types to be affected are mat and cushion tundra, sedge-grass tundra, birch shrubland and woodland spruce. Preliminary observations indicate that the alternative routes are well below the elevation where potential threatened or endangered species might occur.

The impact these losses of vegetation will have on the food supply for wildlife can only be hypothesized or extrapolated from the literature. The principal losses of vegetation impactment for large mammals will likely be in terms of reduced berry supply for black bears and reduced browse for moose. Skoog (1968) did not consider vegetation/habitat types to be of much value for caribou when located on the steep sides or bottoms of the Susitna River canyon.

Our own observations suggest that the berry resources which will be inundated may be of primary importance to the black bears in early spring. South-facing slopes of the canyon are the first to become free of snow, at which time, much of the previous year's berry crop is available to bears coming out of winter torpor.

The impact of the Devil Canyon reservoir on moose browse supply would probably be minimal since the topography is steep and receives relatively light use by moose. The impact of the Watana reservoir could be more substantial, not only because it is larger, but because it also receives at least moderate use by moose. It is not yet clear whether or not this area is critical to overwintering moose. Ballard (1980) states that moose use of the Watana Creek area occurred prior to March in winter (1979-1980). In early November 1980, willow stands along Watana Creek and portions of the Susitna River within the Watana impoundment area had already been heavily browsed by moose. In both years, temperatures were higher than normal in November, and in early November 1980 snow accumulations were light. Consequently, it appears that browse supplies in the bottoms of the Susitna River Canyon and its tributaries may already be depleted before they would have much value as a browse reserve in late winter or during severe winters. Additional information on moose populations and impact is provided in the annual reports produced by ADF&G and Dr. Richard Taber.

4.2 - Operation Impacts

4.2.1 - Impoundment Areas

The Susitna Hydroelectric Project is located in a region of discontinuous permafrost. Consequently, we believe there is potential for large earthflows and slumps, especially on north-facing slopes, as the relatively warm reservoirs thaw adjacent permafrost. This type of disturbance will most likely occur on black spruce sites and may lead to their replacement, in places, by alder stands and possibly open paper birch stands. Bank erosion may also result from wave action and altered subsurface drainage.

4.2.2 - Downstream Floodplain

Impacts on the downstream floodplain have not been adequately considered since vegetation studies are not planned for that area until summer 1981. Preliminary thoughts are that the impacts on vegetation will be relatively slight in the reach from Devil Canyon to the Chulitna River, because this portion of the river is channelized most of its length, and aerial photography indicates relatively little variations in area affected by fluctuating water levels. Comparisons of 1951 aerial photography (1:4000 scale) with 1980 photographs (1:4000 scale) indicates very little shifting of banks or islands during the past 30 years.

Downstream from the Chulitna River to Delta Islands, considerably more shifting of the river has occurred. In this reach plant communities are in more varied stages of succession; the effects of fluctuating water levels are apparently greater. However, the extent to which moderated flows of the Susitna River, above the Chulitna River, affect the periodicity and intensity of flooding in the lower portion will need to be determined before we can appropriately predict impacts on the vegetation.

5 - MITIGATION

5.1 - Avoidance

Some vegetation in the vicinity of access roads, ancillary facilities and reservoir facilities could likely be protected from damage during the environmental studies and construction. This will require planning and regulation of unnecessary activities, especially those involving heavy machinery and ATV use during summer and fall.

5.2 - Compensation

Vegetation in the impoundment areas will obviously be erased. However, some access-road cuts, borrow areas, or other ancillary facilities may be revegetated upon completion of construction. Natural revegetation may be adequate in most cases. Indeed, the current philosophy of those connected with pipeline development in Alaska is that natural revegetation is desirable, providing soils with suitable physical and chemical properties are in place where revegetation is to occur. Often, fertilization is all that is needed before good natural revegetation will occur. The apparent utility of this approach, coupled with the fact that Native ownership of part of the lands prefers revegetation to be natural, makes this approach most desirable. However, there may be some sites where potential wind or water erosion or aesthetic considerations would require more intensive revegetation practices, involving mulching and/or reseeding with native or introduced species.

There appears to be good potential for increasing forage supplies in areas adjacent to Watana Creek. We found considerable evidence suggesting that past wildfires had stimulated growth of willow and birch species. These areas have since received heavy use by moose.

Of all the vegetation types in the Watana Creek area, we believe that woodland and open spruce stands hold the greatest potential for moose habitat development, because, in their climax condition, they are relatively unproductive of most kinds of wildlife habitat. Black spruce stands reverted to an early successional stage would not necessarily be the most valuable habitat of those already existing, but they would represent the type with the least tradeoff in type conversion.

Much more work is needed to determine which kinds of sites would show the best response to manipulation. If fire should be the tool used to bring about a type conversion, then conditions should be determined which result in the greatest removal of overlying moss and provide for good establishment of desirable plant species.

Compensation for moose browse which may be lost along the floodplain downstream from the Devil Canyon dam site appears to have the greatest potential of any compensatory action. There, removal of later successional vegetation (i.e. mature balsam poplar and spruce stands) might effectively be accomplished through logging and/or fire. Indeed, we suspect that more moose browse could be produced than is currently growing there. Winter timber harvest and burning of slash could likely pay its own way.

These types of habitat manipulation have not been studied on forest lands in southcentral Alaska other than to document the effects of wildfires. Consequently, a number of small test burns and clearings would be highly advantageous for establishing which techniques and conditions are most effective. Also, it will be important to determine the extent to which other animal species might be displaced through this type of habitat manipulation.

6 - REFERENCES

Floristic/Botanical Works:

Argus, G. W. 1973. The genus Salix in Alaska and the Yukon. National Museum of Natural Sciences Publications in Botany, No. 2. Ottawa. 279 p.

Batten, A. R., D. F. Murray, and J. C. Dawe. 1979. Threatened and endangered plants in selected areas of the BLM Fortymile planning unit, Alaska. BLM-Alaska Tech. Rep. 3. 127 p.

Conard, H. A. 1979. How to know the mosses and liverworts. Wm. C. Brown Co., Philadelphia. 302 pp.

Crum, H. 1976. Mosses of the Great Lakes forest. University Herbarium, U. of Michigan, Ann Arbor. 104 pp.

*Hulten, E. 1968. Flora of Alaska and neighboring territories. Sanford University Press. 1008 p.

*Murray, D. F. 1980. Threatened and endangered plants of Alaska. USDA For. Serv. Pub. 59 p.

Thomson, J. W. 1979. Lichens of the Alaskan arctic slope. U. of Toronto Press. 314 pp.

*Viereck, L. A. and E. L. Little, Jr. 1972. Alaska trees and shrubs. Agric. Handbook No. 410. USDA For. Serv. 265 p.

*Welsh, S. L. 1974. Anderson's flora of Alaska and adjacent parts of Canada. Brigham Young University Press, Provo, Utah. 724 p.

Plant Ecology/Succession:

Auclair, A. N. and F. G. Goff. 1975. Intraspecific diameter differentiation as a measure of species replacement potential. Can. J. For. Res. 4(4):424-434.

Bliss, L. C. and J. E. Cantlon. 1957. Succession on river alluvium in northern Alaska. Am. Midland Naturalist 58(2):452-469.

Clements, F. E. 1934. The relict method in dynamic ecology. J. Ecol. 22:1-68.

*Drury, W. H., Jr. 1956. Bog flats and physiographic processes in the Upper Kuskokwim River regions, Alaska. Contrib. Gray Herb. Harvard Univ. 130 p.

Dyksterhuis, E. J. 1958. Ecological principles in range evaluation. Bot Review 24:253-272.

*Gatto, L. W., C. J. Merry, H. L. McKim, and D. E. Lawson. 1980. Environmental analysis of the Upper Susitna River Basin using LANDSAT imagery. U. S. Army Cold Regions Research and Engineering Lab., Report CRREL 80-4, Hanover, N. H., 56 p.

Goff, F. G. 1968. Use of size stratification and differential weighting to measure forest trends. Am. Midland Naturalist 79(2):402-418.

*Hanson, H. C. 1953. Vegetation types in northwestern Alaska and comparisons with communities in other arctic regions. Ecology 34:111-140.

Haug, P. T. and G. M. Van Dyne. 1968. Secondary succession in abandoned cultivated fields: An annotated bibliography. ORNL-TM-2104. p. 1-70. (Oak Ridge National Laboratory, Oak Ridge, Tenn.)

Hegg, K. M. 1970. Forest resources of the Susitna Valley, Alaska. USDA For. Serv. Pub. PNW-32.

Henry, J. D. and J. M. A. Swan. 1974. Reconstructing forest history from live and dead plant material: An approach to the study of forest succession in southwest New Hampshire. Ecology 55(4):772-783.

*Hettinger, L. R. and A. J. Janz. 1974. Vegetation and soils of northeastern Alaska. Arctic Gas Biol. Rep. Ser. 21. North Eng. Serv., Co., Ltd, Edmonton, Canada. 206 p.

Itow, S. 1963. Grassland vegetation in uplands of western Honshu, Japan. Part II. Succession and Grazing Indicators. Japanese J. of Bot. 18(2):133-167.

Leeuwen, G. G. 1966. A relation theoretical approach to pattern and process in vegetation. Wentia 15:25-46.

*Mueller-Dubois, D. and H. Ellenberg. 1974. Aims and methods of vegetation ecology. John Wiley and Sons, New York. 547 p.

Pichi-Sermolli, R. E. 1948. An index for establishing the degree of maturity in plant communities. J. Ecol. 36:85-90.

Spenceley, A. P. 1973. The effect of the stratification of vegetation on the analysis of successional data. J. Ecol. 61(3):767-773.

*Viereck, L. A. 1966. Plant succession and soil development on gravel outwash of the Muldrow Glacier, Alaska. Ecol. Monogr. 36:181-199.

*Viereck, L. A. 1970. Forest succession and soil development adjacent to the Chena River in interior Alaska. Arctic and Alpine Research 2(1):1-26.

*Viereck, L. A. 1975. Forest ecology of the Alaska Taiga. Proc. Circumpolar Conf. on Northern Ecology, 1975.

*Viereck, L. A., J. Foote, C. T. Dyrness, K. Van Cleve, D. Kane, and R. Seifert. 1979. Preliminary results of experimental fires in the black spruce type of interior Alaska. USDA For. Serv. Pub. PNW-332.

Whitford, P. B. 1949. Distribution of woodland plants in relation to succession and clonal growth. Ecology 30:199-208.

Zedler, P. H. and F. G. Goff. 1973. Size association analysis of forest successional trends in Wisconsin. Ecol. Monogr. 43(1):79-94.

Remote Sensing:

Hironaka, M., E. W. Tisdale, and M. A. Fosberg. 1976. Use of satellite imagery for classifying and monitoring rangelands in southern Idaho. Forest, Wildlife, and Range Exp. Sta. Bull. No. 9. University of Idaho.

McKendrick, J. D. and P. C. Scorup. 1974. A super bird's eye view of Alaska. Agroborealis 6(1):26-30.

*Payne, D. P. 1975. Introduction to aerial photography for natural resource management. Oregon State University Press. 324 p.

Poulton, C. E. 1971. Inventory and analysis of natural vegetation and related resources from space and high altitude photography annual progress report. Calif. Univ., Berkeley Forestry Remote Sensing Laboratory, U. S. Forest Service.

Vegetation Classification/Mapping:

*Alaska District Corps of Engineers. 1979. Wetlands survey of the Watana and Devil Canyon dam sites. Dept. of the Army, Anchorage, Alaska.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. USF&WS Pub. FWS/BS-79/31.

*Joint Federal-State Land Use Planning Commission of Alaska. 1973. Major ecosystems of Alaska (map).

Kuchler, A. W. 1967. Vegetation mapping. Ronald Press, New York.

Kuchler, A. W. 1964. Where is what? Bio-Science 14(7):39-41.

McCormick, J. 1978. Ecology and regulation of freshwater wetlands. IN: Freshwater Wetlands:Ecological Processes and Management Potential (R. E. Good, D. F. Whigham, and R. L. Simpson, eds.), p. 341-355. Academic Press, New York.

*Mueller-Dubois, D. and H. Ellenberg. 1974. Aims and methods of vegetation ecology. John Wiley and Sons, New York. 547 p.

*Payne, D. P. 1975. Introduction to aerial photography for natural resource management. Oregon State University Press. 324 p.

Sochava, V. 1975. The content of vegetation maps and how to enrich it. XII International Botanical Congress, Section 8, Ecological Botany. Paper for Presentation at Symposium: Logical Principles of Construction and Improvement of Information Content of Vegetation Maps.

*Spetzman, L. A. 1963. Terrain study of Alaska, Part V: Vegetation. Engineer Intelligence Study. Office, Chief of Engineers, Dept. of the Army, Washington, D.C. (map).

*U. S. Fish and Wildlife Service, 1980. Notice. Federal Register, Vol. 45, No. 193.

*Viereck, L. A. and C. T. Dyrness. 1980. A preliminary classification for vegetation of Alaska. Pacific N. W. Forest and Range Exp. Sta., Gen. Tech. Rep. PNW-106. 38 p.

*Walker, D. A., P. J. Webber, and V. Komarkova. 1979. A large scale (1:6000) vegetation mapping method for northern taiga. Institute of Arctic and Alpine Research. Unpublished manuscript. 48 p.

Other:

*Ballard, W. 1980. Upstream moose studies. Quarterly Report, Susitna Hydroelectric Project, Environmental Studies.

*Rost, G. R. and J. A. Bailey. 1979. Distribution of mule deer and elk in relation to roads. J. Wildl. Manage. 43(3):634-641.

Skoog, R. O. 1968. Ecology of the caribou in Alaska. Ph.D. Dissertation. University of California, Berkeley.

*U. S. Army Corps of Engineers. 1978. Plan of study for Susitna hydro power feasibility analysis. U. S. Army Corps of Engineers, Alaska District.

*Wallmo, O. C., D. F. Reed, and L. H. Carpenter. 1976. Alteration of mule deer habitat by wildfire, logging, highways, agriculture, and housing developments, p. 37-47. IN: Mule deer decline in the West -- a symposium. Utah Agric. Exp. Sta. Pub. 134 p.

*Ward, A. L. 1979. Dispersed recreation impact on big game resource. IN: Dispersed recreation and natural resource management -- a symposium. College of Natural Resources, Utah State University, Logan. (in press).

* References actually cited in this report.

7 - AUTHORITIES CONTACTED

Federal Agencies:

Bureau of Land Management
Anchorage, Alaska

Steve Talbot, Ecologist
- Letter from B. Collins 29 Sept. 1980; request of plant species list of Watana Mtn. area.

Paula Krebs, Remote Sensing Specialist
- Telephone call from B. Collins 9 July 1980; request for preliminary vegetation map of the Denali study.

Forest Service (Forest and Range Exp. Station)
Anchorage, Alaska

Fred Larson, Research Forester
- Visit from B. Collins and P. Scorup 8 May 1980; requesting cooperative agreement for inventory and analysis of plant communities in the upper Susitna basin.

Forest Service (Forest and Range Exp. Station)
Fairbanks, Alaska

Leslie Viereck, Plant Ecologist
- 21 May 1980; met with B. Collins (in Anchorage at ALMCTF meeting) to discuss need for a hierarchical classification of Alaska vegetation.

Soil Conservation Service

Weymeth Long, Director of State Office
- 15 May 1980; hand delivered letter of cooperative agreement to obtain approval for cooperative study of vegetation in upper Susitna basin.

Agricultural Stabilization and Conservation Service
Salt Lake City, Utah

Lola Britton, File Manager
- 6 May 1980, 21 July 1980; orders for CIR imagery of the upper Susitna basin.
- 19 Feb 1980; telephone call from J. McKendrick to discuss availability of CIR imagery covering upper Susitna basin.
- 10, 11, 18 June 1980; telephone calls from B. Collins arranging for CIR imagery.

Fish and Wildlife Service
Kenai, Alaska

Wayne Regelin, Research Biologist

- 27 May 1980; visit from B. Collins and J. McKendrick discussing techniques for assessment of moose browse production and utilization.

State Agencies:

Alaska Dept. of Fish and Game

Paul Arneson, Biologist
Suzanne Miller, Statistician

- 13 May 1980; met with B. Collins to discuss needs of lower Susitna moose habitat study.

- 6 June 1980; met in the field with B. Collins to test techniques for sampling moose browse production/ utilization.

Charles Swartz, Biologist

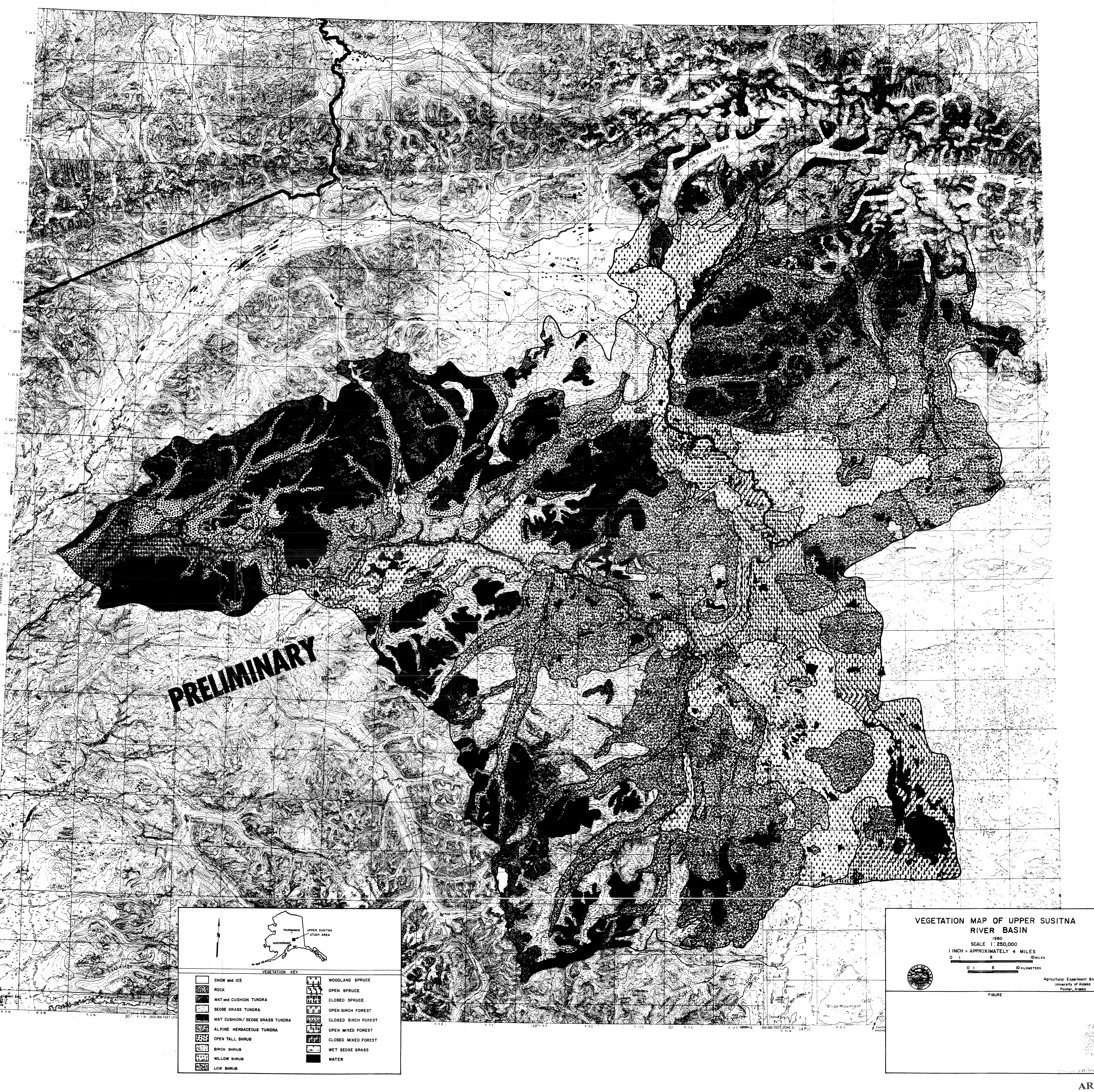
- 27 May 1980; met with B. Collins and J. McKendrick to discuss methods for evaluating moose habitat and nutritional value of browse species.

Local Agencies:

Matanuska-Susitna Borough

Lee Wyatt, Acting Borough Manager

- 8 May 1980; letter from B. Collins to request cooperative purchase of 1:63,360 scale CIR photography of upper Susitna basin.


PRELIMINARY
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SEDGE GRASS TUNDRA
MAT CUSHION / SEDGE GRASS TUNDRA
ALPINE HERBACEOUS TUNDRA
OPEN TALL SHRUB
BIRCH SHRUB
WILLOW SHRUB
LOW SHRUB
WOODLAND SPRUCE
OPEN SPRUCE
CLOSED SPRUCE
OPEN BIRCH FOREST
CLOSED BIRCH FOREST
OPEN MIXED FOREST
CLOSED MIXED FOREST
WET SEDGE GRASS
WATER
VEGETATION MAP OF UPPER SUSITNA RIVER BASIN
1980
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1 INCH = APPROXIMATELY 4 MILES
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