SUSITNA HYDROELECTRIC PROJECT
Vegetation Mapping Final Report and User Guide

April, 1985 (revised April,1987)

Prepared By:

R.A. KREIG &
ASSOCIATES, INC.

for

HARZA-EBASCO SUSITNA JOINT VENTURE

ALASKA POWER AUTHORITY

TABLE OF CONTENTS

List of Tables

List of Figures

Susitna Hydroelectric Project

Vegetation Mapping Final Report and User Guide

R. A. Kreig & Associates, Inc.

April, 1985 (revised April, 1987)

1.0 BACKGROUND[1]

The Susitna Hydroelectric Project, located approximately 120 air miles northeast of Anchorage, Alaska, is planned for construction in two phases. The first phase, Watana Dam, will be an earthfill structure located approximately 184 river miles upstream from the Susitna River mouth at Cook Inlet. At its normal maximum operating water level elevation of 2,185 feet, the Watana Reservoir will occupy a 48-mile long, 38,000-acre area. The second phase of development, Devil Canyon Dam, will be a concrete arch structure located approximately 32 river miles downstream of the Watana Dam. The Devil Canyon Reservoir will occupy a 26-mile long, 7,800-acre area at its maximum operating water level elevation of 1,455 feet.

Ancillary structures and facilities will be required to support construction and operation of the Watana and Devil Canyon projects, including: borrow areas, construction camps, villages, and work areas; a permanent access road extending southward from the Denali Highway to the Watana damsite and from there westward to the Devil Canyon damsite; a rail extension from the Alaska Railroad main line at Gold Creek to the Devil Canyon area; a transmission corridor

---

1. After Harza-Ebasco Susitna Joint Venture (1984), p. 4-5.

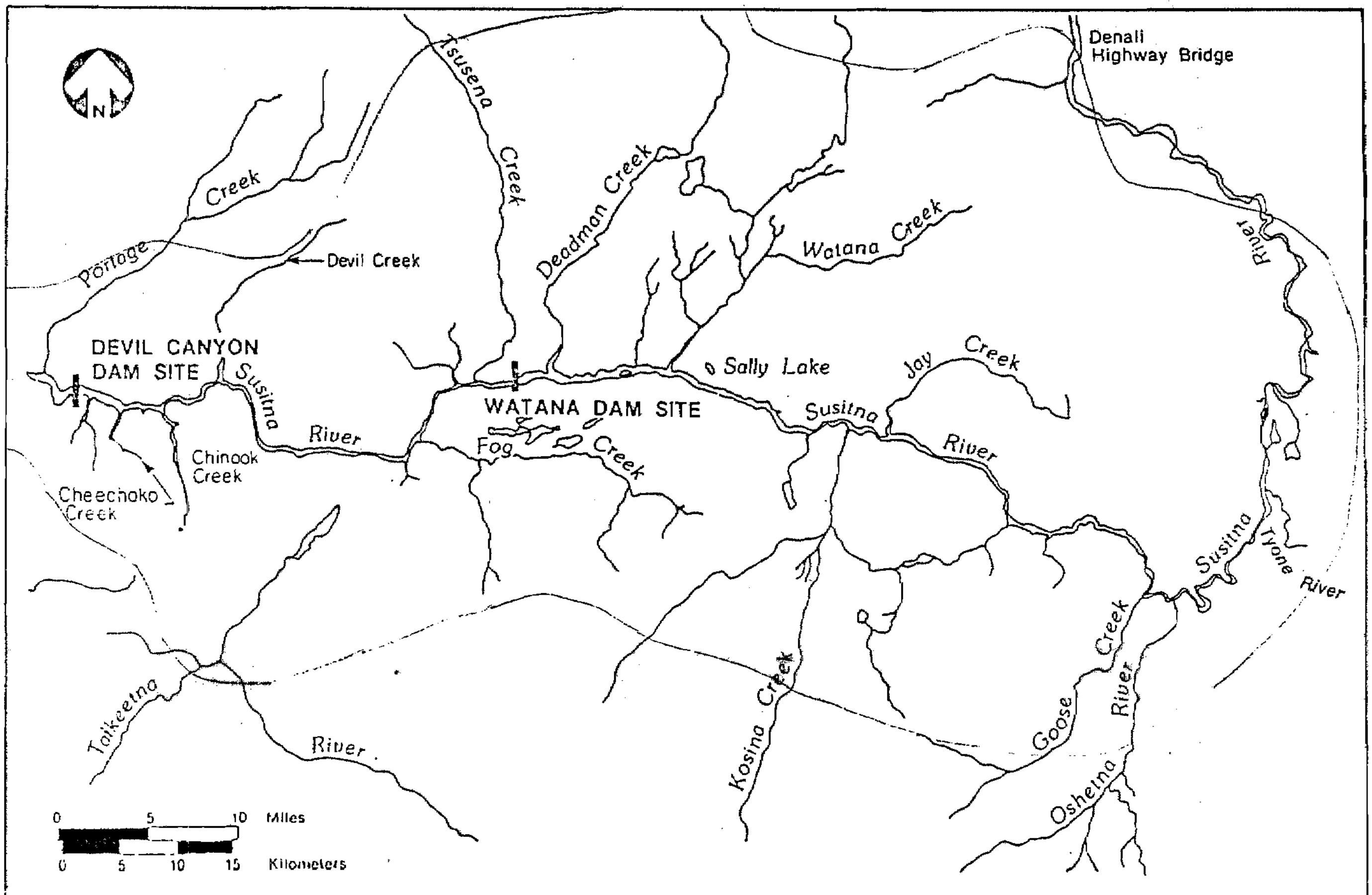
extending alongside the road from the Watana damsite to the Devil Canyon damsite, and from there to a junction with the planned Intertie transmission corridor near Gold Creek; temporary and permanent service roads; and a permanent village and airstrip near the Watana damsite. Locations of many of these facilities as currently planned are shown in Figure 1.

An application for a federal license to develop the Susitna Hydroelectric Project was submitted by the Alaska Power Authority to the Federal Energy Regulatory Commission (FERC) in February 1983.

2.0 PRESENT STUDY - FORAGE VEGETATION MAPPING

As part of the licensing process, detailed mapping of existing vegetation which will be affected as a result of project construction and operation was undertaken. The emphasis is on moose forage vegetation as an important requirement to support the habitat-based impact assessment, mitigation planning, and settlement process currently underway.

The forage vegetation mapping described herein is designed to create a more detailed map database than that previously available. These maps are intended to be used, in general, for quantification of habitat-based impacts and, more specifically, to provide a more accurate basis for stratification of the browse inventory through improved statistical efficiency. The mapping will allow more precise habitat use and availability analyses to be conducted for big game species, thus, refining the project's ability to assess impacts.



SUSITNA RIVER AND MAJOR TRIBUTARIES FROM DEVIL CANYON TO DENALI HIGHWAY

Figure 1 - Susitna River and major tributaries from Devil Canyon to Denali Highway.

The objectives of the vegetation mapping were to prepare: 1) a detailed 1:63,360 - scale map of vegetation for the Susitna Project area, and 2) a concise user guide to accompany the map product. The vegetation mapping study area boundary includes approximately 2,550 square miles (figure 2).

3.0 CONTRACT HISTORY

The request for proposal for vegetation mapping services was issued by Harza-Ebasco on behalf of the Alaska Power Authority in January, 1984. R. A. Kreig & Associates, Inc. responded with a statement of interest and proposal, on February 14, 1984. It was accepted and authorization to proceed on the contract was received on March 14, 1984. Personnel involved in the Susitna Hydroelectric Project Vegetation mapping include (all from R.A. Kreig & Associates Inc. unless otherwise noted):

Raymond A. Kreig, Principal -	Project manager
Raymond A. Koleser, Forester -	Mapping & fieldwork
Deborah Heebner, Biologist -	Mapping & fieldwork
Kenneth Winterberger, Forester - (US Forest Service, Forestry Sciences Lab)	Reviewer and project planning

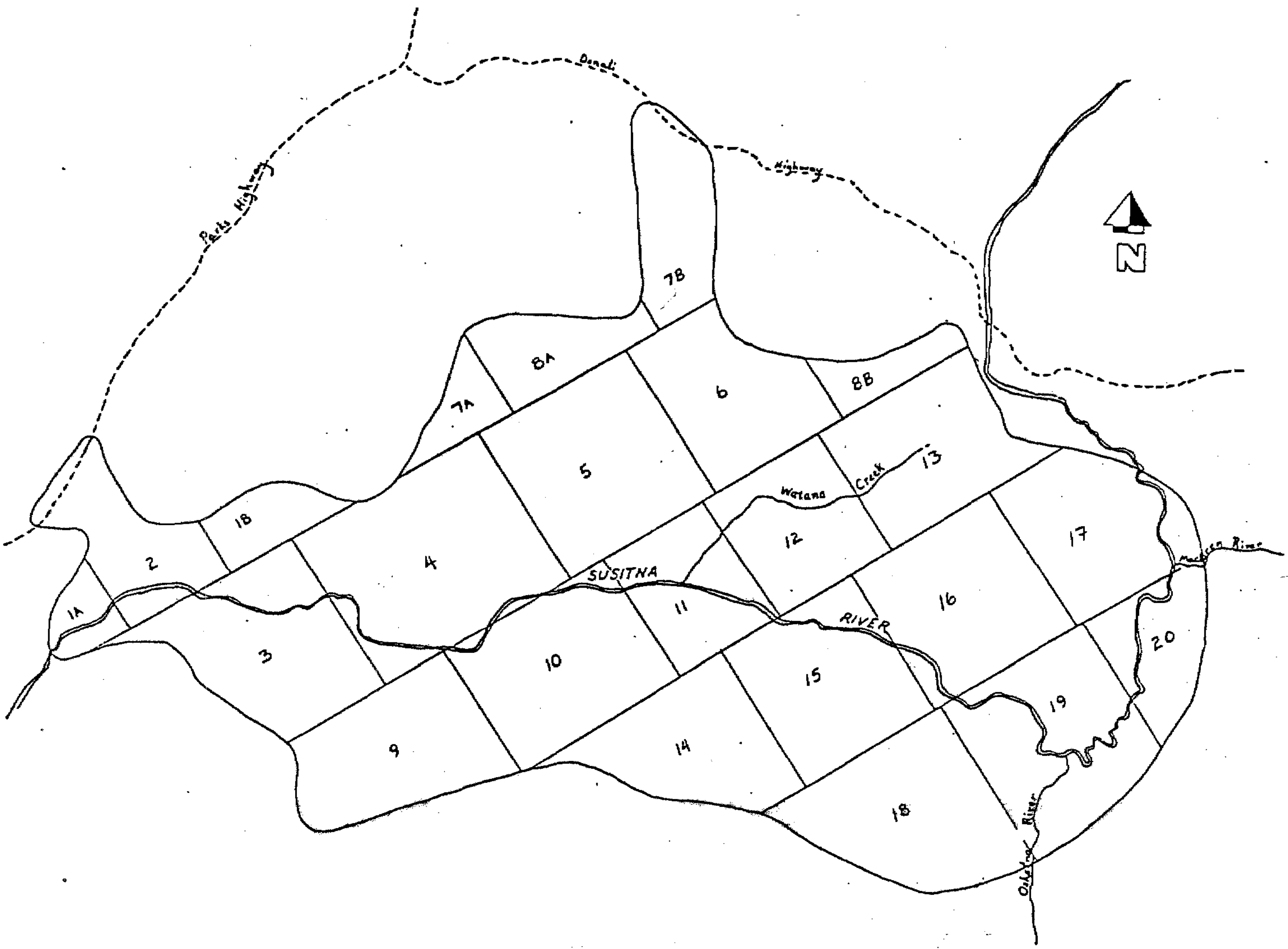


Figure 2. Index to Susitna vegetation mapping study area showing individual map sheets.

4.0 MAPPING TECHNIQUES AND PROCEDURES

A thorough review and collection of all available reference and ground plot data provided a basis for pre-field legend and mapping methodology development.

4.1 Collection of Existing Field Data

Prior to commencing work on the project, two main existing ground data sources were known:

1. Vegetation studies performed under contract to the Alaska Power Authority by the University of Alaska Agricultural Experiment Station in Palmer.
2. Plot data gathered by the Forestry Sciences Lab of the U.S. Forest Service as part of their ongoing vegetation and land inventory process.

A large amount of additional ground data collected by the Bureau of Land Management as part of their 1977-78 Denali Study was identified later. The acquistion of this information was fortunate because it more than tripled the number of ground sites that could be used in formulation of the mapping legend and methodology (Table 1). After collection, all of this existing data was reformated so that the photointerpreters could more easily and efficiently utilize it during mapping. Previous studies are described in more detail in the following sections.

TABLE 1

Susitna Vegetation Mapping - Ground Data

Source	Inside Mapping Area	Outside Mapping Area	Total
University of Alaska- Ag. Expt. Sta. (Palmer) Browse Studies Phenology Transects	62	25	87
Forestry Sciences Lab (USFS)			
Ground Plots	52	35	87
Large Scale Plots	3	5	8
Bureau of Land Mgt. Denali Study	625	600	1,225
Total Prefield	742	665	1,407
RA Kreig & Associates Ground Transect Sites	675 (approx)		675
ADF&G Browse Inventory			
Transect Quadrats	2,376 (approx)		2,376
Totals for ground plots	3,793	665	4,458
RA Kreig & Associates Stereo Oblique Sites	87		87
Total all sites	3,880	665	4,545

4.1.1 University of Alaska AES (Palmer) Data

The plant ecology group of the University of Alaska, Agricultural Experiment Station at Palmer (AES) described, classified and mapped the vegetation/habitat types found in the upper Susitna River basin and the floodplain as far south as Talkeetna in the first phase of their study. Field locations were visited in 1980 and Landsat imagery and 1:120,000 scale CIR photography were used to map the vegetation cover types at 1:250,000 for the entire basin and 1:24,000 for the direct impact areas. In addition, the area extending 16 km on either side of the upper Susitna River between Gold Creek and the mouth of the Maclaren River was mapped at 1:63,360.

In the final phase, a browse inventory, plant phenology study in the middle Susitna River Basin and a pre-burn inventory and assessment study in the Alphabet Hills to the east were conducted. In the browse inventory study, canopy cover, shrub stem density, browse utilization, browse availability, and current annual growth were measured. The phenology study involved transects along the canyon slopes above the middle Susitna River to evaluate forage availability for cow moose during parturition. Exclosures along four transects were sampled at time intervals to document the phenelogical development of the vegetation. These studies are described in McKendrick et al. (1982) and Steigers et al. (1983).

4.1.2 Forestry Sciences Lab Data

Data were collected in and adjacent to the study area as part of a U.S. Forest Service multi-level sampling plan. Information for each individual plot was taken from a 20 acre area on the ground and from interpretation of large scale, color infrared aerial photos. For the ground plots, information was taken on timber volume and grade, spatial distribution of overstory and understory vegetation, biomass and cover of shrub species and wildlife cover. The information from the shrub and wildlife plots was very useful and was easily adapted to fit our data base. In addition to the ground data, there is also information from the large scale photo plots. This data involves cover and height information by species for vegetation types mapped on the photos.

4.1.3 Bureau of Land Management (Denali) Data

A large amount of data used in the study area was obtained from data developed for the Denali Project in a Bureau of Land Management vegetation study conducted from 1977 to 1979 in the Susitna area. The information from this study included large scale aerial photography and extensive, very useful ground vegetation sampling that was later incorporated into a large part of our database.

The study had 168 cluster sample units (12-points each) randomly selected on topographic maps. Ground information on vegetation types, as well as, 35mm ground photos were obtained for half of the cluster units. In addition to this, all of the sites had 1:6,000 scale color photography flown (which will be futher described below). The 12 points in each cluster were later located and marked on the photos. The combination of large scale photos, ground photos and ground information for specific areas was a great asset in the mapping process.

During this study, the Denali data was analyzed, patterns identified and graphics designed to better display the data on the photographs for the vegetation mappers. A sample Denali ground data form for one of the twelve cluster points at a sample location is illustrated in Table 2.

4.2 SUSVEG Database for Analysis of Existing Field Data

4.2.1 Purpose of Database

From the mapping perspective, one of the main purposes in studying the data base of all existing plots was to identify the variation in forage cover classes and Level IV detail which might not always be directly recognizable on 1:60,000 CIR aerial photography. Variation that cannot be directly interpreted can frequently be mapped by association with other factors that can be directly mapped (such as slope and aspect, Viereck Level III vegetation class, landform, soil type, permafrost, site drainage, etc.) To do this, it was necessary to identify mapping guidelines for these

Table 2. Sample Denali Project ground data form.

DENALI PROJECT
Summer-Fall 1979
9

79 Cluster | ☒ Field Data | Summary Class No. 12

1 A̶H̶ Sample Unit | ☐ P.I. Data | Name ______

Date: 8 / 12 / 79 | Level II ______

Collector: C | Level III ______

Ground Photo: ______ Roll ______ Frame

______ N Lat. ______ W Long. ______ UTM

2100' Elev. ______ Ft. ______ m. Aspect NNE Slope 20-35 Declination 28½ °

floodplain ☐ moraine ☐ eskers ☐ other ______

flats ☐ rolling hills ☒ mountains ☐ (if checked, mark below)

lower 1/3 slope ☐ mid-slope ☐ upper 1/3 slope ☐
valley floor ☐ ridge crest ☐

LANDCOVER COMPONENT (based on framework description)

Level II		Level III
Coniferous Forest	(0) 1 2 3 4	Dense Conifer
	0 (1) 2 3 4	Open Conifer
Deciduous Forest	(0) 1 2 3 4	Dense Deciduous
	(0) 1 2 3 4	Open Deciduous
Mixed Forest	(0) 1 2 3 4	Deciduous Mix
	(0) 1 2 3 4	Coniferous Mix
Low Shrub	(0) 1 (2) 3 4	Low Shrub
		(ratio dwarf birch 3 :willow 1)
		(conifer 1% 5% ______ %)
Tall Shrub	(0) 1 2 3 4	Tall Shrub
		(ratio alder ______ :willow ______)

Table 2. Sample Denali Project ground data form (cont'd).

Dry Tundra	(0) 1 2 3 4	Fellfield
	(0) 1 2 3 4	Prostrate Shrub
Mesic Tundra	(0) (1) 2 3 4	Woody Tundra
	(0) 1 2 3 4	Non-woody Tundra
Wet Tundra	(0) 1 2 3 4	Wet Tundra
Wetlands	(0) 1 2 3 4	Wetlands
Water	(0) 1 2 3 4	Water silty ☐ clear ☐ shallow ☐
Ice/Snow	(0) 1 2 3 4	Ice/Snow
Bare Rock/Soil	(0) 1 2 3 4	Bare Rock/Soil rock outcrop ☐ gravel ☐ soil ☐ organic ☐ natural ☐ man-caused ☐

Comments:

coltsfoot
equisitum
ledum
vacc.
moss sphagnum
lichens
carex
d. birch
willow
alder
spirea
grass
cloudberry
sorrel
rose

lot of seedling conifer would increase crown closure to 75%

patterns of occurrence that could then be used to infer vegetation characteristics below the resolution of the photography.

The SUSVEG microcomputer data base was designed to handle the 1407 prefield plots shown on Table 1.

4.2.2 Database Fields and Scope

Before any of the plot data could be input, it had to be examined for comparability between the different studies. As expected, each study followed somewhat different field procedure guidelines and some transformation and normalization of the data was necessary. For example, forage cover classes were assigned in the University of Alaska AES (Palmer) plots by ignoring airspace between leaves or foliage in the canopy and understory cover shadows while Forest Service and Denali project data ignored interfoilage spacing and counted everything within the outer limits of a plant canopy shadow as contributing to resultant cover class estimates. After inspection, it appeared that multiplying the Palmer cover classes by a factor of three was a reasonable approach to allow comparison with plots from the other studies. It was also necessary to confirm plot locations and satisfy ourselves of the reliability of the field data from the different projects. All plot information contained for each location in each study has not been added to the data base. Only those common elements have been added which 1) contribute to the forage mapping task and 2) were collected in nearly all studies. The following data items are included as separate fields in the database:

1. Plot No. P - University of Alaska AES (Palmer) Forage Plots
   PT - University of Alaska AES (Palmer) Phenology Transect Sites
   D - Denali Project
2. Viereck Classification Level III Call
3. Viereck Classification Level IV Call
4. Cover percent for Willow
5. Dwarf Birch cover percent
6. Alder cover percent
7. Moss cover percent (this data was collected only on Palmer phenology transect and FSL plots.
8. Lichen (this data was collected only on Palmer phenology transect and FSL plots.
9. Unvegetated (this data was collected only on Palmer phenology transect and FSL plots.
10. Slope
11. Aspect
12. Elevation

The database has been set up on an IBM-PC using Knowledgeman Data Base Management software (Micro Database Systems, Inc.) The basic data input and error checking is complete for all 1407 existing plot sites.

4.2.3 Potential Insolation Index

To evaluate variations in forage cover, it was felt desirable to program a subroutine that compared the sites to one another utilizing slope and aspect. The approach used is the equivalent latitude method (Dingman and Koutz, 1974, originally developed by Lee, 1962, 1964).

The relationship between the differing vegetation communities on north-facing versus south-facing slopes has frequently been noted by researchers working throughout Alaska. When working with a large amount of plot data, it is necessary to quantify slope and aspect site factors. The concept is based on the fact that every slope is parallel to a horizontal plane on the earth's surface which receives the same potential insolation as that plane. The latitude of that plane is called the equivalent latitude, l', and it depends on the inclination, k, and aszimuth, h, of the slope as follows:

$$(1)\ l' = \sin^{-1} (\sin k \cos h \cos l + \cos k \sin l)$$

Where l is the actual latitude of the site.

The effects of equivalent latitude (i.e. slope and aspect) on vegetation are related to differences of in the quantity of solar energy that surfaces receive over the course of the season (absent the effects of orographic rainfall). Equivalent latitude is not linearly related to potential solar insulation. This relationship is shown in Figure 3 which relates potential insulation, I (as a percentage of the amount received at the equator) as a function of latitude, l.

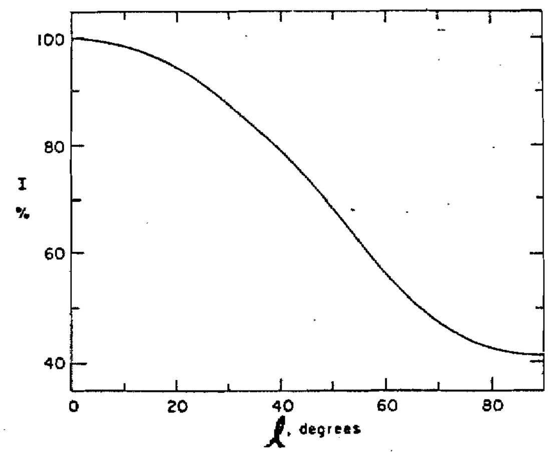


Figure 3. Potential-insolation index, I, expressed as a percentage of the potential insolation at the equator, as a function of latitude, l.

Because of the definition of equivalent latitude, Figure 3 is also a graph of potential insulation, p, versus equivalent latitude. We have approximated this relationship by the following sine function:

$$(2)\ p = 59\ (0.5\ (1 + \cos 2l')) + 41$$

Combining expressions (1) and (2) results in the subroutine used to compute the potential insolation index for each site on the SUSVEG data base.

4.2.4 Other Database Operations and Reports

Cover percentage classes in the willow, dwarf birch and alder fields were each evaluated and the appropriate cover class forage denominator that would be used in the mapping legend symbology was computed for each groundtruth point in the data base. This permitted much easier comparison of field data sites with the units on the draft vegetation maps.

At present, three data sorting reports have been written:

PLOTNOVI - This is the basic data listing sorted by plot number (Table 3).

VIERPIIE - This report sorts the database by sorting the first field by Viereck Level III vegetation call. This is normally the limit that can be mapped by direct observation of growth form on the 1:63,360 CIR photography (without the interpretor's analysis including other mappable site conditions). Note that the Viereck Level III classes are not ordered alphabetically but rather by growth form and precedents according to the order in the Alaska Vegetation Classification, i.e. 1st - coniferous forest, then deciduous, etc. then shrub, then herbaceous, last barren site types, etc. The second level of sorting (within a given Viereck Level III type) is ascending order of increasing potential insolation index (PII). The last sort is by increasing elevation. An example of this report format is included as Table 4.

Table 3 - Plotnovi sample printout report

T01	PLOTNO	VIER	VIE	MAP	WIL	DBI	ALD	MOS	LIC	UNV	SLO	ASP	ELEV
300	D 25-07	SMo	e	000	0	0	0	0	0	0	17	90	3700
301	D 25-08	SMo	e	000	0	0	0	0	0	0	17	90	3700
302	D 25-09	SLo	bw	110	10	25	0	0	0	0	17	90	3700
303	D 25-10	SLo	b	010	0	25	0	0	0	0	17	90	3700
304	D 25-11	SLo	bw	110	10	25	0	0	0	0	17	90	3700
305	D 25-12	SLo	bw	110	5	5	0	0	0	0	17	90	3700
306	D 25-13	SLo	bw	110	5	5	0	0	0	0	17	90	3700
307	D 25-14	SMo	e	000	0	0	0	0	0	0	17	90	3700
308	D 25-15	SMo	e	000	0	0	0	0	0	0	17	90	3700
309	D 25-16	SMo	e	000	0	0	0	0	0	0	17	90	3700
310	D 25-17	SLo	b	010	0	25	0	0	0	0	17	90	3700
311	D 25-18	SMo	e	000	0	0	0	0	0	0	17	90	3700
312	D 25-19	SMo	e	000	0	0	0	0	0	0	17	90	3700
313	D 25-20	SMo	w	100	5	0	0	0	0	0	17	90	3700
314	D 25-21	SMo	bw	110	5	5	0	0	0	0	17	90	3700
315	D 25-22	SMo	w	100	20	0	0	0	0	0	17	90	3700
316	D 25-23	SLo	w	200	30	0	0	0	0	0	17	90	3700
317	D 25-24	SLo	w	200	30	0	0	0	0	0	17	90	3700
318	D 25-25	SLo	w	300	60	0	0	0	0	0	17	90	3700
319	D 33-01	SLc	bw	230	30	60	0	0	0	0	22	0	3200
320	D 33-02	SLc	w	400	90	0	0	0	0	0	22	0	3200
321	D 33-03	SLc	w	400	90	0	0	0	0	0	22	0	3200
322	D 33-04	SLc	w	400	90	0	0	0	0	0	22	0	3200
323	D 33-05	SLc	w	400	80	0	0	0	0	0	22	0	3200
324	D 33-06	SLc	w	400	80	0	0	0	0	0	22	0	3200
325	D 33-07	SLc	w	400	90	0	0	0	0	0	22	0	3200
326	D 33-08	SLc	bw	120	13	39	0	0	0	0	22	0	3200
327	D 33-09	SLc	bw	120	17	34	0	0	0	0	15	0	3200
328	D 33-10	SLc	bw	130	20	60	0	0	0	0	15	0	3200
329	D 33-11	SLo	b	020	0	50	0	0	0	0	15	0	3200
330	D 33-12	SLo	b	020	0	50	0	0	0	0	15	0	3200
331	D 33-13	SLc	b	040	0	80	0	0	0	0	15	0	3200
332	D 33-14	SLc	bw	310	60	20	0	0	0	0	15	0	3200
333	D 33-15	SLc	bw	310	60	20	0	0	0	0	15	0	3200
334	D 33-16	SLc	w	400	80	0	0	0	0	0	15	0	3200
335	D 33-17	SLo	b	020	0	50	0	0	0	0	19	0	3200
336	D 33-18	SLc	bw	130	20	60	0	0	0	0	19	0	3200
337	D 33-19	SLc	bw	130	12	72	0	0	0	0	19	0	3200
338	D 33-20	SLo	bw	110	20	20	0	0	0	0	19	45	3200
339	D 33-21	SLc	bw	140	15	90	0	0	0	0	12	45	3200
340	D 33-22	SLc	bw	410	100	5	0	0	0	0	12	45	3200
341	D 33-23	SLc	bw	230	26	52	0	0	0	0	10	315	3200
342	D 33-24	SLc	bw	230	26	52	0	0	0	0	12	315	3200
343	D 33-25	SLc	w	400	100	0	0	0	0	0	10	315	3200
922	D 37-01	SLc	bw	220	50	50	0	0	0	0	40	135	3300
923	D 37-02	SLc	bw	230	38	62	0	0	0	0	40	135	3300
924	D 37-03	SLc	bw	230	41	58	0	0	0	0	40	135	3300
925	D 37-04	SLc	bw	230	33	66	0	0	0	0	40	135	3300
926	D 37-05	SLc	b	140	15	85	0	0	0	0	40	135	3300
927	D 37-06	SLc	b	140	10	90	0	0	0	0	60	135	3300
928	D 37-07	SLc	bw	140	70	25	0	0	0	0	60	135	3300
929	D 37-08	SLc	bw	230	40	60	0	0	0	0	60	135	3300
930	D 37-09	SLc	bw	230	40	60	0	0	0	0	60	135	3300
931	D 37-10	SLo	b	130	16	56	0	0	0	0	60	135	3300
932	D 37-11	SLo	b	120	15	50	0	0	0	0	50	135	3300
933	D 37-12	SLc	bw	220	45	45	0	0	0	0	50	135	3300

Table 4 - Vierpiie sample printout report

Page 1

VIER	VIE	PII	ELEV	MAP	PLOTNO	WIL	DBI	ALD	MOS	LIC	UNV	SLO	ASP	T01
Cc	w	53	1400	002	F 8-	0	0	50	20	12	0	0	0	70
Cc	w	53	2600	310	F 23-	70	10	0	32	17	0	0	0	85
Cc	w	54	2500	110	F 1-	10	20	0	36	18	0	10	258	63
Co	m	41	2200	212	P 65-	40	18	32	75	3	0	40	0	42
Co	w	44	2100	121	D 79-01	15	45	5	0	0	0	28	23	469
Co	w	44	2100	120	D 79-02	15	45	0	0	0	0	25	23	470
Co	w	44	2100	120	D 79-03	15	45	0	0	0	0	25	23	471
Co	w	44	2100	120	D 79-04	15	45	0	0	0	0	25	23	472
Co	w	44	2100	120	D 79-05	15	45	0	0	0	0	25	23	473
Co	w	44	2100	120	D 79-06	15	45	0	0	0	0	25	23	474
Co	w	44	2100	120	D 79-07	15	45	0	0	0	0	25	23	475
Co	w	44	2100	120	D 79-08	15	45	0	0	0	0	25	23	476
Co	w	44	2100	120	D 79-09	15	45	0	0	0	0	25	23	477
Co	w	44	2100	120	D 79-10	15	45	0	0	0	0	25	23	478
Co	w	44	2100	120	D 79-11	15	45	0	0	0	0	25	23	479
Co	w	44	2100	120	D 79-12	15	45	0	0	0	0	25	23	480
Co	w	44	2100	120	D 79-13	15	45	0	0	0	0	25	23	481
Co	w	44	2100	120	D 79-14	15	45	0	0	0	0	25	23	482
Co	w	44	2100	120	D 79-15	15	45	0	0	0	0	25	23	483
Co	w	44	2100	120	D 79-16	15	45	0	0	0	0	25	23	484
Co	w	44	2100	120	D 79-17	15	45	0	0	0	0	25	23	485
Co	w	44	2100	120	D 79-18	15	45	0	0	0	0	25	23	486
Co	w	44	2100	120	D 79-19	15	45	0	0	0	0	25	23	487
Co	w	44	2100	120	D 79-20	15	45	0	0	0	0	25	23	488
Co	w	44	2100	120	D 79-21	15	45	0	0	0	0	25	23	489
Co	w	44	2100	120	D 79-22	15	45	0	0	0	0	25	23	490
Co	w	44	2100	120	D 79-23	15	45	0	0	0	0	25	23	491
Co	w	44	2100	120	D 79-24	15	45	0	0	0	0	25	23	492
Co	m	50	1800	111	P 63-	7	11	22	57	10	0	10	45	40
Co	m	51	2200	010	P 53-	3	24	0	48	5	0	7	315	32
Co	mw	51	2800	220	F 45-	50	50	0	12	7	0	3	0	107
Co	w	52	1680	010	PT43-	0	12	0	90	0	0	3	70	62
Co	w	52	1900	202	F 2-	30	0	50	6	3	0	3	282	64
Co	w	52	1700	003	F 5-	0	0	60	16	0	0	8	70	67
Co	w	52	2300	220	F 11-	40	50	0	60	15	0	1	329	73
Co	w	52	2700	220	F 36-	30	50	0	42	10	0	3	69	98
Co	w	52	2300	300	D 57-10	75	0	0	0	0	0	2	18	981
Co	m	53	2100	010	P 22-	2	17	0	0	9	1	7	270	13
Co	w	53	2100	311	P 67-	61	22	10	53	1	0	9	90	44
Co	w	53	1700	100	P 68-	12	3	1	50	7	0	0	0	45
Co	mw	53	2600	140	F 32-	10	90	0	20	8	0	0	0	94
Co	w	53	2700	110	D 67-01	25	25	0	0	0	0	2	90	444
Co	w	53	2700	110	D 67-02	25	25	0	0	0	0	2	90	445
Co	w	53	2700	110	D 67-03	25	25	0	0	0	0	2	90	446
Co	w	53	2700	110	D 67-04	25	25	0	0	0	0	2	90	447
Co	w	53	2700	110	D 67-05	10	10	0	0	0	0	2	90	448
Co	w	53	2700	110	D 67-06	25	25	0	0	0	0	2	90	449
Co	w	53	2700	110	D 67-07	25	25	0	0	0	0	2	90	450
Co	w	53	2700	110	D 67-08	25	25	0	0	0	0	2	90	451
Co	w	53	2700	110	D 67-09	25	25	0	0	0	0	2	90	452
Co	w	53	2700	110	D 67-10	25	25	0	0	0	0	2	90	453
Co	w	53	2700	110	D 67-11	25	25	0	0	0	0	2	90	454
Co	w	53	2700	110	D 67-12	25	25	0	0	0	0	2	90	455
Co	w	53	2700	110	D 67-13	25	25	0	0	0	0	2	90	456

PIIVIER - The third report orders all sites, first, by potential insolation index (PII), second, within a given PII; by Viereck Level III call. An example output is included as Table 5.

We can provide machine readable copies of the data base on 5-1/4 inch floppy disks in the following four formats:

1. Knowledgeman Data Table
2. ASCII File
3. Unquoted ASCII File
4. Data interchange format (DIF)
5. Basic Compatible File

Table 5 - Piivier sample printout report

Page 1

PII	VIER	VIE	ELEV	MAP	PLOTNO	WIL	DBI	ALD	MOS	LIC	UNV	SLO	ASP	T01
41	Co	m	2200	212	P 65-	40	18	32	75	3	0	40	0	42
41	SMc		4600	000	D151-01	0	0	0	0	0	25	55	0	1197
41	SMo	w	4300	000	F 86-	0	0	0	11	0	0	55	349	148
41	SMo		4600	000	D151-02	0	0	0	0	0	50	55	0	1198
41	SMo		4600	000	D151-03	0	0	0	0	0	50	48	0	1199
41	SMo		4600	000	D151-04	0	0	0	0	0	50	50	0	1200
41	SMo		4600	000	D151-05	0	0	0	0	0	75	45	0	1201
41	SMo		4600	000	D151-06	0	0	0	0	0	75	45	0	1202
41	SMo		4600	000	D151-07	0	0	0	0	0	75	50	0	1203
41	SMo		4600	000	D151-08	0	0	0	0	0	50	45	0	1204
41	SMo		4600	000	D151-09	0	0	0	0	0	25	45	0	1205
41	SMo		4600	000	D151-13	0	0	0	0	0	25	45	0	1209
41	SMo		4600	000	D151-14	0	0	0	0	0	50	40	0	1210
41	SMo		4600	000	D151-15	0	0	0	0	0	50	40	0	1211
41	SMo		4600	000	D151-16	0	0	0	0	0	50	40	0	1212
41	SMo		4600	000	D151-17	0	0	0	0	0	50	40	0	1213
41	SMo		4600	000	D151-25	0	0	0	0	0	75	40	0	1221
42	SLo	bw	3400	110	P 39-17	9	17	0	0	0	0	30	0	963
42	SLo	bw	3400	110	P 39-18	7	13	0	0	0	0	30	0	964
42	SMo		3700	110	D105-01	25	25	0	0	0	0	33	360	693
42	SMo		3700	110	D105-02	25	25	0	0	0	0	33	360	694
42	SMo		3700	110	D105-03	25	25	0	0	0	0	33	360	695
42	SMo		3700	110	D105-04	25	25	0	0	0	0	33	360	696
42	SMo		3700	110	D105-05	25	25	0	0	0	0	33	360	697
42	SMo		3700	110	D105-06	25	25	0	0	0	0	33	360	698
42	SMo		3700	110	D105-07	25	25	0	0	0	0	33	360	699
42	SMo		3700	110	D105-08	25	25	0	0	0	0	33	360	700
42	SMo		3700	110	D105-09	25	25	0	0	0	0	33	360	701
42	SMo		3700	110	D105-10	25	25	0	0	0	0	33	360	702
42	SMo		3700	110	D105-11	25	25	0	0	0	0	33	360	703
42	SMo		3700	110	D105-12	25	25	0	0	0	0	33	360	704
42	SMo		3700	110	D105-13	25	25	0	0	0	0	33	360	705
42	SMo		3700	110	D105-14	25	25	0	0	0	0	33	360	706
42	SMo		3700	110	D105-15	25	25	0	0	0	0	33	360	707
42	SMo		3700	110	D105-16	25	25	0	0	0	0	33	360	708
42	SMo		3700	110	D105-17	25	25	0	0	0	0	33	360	709
42	SMo		3700	110	D105-17	25	25	0	0	0	0	33	360	710
42	SMo		3700	110	D105-18	25	25	0	0	0	0	33	360	711
42	SMo		3700	110	D105-19	25	25	0	0	0	0	33	360	712
42	SMo		3700	110	D105-20	25	25	0	0	0	0	33	360	713
42	SMo		3700	110	D105-21	25	25	0	0	0	0	33	360	714
42	SMo		3700	110	D105-22	25	25	0	0	0	0	33	360	715
42	SMo		3700	110	D105-23	25	25	0	0	0	0	33	360	716
42	SMo		3700	110	D105-24	25	25	0	0	0	0	33	360	717
42	SMo		3700	110	D105-25	25	25	0	0	0	0	33	360	718
42	SMo		4600	000	D151-10	0	0	0	0	0	25	35	0	1206
43	SLo	bw	1800	020	P 42-	2	47	0	25	14	7	29	0	26
43	SMc	e	5000	000	F 94-	0	0	0	12	28	0	30	9	156
43	SMo		3700	000	L119-02	0	0	0	42	10	0	30	339	204
43	SMo		3700	000	L119-08	0	0	0	0	20	40	30	339	205
43	SMo		3700	000	L119-13	0	0	0	1	15	83	30	339	206
43	SMo		3700	000	L119-19	0	0	0	0	20	79	30	339	208
43	B		3700	000	L119-14	0	0	0	0	0	0	30	339	207
44	Co	w	2100	121	D 79-01	15	45	5	0	0	0	28	23	469
44	Co	w	2100	120	D 79-02	15	45	0	0	0	0	25	23	470
44	Co	w	2100	120	D 79-03	15	45	0	0	0	0	25	23	471

4.3 Airphoto and Image Coverage of the Study Area

The study area has a variety of aerial photographic and image coverage available ranging from 1) a landsat image for general overviews at scales of 1:1,000,000 to 1:250,000, 2) high altitude 1:120,000 and 1:60,000 CIR airphoto coverage for medium to small scale mapping purposes and 3) Color photography at scales from 1:6,000 to 1:24,000 is available for significant portions of the project area. The individual coverages are described in more detail in the following sections.

4.3.1 GEOPIC Enhanced Landsat Image

The Talkeetna Mountains Image (Scene #11470-19560 dated August 1, 1976) is a virtually cloud-free CIR landsat image that covers the entire project area. It has been produced by the GEOPIC process of Earth Satellite Corporation (Washington, D.C.) The scene has been debanded, edge enhanced, and geometrically corrected. It has served as an excellent 1:250,000 base for compilation of basic data, planning of field work and reference during meetings and presentations.

4.3.2 NASA-Alaska High Altitude Photography Program (AHAP)

The prime mapping photography used on this project is 1:60,000 CIR photography flown 1981 to 1984. This coverage is generally of adequate exposure and print quality. Some flightlines contain excessive amounts of red tones in the original negatives. The eastern half of flightline 90 contained a coverage gap that resulted in a special request to NASA to obtain coverage in this gap. It was flown in August, 1984 and used for the vegetation mapping. Unfortunately this new flightline still left a very thin holiday (coverage gap) between the adjoining flightlines. Enlargements of the older 1:120,000 CIR (described in following section) were ultimately used for mapping this remaining area.

4.3.3 NASA-Susitna Basin 1:120,000 Coverage

The entire map area had been previously flown in 1977-78 with 1:120,000 CIR coverage on northeast-southwest trending flightlines as part of NASA coverage acquired for the Soil Conservation Service-Susitna River Basins Study. This coverage was used in the previous mapping effort performed by the University of Alaska (Palmer). These flights were selected as the photo base for the project because of superior image quality and other factors (discussed further in base map section).

4.3.4 Susitna Project 1:24,000 Coverage

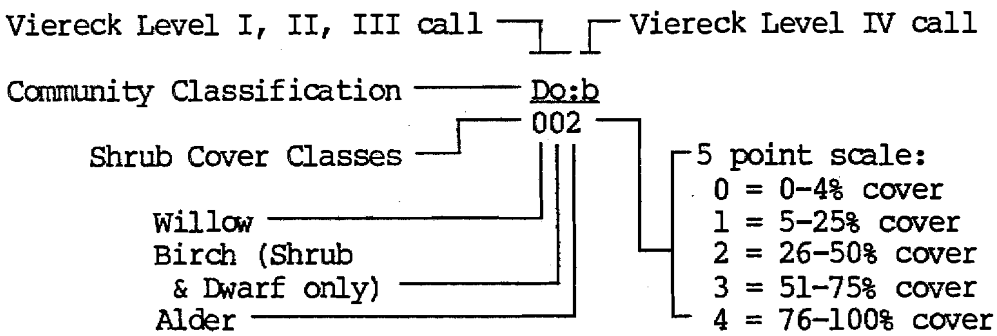
Approximately 40 percent of the project map area has been covered by 1:24,000 color flown by North Pacific Aerial Surveys for the Susitna project. This coverage served as a reference and backup source used in conjunction with the 1:60,000 CIR. It is generally of high quality, however, flightlines covering the access corridors north to the Denali Highway are snow covered and not usable for vegetation mapping. 1:20,000 Bureau of Land Management color coverage dated 1978 is available for this missing area.

4.3.5 BLM Denali Project and Forest Service Large Scale Plot Coverage

Approximately 610 frames of 1:6,000 color transparencies were flown in 1976 by BLM as part of the Denali project. These flights cover 625 plot locations inside the map area. They are concentrated generally north of the Susitna River and in the central and eastern part of the map area. This coverage has proven to be very useful to the mapping effort. 1:3,000 CIR plot photography has also been acquired by the Forestry Sciences Lab for three plots within and near the western portion of the map area.

4.4 Legend Design

The mapping scheme and symbology designed for this effort consists of a fractional symbol with the numerator denoting level three and four calls under the Alaska Vegetation Classification (Viereck et al,. 1982) and the denominator denoting a three-part forage cover call thus:



Level I, II, and III calls occur left of a colon in the numerator while the Level IV call occurs to the right of the colon. The symbology for the Viereck units is based on the design we developed for the statewide 1:250,000 scale Department of Natural Resources, Alaska Resource Mapping Project (ALARM). The symbols are alpha characters chosen as mnenonics to help new users rapidly associate map unit labels with vegetation types. For the complete list for the entire Susitna mapping area see Table 6.

In most cases, the symbology for Viereck Level III calls is identical to that used on the ALARM statewide inventory. Our symbology has been modified to include changes made during the Alaska Vegetation Classification Workshop (Anchorage - February 21, 1984), consequently, the six dwarf tree catagories and scrub are new. Hereafter, references to the Viereck classification should be understood to include Viereck et al. (1982) as modified by the 1984 workshop. The lower case letters used to denote Level IV classifications were originally designed to be included as part of

TABLE 6

Susitna Hydroelectric Project Vegetation Mapping
R. A. Kreig & Associates, Inc.
Mapping Legend (Revision 4)
March 1, 1987

Alaska Vegetation Classification Unit Name (Viereck et al. 1982)				Susitna Vegetation Mapping Unit Symbol
1. Forest	A. Conifer	1. Closed (60-100%)	K) White Spruce	Cc:w
			L) Black Spruce	Cc:m
			M) Black & White Spruce	Cc:mw
		2. Open (25-60%)	F) White Spruce	Co:w
			G) Black Spruce	Co:m
			H) Black & White Spruce	Co:mw
		3. Woodland (10-25%)	C) White Spruce	Cw:w
			D) Black Spruce	Cw:m
			E) Black & White Spruce	Cw:mw
	B. Broadleaf	1. Closed (60-100%)	B) Black Cottonwood	Dc:o
			C) Balsam Poplar	Dc:p
			D) Paper Birch	Dc:b
			E) Aspen	Dc:a
			F) Birch - Aspen	Dc:ba
		2. Open (25-60%)	A) Paper Birch	Do:b
			B) Aspen	Do:a
			C) Balsam Poplar	Do:p
		3. Woodland (10-25%)	A) Paper Birch	Dw:b
			B) Balsam Poplar	Dw:p
			C) Paper Birch - Poplar	Dw:bp
	C. Mixed	1. Closed (60-100%)	A) Spruce - Birch	Mc:sb
			B) Spruce - Birch - Poplar	Mc:sbp
			C) Spruce - Birch - Aspen	Mc:sba
			D) Aspen - Spruce	Mc:as
			E) Spruce - Poplar	Mc:sp
		2. Open (25-60%)	A) Spruce - Birch	Mo:sb
			B) Aspen - Spruce	Mo:as
			C) Spruce - Birch - Poplar	Mo:sbp
			D) Spruce - Poplar	Mo:sp
		3. Woodland (10-25%)	A) Spruce - Birch	Mw:sb
			B) Spruce - Poplar	Mw:sp
			C) Spruce - Birch - Poplar	Mw:sbp

Table 6 - Susitna Vegetation Mapping Legend 3/87 (Cont'd)

2. Scrub	A. Dwarf Tree (<5m) Conifer	1. Closed (60-100%)		FCc
		2. Open (25-60%)		FCo
		3. Woodland (10-25%)		FCw
	Broadleaf	1. Closed (60-100%)		FDc
		2. Open (25-60%)		FDo
		3. Woodland (10-25%)		FDw
	Mixed	1. Closed (60-100%)		FMc
		2. Open (25-60%)		FMo
		3. Woodland (10-25%)		FMw
	B. Tall Shrub (>1.5m)	1. Closed (75-100%)	A) Willow	STc:w
			B) Alder	STc:l
			C) Shrub Birch	STc:b
			D) Alder - Willow	STc:lw
			E) Shrub Birch - Willow	STc:bw
			*) Alder - Shrub Birch - Willow	STc:lbw
		2. Open (25-75%)	A) Willow	STo:w
			B) Alder	STo:l
			C) Shrub Birch	STo:b
			D) Alder - Willow	STo:lw
			E) Shrub Birch - Willow	STo:bw
			*) Alder - Shrub Birch	STo:lb
	C. Low Shrub (0.2-1.5m)	1. Closed (75-100%)	A) Dwarf Birch	SLc:b
			B) Low Willow	SLc:w
			C) Dwarf Birch - Low Willow	SLc:bw
			D) Ericaceous Shrub Tundra	SLc:e
			E) Dwarf Birch - Ericaceous	SLc:be

Table 6 - Susitna Vegetation Mapping Legend 3/87 (Cont'd)

		2. Open (25-75%)	A) Dwarf Birch	SLo:b
			B) Low Willow	SLo:w
			C) Dwarf Birch - Willow	SLo:bw
			*) Birch - Ericaceous-Grass	SLo:beg
			D) Low Alder	SLo:l
			J) Ericaceous Shrub - Sphagnum Bog	SLo:eu
			S) Willow Grass Tundra	SLo:wg
			T) Birch & Ericaceous Shrub	SLo:be
			*) Birch - Willow - Grass	SLo:bwg
			*) Ericaceous Shrub	SLo:e
			*) Ericaceous Shrub - Grass	SLo:eg
	D. Dwarf Shrub (<0.2m)	1. Closed (75-100%)		SMc
			A) Mat & Cushion - Sedge	SMc:s
			B) Mat & Cusion - Grass	SMc:g
			D) Cassiope	SMc:j
			G) Low Ericaceous Shrub	SMc:e
		2. Open		SMo
			E) Low Willow	SMo:w
			*) Ericaceous Shrub	SMo:e
3. Herbaceous	A. Graminoid	1. Dry		HGd
		2. Mesic		HGm
		3. Wet		HGw
			A) Wet Sedge Meadow	HGw:s
			C) Wet Sedge - Herb	HGw:sh
			M) Sedge - Moss Bog	HGw:sm
	B. Forb	1. Dry		HFd
			C) Alpine Herbs	HFd:h
		2. Mesic		HFm
		3. Wet		HFw
	C. Bryoid	1. Mosses		HBm
		2. Lichens		HBl
	D. Aquatic	1. Fresh water		HAf
4. Sparse Vegetation	A. Forest			Pf
	B. Scrub			Ps
	C. Herbaceous			Ph
5. Barren				O
	A. Bedrock			Ob
6. Artificial Disturbance from Cultural, Urban Development, etc.				U
7. Agricultural				A
8. Water				W

the statewide system (but were not mapped nor included in the technical specifications for these previous 1:250,000 DNR projects).

The three forage scrub cover species (willow-birch-alder) in the denominator are rated on the five point scale shown. The first term is the cover for willows (*Salix* sp. excluding decumbent dwarf *Salix* sp). The second term is the cover for dwarf birch (*Betula nana* and *B. glandulosa*), while the third figure is the cover percentage for alder (*Alnus crispa*).

Map units are labeled with one symbol if one type represents at least 75 percent of a polygon or more. In cases where more than one type is present in a polygon, where cartographic separation of two or more vegetative types is not possible, the polygon is labeled as a complex with the major component occurring first in the label. The minor component must have at least 25 percent of the unit area to be included. These complexes are used in distinct patterned vegetation, such as a polygon of mesic graminoid herbacous (HGm) that contains clumped low willow shrubs (SLo:w).

Complexes are used in this manner: $\frac{\text{Do:b}}{002} + \frac{\text{SLo:bw}}{240}$

Major component — (Do:b/002)

Minor component (not less than 25% of unit area) — (SLo:bw/240)

The first legend was prepared April 23, 1984 (entitled "Tentative Mapping Legend"). Revision 2 was prepared June 15, 1984 after an initial field reconnaissance. It incorporated several minor changes including 1) a shift in the zero shrub cover class from "not present" to 0 to 4% cover. We felt that it was desireable to differentiate trace occurrences of a browse species from larger and more significant forage occurrences (for instance, 10-20% cover occurrences) at the lower end of the forage cover class scale. After discussion with LGL and ADF&G, it was agreed that this change should be made. Several new Level IV types were also added to the legend, including four not presently recognized in Viereck. A rearrangement of the nine scrub dwarf tree catagories and a symbology change has been made to improve the overall design of the classification and symbology and to incorporate parallelism with the structure of the classification in the forest and scrub sections. These changes are not strictly in accordance with the Viereck classification. Ken Winterberger with the Forestry Sciences Lab originated these types (which were ultimately incorporated late into the Viereck classification.)

4.5 Mapping Techniques

All vegetative types were mapped to at least cartographic 40 acre minimums at 1:63,360 scale (one-fourth inch square) with a minimum categorical interpretation to Level III by Viereck. All forest, dwarf tree, tall shrub and low shrub types were mapped to Level IV. Where cartographically possible, mapping down to 10 acre minimums was done. The dwarf shrub, herbaceous and sparse vegetation types were mapped at least to Level III but usually the forage cover was less than 5%, therefore, the forage cover class calls were omitted.

The tall shrub and forest vegetation types were mapped with the most detailed categorical resolution. Forage cover class pecentage calls were mapped for willow-birch-alder. If there was a distinct mosaic of vegetation types or forage cover classes within a given vegetation polygon that was not cartographically mapable, complexes were used. The inclusion of 1) percentage forage species distribution, 2) overstory cover mapping, and 3) complexes within a polygon were necessary for accurate stratification for the moose forage study. The combination of all three of these data attributes on one map is a special feature of our mapping methodology which, we feel, has permitted the mapping of more complexity at a higher level of resolution.

To obtain the maximum and most accurate amount of forage species detail from the aerial photography, it was necessary to analyze all existing data and incorporate the analysis into the photo interpretation process so that relationships between vegetation associations, physiography, and photo signature could be made. A multiscale approach was used to analyse and display the data on the photographs. The site/photosignature/vegetation relationships demonstrated were a critical part of the process that resulted in a more uniform and repeatable photo interpretation product. Vegetation type/forage cover class/site condition relationships were first studied and identified from large scale (1:6,000) Denali project photos and ground plots. These relationships were then extended to the smaller scales of photography (ie. 1:24,000 and 1:60,000) where such cover classes cannot be directly interpreted because they are below the minimum level of photo resolution.

4.6 Test Mapping at 1:63,360 and 1:24,000 Scales

The moose carrying capacity modeling which was used to assess both 1) the impact of the reservoir and related facilities and 2) the necessary mitigation measures required a vegetation map which can adequately separate the important forage shrub elements (birch, alder and willow). For many sites in the upper Susitna, it is not possible for an interpreter to separate these three forage classes on the basis of direct recognition (photo signature) alone. This separation has to be made by the use of photo interpretive skills and the specific experience of the mappers in the upper Susitna area through the recognition of vegetation community characteristics and site relationships. These relationships were established by examining all existing plot data in reference to vegetation, landform and moisture gradient correlations through a multiscale photo interpretative approach.

The preliminary forage mapping legend was tested by trial mapping for several purposes:

1) To determine what could actually be observed and mapped on the photography.

2) To compare the proposed legend against the extensive ground truth data that already existed in the Upper Susitna.

3) To make an informed decision on the most appropriate final scale for the vegetation mapping (either 1:63,360 or 1:24,000 scales).

4) To obtain comments from users (habitat modeling group) that the map was intended to serve.

Two locations were selected for test mapping in areas with extensive existing ground truth. Criteria used for selecting these locations included 1) that the area be of interest to LGL and ADF&G because of high moose utilization, 2) suitable forage vegetation, such as willow, be present, 3) there be ample existing plot data, ground truth and low level 1:6,000 scale Denali color coverage (because this test mapping had to be completed prior to any opportunity for field verification) and 4) the area be covered with suitable 1:24,000 color airphotos.

Two areas satisfying these criteria were selected for mapping. The Oshetna and Watana test map areas (Figure 4). Results were presented and discussed on April 23, 1984 with LGL and ADF&G. Comparisons were made of the different levels of detail possible at the two different scales. While there is definitely some loss of detail (primarily cartographic, as opposed to categorical) at the 1:63,360 scale, the general consensus was that mapping should move ahead at 1:63,360 due to budget limitations and the incomplete partial coverage of existing suitable 1:24,000 scale airphotos.

ADF&G (S. Miller) requested test mapping at 1:24,000 scale in three additional areas (Figure 4) other than the Watana and Oshetna test areas. Further mapping was required to assess the actual detail loss at the smaller scale when directly compared to the 1984 browse inventory analysis of the forage clipping program results. This was accomplished by mapping at 1:24,000 scale the area of vegetation influence around 35 Browse Inventory transects (an approximate area of 1 mile in length by .5 miles in width) that were located in the test areas. Vegetation mapping at 1:63,360 scale was also made available for the browse sampling activities in summer 1984 for the five photo map areas on Figure 4.

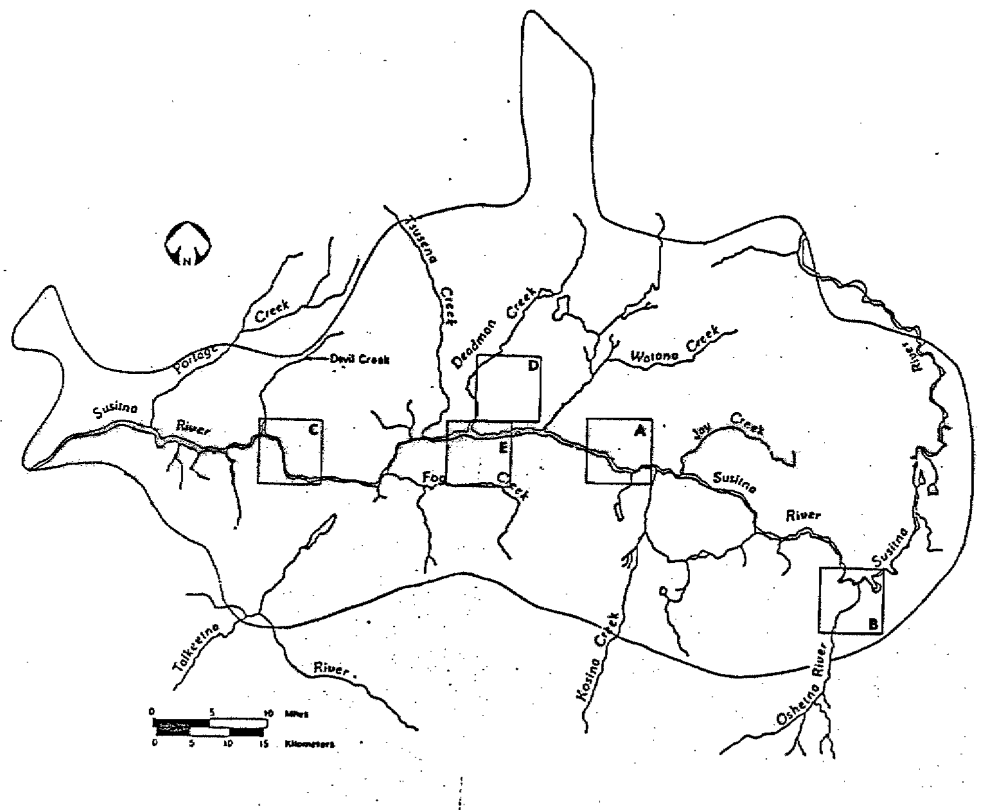


Figure 4. Map showing locations of Oshetna (H) and Watana (B) advance 1:63,360 scale mapping areas and three additional test map areas: Devil Creek (C), Pistol Lake (D), and Fog Lakes (E). All areas were mapped at 1:63,360 for the entire area and 1:24,000 scale encompassing seven transects each.

5.0 FIELD PROCEDURES

R.A. Kreig & Associates field efforts concentrated on the collection of representative forage cover percentages, checking of prefield and advance test area mapping, the interpretation of difficult or complex site/signature relationships and the establishment of a consistent approach to use of the legend.

An initial helicopter reconnaissance of the mapping area was performed from June 10 to June 12, 1984. Approximately 10 sites were visited and numerous overflights were made to check problem areas detected in the earlier data analysis and test area mapping. Field observations were recorded on 1:60,000 CIR, 1:24,000 color, and 1:6,000 color, airphotos.

On July 10 to 12, 1984 we provided orientation and training in the use of the photography and mapping legend to ADF&G crews associated with the seperate Browse Inventory Study forage sampling effort. We also developed procedures for cooperative field checking and verification of the mapping products. This integral involvement with the Browse Inventory Study provided us with a very large amount of additional field data as well as interactive refinement of the map product while the project was progressing. The Browse Inventory Study stratified vegetation types in the study area by elevation, slope, and aspect. Within these vegetation types, one mile long transects were then plotted at random locations. At each transect site, the Browse Inventory crew located approximately 22 quadrats at random locations along the transect and collected the data outlined on the Vegetation Mapping Ground Data form (Table 7). Current annual woody growth of browse species important in winter moose diets was clipped and bagged by species. ADF&G personnel provided us with the data and subsequent analyses from the 108 transects done in the summer of 1984. Two additional R.A. Kreig & Associates field trips occurred from July 10-17 and August 11-20, 1984.

Forty-four transects were checked on the ground with an average of 15 sites located along each transect. The transects were located in representative forage cover types with due regard to percentage variations and differing levels of complexity. The transects were plotted on 1:60,000 CIR and 1:24,000 color photography. In the field they were located on the ground using compass triangulation and reference to photoidentifiable vegetation and topographic features. The transect line was walked and vegetation type-forage species cover changes and locations of the calls were recorded on the airphotos.

Data recorded at each site included vegetation classification legend type, forage shrub cover class, understory species, and qualitative observations on the togography. All fieldwork was done by the same interpreters who did the mapping. These interpreters field checked the transects and collaborated on all vegetation type, forage species cover class calls to establish consistency in the application of legend descriptions to all mapping. Site

Table 7 - Vegetation Mapping Ground Data Form

Vegetation Mapping Ground Data Form
Susitna Hydroelectric Project
Prepared 6-29-84
by R. A. Kreig & Associates, Inc.

CIR-COL Photo No: ________ ________________ _________ ________________________
Line # Roll #(optional) Print # Site No. (arbitrary)

Viereck vegetation call __________:__________ Level 3 Level 4

Cover call ______% __________% _______%
Willow Dw. Birch Alder

Elevation ______ ft. Slope __________% Aspect __________° Azimuth

Local Topography (100 ft. radius of site): Convex Simple Slope Concave Complex

Landscape Setting (1/2 mile radius of site): flats undulating flats hills or mtns.

(if yes, then where on slopes:)

valley floor lower 1/3 slope mid-slope upper 1/3 slope ridge crest

Surface drainage (runoff): Fast Intermediate Ponded

	1	2	3	4	5	6	7	8
Site Moisture:	Very dry	Dry			Moist			Wet
Examples:	Exposed Soil on steep slopes sand or gravel				Moss Mat on slope or flats. No open standing water			Standing water or soggy High water table

Organic Terrain Type: Ombotrophic Minerotrophic

Mineral soil in active layer? No Yes

vegetation calls along the transect were considered in terms of photointerpreted polygons on the 1:60,000 CIR (approximately 100 meters square in minimum area). The photosignatures of the sites were examined and the consistency of vegetation type and forage species cover class calls were established.

On August 30, 1984 and September 14, 1984, a systematic helicopter check was made to map additional forage detail during the optimum fall shrub color change (senescence). Stereo 35mm color slide obliques were taken of 87 different locations throughout the mapped area of both representative and complex forage cover classes. The timing of this final check also allowed additional understory shrub discrimination in forest areas. Vegetation type cover calls and forage species cover class information was interpreted later in the office from each slide and the information was then transferred and plotted on the 1:60,000 CIR photography.

6.0 VEGETATION TYPE DEFINITIONS

I. Forest

All forest types are composed of at least 10% canopy cover of trees over five meters in height at maturity. The forest types are classified according to the species contributing at least 75% of the canopy cover percentage. They are further classified by the total canopy cover percentage.

A. Conifer forest types have at least 75% of the total forest canopy cover value composed of conifer species. Deciduous species may occur with up to 25% crown cover.

1. All closed conifer types have canopy cover values of 60-100% of the total area.

a. Cc:w - Closed white spruce is a community with 75% of the total canopy cover composed of white spruce (Picea glauca). This type generally occurs along drainages or well-drained slopes of North, Northeast or Northwest aspects. Willow (Salix planifolia ssp.pulchra), dwarf birch (Betula glandulosa) and alder (Alnus crispa) occur in the understory. Ground cover species include Rubus chamaemorus, Rubus arcticus, Equisetum silvaticum, Linnaea borealis and Hylocomium splendens.

b. Cc:m - Closed black spruce is a community with 75% of the total canopy cover composed of black spruce (Picea mariana). This type typically occurs on poorly drained organic permafrost soils. Willow, dwarf birch and alder occur in the shrub layer. Ground cover species include Ledum groenlandicum, Vaccinium uliginosum, Empetrum nigrum, Rubus arcticus, Rubus chamaemorus, Carex sp. and Sphagnum sp.

c. Cc:mw - Closed black and white spruce is a community with neither black spruce nor white spruce dominating the canopy cover with 75% of the cover value. This type occurs on terraces, at the base of south-facing slopes and on poorly drained north facing slopes. Willow, dwarf birch and alder occur in the understory. Ground cover species include Ledum groelandicum, Vaccinium uliginosum, Vaccinium vitis-idaea, Empetrum nigrum, Rubus arcticus, Rubus chamaemorus, Sphagnum sp. and Hylocomium splendens.

2. All open conifer forest types have canopy cover values of 25-50% of the total area.

   a. Co:w - Open white spruce is a community with 75% of the total canopy cover composed of white spruce. This type commonly occurs on well-drained convex sites, along drainages and near treeline. The understory of this type is similar to the closed white spruce type but with more shrub cover because of the more open tree canopy. Willow, dwarf birch and occasionally alder compose the shrub layer. The wetter sites generally support a greater percentage of willow and the dryer sites support more dwarf birch. Typical ground cover species are <u>Empetrum nigrum</u>, <u>Ledum decumbens</u>, <u>Vaccinium uliginosum</u>, <u>Vaccinium vitis-idaea</u>, <u>Equisetum silvaticum</u>, <u>Calamagrostis canadensis</u>, <u>Hylocomium splendens</u>, <u>Cladonia</u> sp. and <u>Stereocaulon</u> sp.

   b. Co:m - Open black spruce is a community with 75% of the total canopy cover composed of black spruce. The open black spruce type is common on poorly drained, cold sites. Willow, dwarf birch and occasionally alder occur in the understory. Other important understory species are Vaccinium uliginosum, Ledum sp., Empetrum nigrum, Rubus chamaemorus, Carex sp., Equisetum silvaticum, Rumex arcticus, Petasites hyperboreus and Sphagnum sp.

c. Co:mw - Open black and white spruce is a community with both black spruce and white spruce occurring with cover values of greater than 25% of the total cover value. This type occurs near treeline, on moist slopes and in transitional areas between black and white spruce. The shrub layer is composed of willow, dwarf birch and occasionally alder. The major species of the understory are Vaccinium uliginosum, Spirea beauverdiana, Rosa acicularis, Calamagrostis canadensis, Equisetum silvaticum, Carex bigelowii, Ledum sp., Rubus arcticus, Rubus chamaemorus, Empetrum nigrum, Vaccinium vitis-idaea, feather mosses and Sphagnum.

3. All woodland conifer forest types have canopy cover values of 10-25%. These types are frequently difficult to distinguish from a non-forest type.

a. Cw:w - Woodland white spruce is a community with 75% of the total canopy cover value composed of white spruce. This type generally occurs on well-drained sites at elevational treelines, in areas of regenerating vegetative growth, or in transitional areas between white spruce and low shrub. This type is similar to the open white spruce type, but with even more shrub cover because of the more open tree canopy. Willow, dwarf birch and occasionally alder compose the shrub layer. Important ground cover species are Ledum decumbens, Vaccinum uliginosum, Vaccinium vitis-idaea, Equisetum silvaticum, Arctagrostis latifolia, Epilobium latifolium and feather mosses.

b. Cw:m - Woodland black spruce is a community with 75% of the total canopy cover value composed of black spruce. This type occurs on wet poorly drained cold sites and it often grades into a sphagnum bog. The shrub layer is composed of willow and dwarf birch. Ground cover species are Salix fuscescens, Oxycoccus microcarpus, Ledum groenlandicum, Vaccinium uliginosum, Eriophorum sp., Carex sp. and Sphagnum sp.

c. Cw:mw - Woodland black and white spruce is a community with neither black spruce nor white spruce dominating the tree canopy cover value with 75% of the cover value. This type occurs near altitudinal limits of trees, on moist sites, and in transitional areas between black and white spruce. Willow, dwarf birch and occasionally alder occur in the shrub layer. Understory species are commonly _Salix reticulata_, _Potentilla fruticosa_, _Vaccinium uliginosum_, _Vaccinium vitis-idaea_, _Equisetum silvaticum_, _Carex_ sp., _Hylocomium splendens_, _Ledum_ sp., and _Empetrum nigrum_.

B. Broadleaf forest types have at least 75% of the tree cover percentage composed of broadleaf species. Coniferous species may occur with up to 25% crown cover.

1. All closed broadleaf forest types have canopy cover values of 60-100% of the total area.

a. Dc:o - Closed black cottonwood is a community with 75% of the total canopy cover composed of black cottonwood (_Populus balsamifera ssp. trichocarpa_). It is generally found along streams or river in the extreme southwestern portion of the Susitna study area. Willow and alder occur in the shrub layer. Understory species include Calamagrostis canadensis, Epilobium angustifolium, Gerianum erianthum, Geracleum lanatum and Pleurozium schreberi.

b. Dc:p - Closed balsam poplar is a community with 75% of the tree canopy cover composed of balsam poplar (Populus balsamifera ssp. balsamifera). This type occurs most frequently on river floodplains. The deciduous types have more complete foliage cover than the conifer types and, therefore, the understory layers are not as well developed. Willow and alder occur in the shrub layer. The ground cover species are Festuca altacai, Senecio lugens, Rosa acicularis Mertensia paniculata and Equisetum silivaticum.

c. Dc:b - Closed paper birch is a community with 75% of the total canopy cover composed of paper birch (Betula papyrifera). This type occurs on well-drained slopes, along floodplains, and drainage ravines. Willow and alder occur with low percentage cover values in the shrub layer because of the almost complete foliage cover of paper birch. Understory cover species include Calamagrostis canadensis, Ledum groenlandicum, Cornus canadensis, Gymnocarpium dryopteris, and Polytrichum juniperinum.

d. Dc:a - Closed aspen is a community with 75% of the total canopy cover composed of aspen (Populus tremuloides). This type occurs on well-drained steep slopes with southern aspects. Typically, there is no developed shrub layer but willow does occasionally occur. Understory species are Viburnum edule, Linnaea borealis and Arctostaphylos uva-ursi.

e. Dc:ba - Closed paper birch and aspen is a community with neither paper birch nor aspen dominating the canopy cover with 75% of the total cover value. This type is found on well-drained slopes with southern aspects. Willow and alder occasionally occur in the understory with low percentage cover values. Understory species are Rosa acicularis, Calamagrostis canadensis and Arctostaphylos uva-ursi.

2. The open broadleaf forest types have canopy cover values of 25-60%.

a. Do:b - Open paper birch is a community with 75% of the total canopy cover composed of paper birch. This type occurs on well-drained slopes and drainages. The shrub layer is better developed especially on the moist sites than in closed paper birch types. Willow, dwarf birch and alder occur. Understory species include Ledum groelandicum, Calamagrostis canadensis, Empetrum nigrum, Vaccinium uliginosum, Vaccinium vitis-idaea, and Cornus canadensis.

b. Do:a - Open aspen forest is a community with 75% of the total canopy cover composed of aspen. This type occurs on extremely dry steep south facing slopes. The shrub layer is composed of willow. The understory species are Arctostophylos uva-ursi, Epilobium angustifolium, Lycopodium sp., Vaccinium vitis-idaea, Cornus canadensis and

Polytrichium sp.

c. Do:p - Open balsam poplar forest is a community with 75% of the total canopy cover composed of balsam poplar. This type occurs along drainages and as open clumps near treeline. The shrub layer is composed of willow and alder. Understory species include *Calamagrostis canadensis*, *Cornus canadensis*, *Ribes triste*, *Spiraea beauverdiana*, and *Polytrichium* sp.

d. Do:bp - Open paper birch-balsam poplar forest is a type in which neither paper birch nor balsam poplar dominate 75% of the total tree canopy cover value. This type occurs on floodplains and stream banks. Shrub species are willow and alder. Understory species include *Ledum decumbens*, *Vaccinium uliginosum*, *Vaccinium vitis-idaea*, *Equisetum silvaticum* and *Cornus canadensis*.

3. The woodland broadleaf forest types have canopy cover values of 10-25%. The woodland deciduous types are analagous in species composition to the open broadleaf types. The shrubs and understory species have higher percentage cover values than in the open deciduous types.

C. Mixed conifer - broadleaf types have neither conifer species nor broadleaf species dominating with 75% of the tree canopy cover value.

1. The closed mixed conifer-broadleaf types have canopy cover values of 60-100%.

a. Mc:sb - The closed spruce-paper birch mixture occurs with black spruce and/or white spruce as the spruce component of the mixture. When white spruce is present in the mixture this type typically occurs on well-drained south facing slopes and along drainages. When black spruce is present in the mixture, the site is usually a poorly drained north facing slope. Willow and alder are present in the shrub layer. Typical species in the understory are _Vaccinium uliginosum_, _Vaccinium vitis-idaea_, _Calamagrostis canadensis_, _Cornus canadensis_, _Ledum_ spp., and _Polytrichium_ spp.

b. Mc:sbp - The closed spruce-paper birch-balsam poplar mixture occurs along floodplains. Willow and alder are present in the shrub layer. _Spiraea beauverdiana_, _Cornus canadensis_, Ledum decumbens, Empetrum nigrum, Vaccinium uliginosum and Vaccinium vitis-idaea are species common to the understory.

c. Mc:sba - The closed spruce-paper birch-aspen mixture typically occurs on well-drained south facing slopes. Willow, dwarf birch and occasionally alder are present in the shrub layer. Understory species include Cornus canadensis, Linnaea borealis, Vaccinium vitis-idaea, Ledum decumbens, Lycopodium spp. and Vaccinium uliginosum.

d. Mc:as - The closed aspen-spruce mixture typically occurs on well-drained south facing slopes. The shrub layer is composed of willow and occasionally alder. The most common understory species are Arctostaphylos uva-ursi, Epilobium spp., and Drepanocladus spp.

e. Mc:sp - The closed spruce-balsam poplar mixture occurs on floodplains. Willow and alder occur in the shrub layer. Equisetum silivaticum, Epilobium sp., Cornus canadensis, Spiraea beauverdiana and

Polytrichium spp. are common to the understory.

2. The open mixed conifer-broadleaf types have canopy cover values of 25-60%.

   a. Mo:sb - The open mixed spruce-paper birch type occurs on well drained south-facing slopes and along drainages when white spruce is present in the mixture. The open black spruce-paper birch mixture occurs on the wetter north-facing slopes. Willow and alder have higher percentage cover values then was evident in the shrub layer of the closed mixed spruce-birch. Dwarf birch may also occur in the shrub layer. Species common to the understory are *Spirea Beauverdiana*, *Epilobium latifolium*, *Calamagrostis canadensis*, *Gymnocarpium dryopteris* and *Hylocomium splendens*.

   b. Mo:as - The open aspen-spruce mixture typically occurs on well-drained south facing slopes. Willow and occasionally alder occur in the shrub layer. Understory species include *Calamagrostis canadensis*, *Epilobium* latifolium, Arctostaphylos uva-ursi, Rosa acicularis and Equisetum sp.

c. Mo:sbp - The open paper birch-poplar-spruce mixture occurs on floodplains and streambanks. Willow and alder occur in the shrub layer. The understory species include Vaccinium uliginosum, Vaccinium vitis-idaea, Epilobium latifolium, Carex sp, Ledum decumbens and Hylocornium splendens.

d. Mo:sp - The open spruce-poplar mixture occurs on floodplains and streambanks. Willow and alder occur in the shrub layer. The ground layer species include Ledum decumbens, Vaccinium uliginosum, Vaccinium vitis-idaea, Cornus canadensis, Empetrum nigrum and Ptilium spp.

3. The woodland mixed conifer-broadleaf types have canopy cover values of 10-25%. The woodland mixed conifer-broadleaf types are analagous in species composition to the open mixed conifer-broadleaf. The shrubs and understory species have higher percentage cover values than in the open conifer-broadleaf types.

II. Scrub

All scrub types have less than 10% forest canopy cover (i.e. trees over five meters in height at maturity) and shrubs comprise 25% or more of the absolute cover.

A. Dwarf tree scrub types have dwarf trees under five meters in height at maturity (Alaska Vegetation Classification Workshop, March 27, 1984) and they comprise at least 10% dwarf forest canopy cover values.

1. FCc - The closed conifer dwarf scrub type (60-100% canopy cover value) has 75% of the total dwarf tree canopy cover value composed of conifer species. The closed conifer dwarf trees are most frequently black spruce and inhabit north facing permafrost slopes or wet poorly drained concave sites. Willow, dwarf birch and alder comprise the shrub layer. Ground cover species include Carex spp., Calamagrostis canadensis, Vaccinium uliginosum, Ledum groelandicum, Empetrum nigrum, Rubus chamaemorus, Equisetum silvaticum and Sphagnum spp.

2. FCo - The open conifer dwarf scrub type (25-60% canopy cover value) has 75% of the total dwarf tree canopy cover value composed of conifer species. The open conifer dwarf trees are usually black spruce and occur on flat poorly drained permafrost sites or on north facing

permafrost slopes. The shrub layer species are willow, dwarf birch and occasionally alder. Ground cover species include _Carex_ spp., _Calamagrostis canadensis_, _Vaccinium uliginosum_, _Betula nana/glandulosa_, _V. vitis-ideas_, _Ledum_ spp., _Empetrum nigrum_, _Salix fuscescens_, _Oxycoccus microcarpus_, _Petasites_ spp., _Rubus chamaemorus_, _Eriophorum_ spp., _Equisetum_ spp. and _Sphagnum_ spp.

3. FCw - The woodland conifer dwarf tree type (10-25% canopy cover value) has 75% of the total dwarf tree canopy cover value composed of conifer species. The woodland dwarf trees are usually black spruce occurring on wet poorly drained permafrost sites which grade into sphagnum bog areas. The shrub layer is composed of willow and dwarf birch. The understory species include _Andromeda polifolia_, _Ledum palustre_, _Eriophorum_ spp., _Equisetum_ spp., _Salix fuscescens_, _Menyanthes trifoliata_, _Sparganium angustifolium_, _Potentilla palustris_ and _Sphagnum_ spp. The woodland conifer scrub may also occur as dwarf white spruce and/or black spruce trees at elevational treeline.

The broadleaf closed (FDc), open (FDo), and woodland (FDw) dwarf scrub types have 75% of the total dwarf tree canopy cover value composed of broadleaf species. In the study area, these types occur at treeline. Willow, dwarf birch and alder are important in the shrub layer.

The mixed broadleaf-conifer closed (FMc), open (FMo) and woodland (FMw) dwarf scrub types have neither broadleaf nor conifer trees dominating at least 75% of the total dwarf tree canopy cover value. We do not have data on these types for the study area.

B. The tall shrub scrub are shrublands in which at least 25% of the overstory is of a height greater than 1.5 meters. The tall shrub communities are divided into closed and open categories on the basis of the cover percentage of the tall shrub overstory.

1. The closed tall shrub types have canopy cover values of 75-100%.

a. STc:w - Closed tall shrub willow communities typically occur as riparian communities along drainages and as pioneer communities on river floodplains. <u>Salix alaxensis</u> and/or <u>Salix planifolia</u> ssp. pulchra comprise the shrub layer. Species in the understory include <u>Carex</u> spp., <u>Arctagrostis latifolia</u>, <u>Rumex arcticus</u>, and <u>Equisetum silvaticum</u>.

b. STc:l - Closed tall alder shrub communities are usually found on steep slopes above treeline, along drainages and as pioneer communities on river floodplains. Alder has almost complete canopy cover in the shrub overstory. Willow occasionally occurs in the shrub understory. Other understory species include Calamagrostis canadensis, Equisetum silivaticum, Linnaea borealis and Dicranum sp.

c. STc:b - The closed tall shrub birch communities occur occasionally on moist convex sites. Species in the understory are Vaccinium vitis-idaea, Vaccinium uliginosum, Rubus chamaemorus and Sphagnum spp.

d. STc:lw - In the closed tall alder-willow shrub community neither alder nor willow dominate the shrub canopy with at least 75% of the total shrub overstory cover value. This type is usually found on steep slopes above treeline, as a riparian community along drainages and on floodplains. Understory species include Arctagrostis latifolia and Carex bigelowii.

e. STc:bw - In the closed tall shrub birch-willow mixture dwarf birch and willow both occur with greater than 25% values. This type is found rarely on moist convex sites. Understory species include Vaccinium vitis-idaea, Rubus chamaemorus and Carex bigelowii.

f. STc:lbw- In the closed tall alder-shrub birch-willow community alder, shrub birch and willow occur with greater than 25% cover values. This community is found on steep slopes or along drainages above treeline. Understory species include Arctagrostis latifolia and Carex bigelowii

2. The open tall shrub types have shrub canopy cover values of 25-75%.

a. STo:w - Open tall shrub willow typically occurs along rivers or on drainages and slopes above treeline. Salix alaxensis, S. glauca or S. planifolia ssp. pulchra occupy at least 75% of the total shrub cover value. Epilobium latifolium, Calamagrostis canadensis and Equisetum sp. occur in the understory.

b. STo:l - Open tall alder scrub occurs along rivers or on steep slopes above treeline. Alder occupies at least 75% of the total shrub cover value. Willow usually occurs in the low shrub understory. _Calamagrostis canadensis_, _Aconitum delphinifolium_ and _Equisetum silvaticum_ occur as ground cover.

c. STo:b - Open tall shrub birch is of rare occurrence on moist convex sites. Dwarf birch occupies at least 75% of the total shrub cover value. Understory species include _Ledum_ sp., _Vaccinium_ spp., _Arctostaphylos alpina_ and _Festuca altaica_.

The open tall shrub mixtures of alder-willow (STo:lw), shrub birch-willow (STo:bw), and alder-shrub birch (STo:lb) typically occur along rivers or on drainages and slopes above treeline. The community structure of these open tall shrub mixtures are similar to their closed tall shrub counterparts.

C. The low shrub scrub are shrublands with 25% or more overstory cover which is between 20 cm and 1.5 meters in height. If tall shrubs are present, they have less than 25% cover.

1. The closed shrub types have canopy cover values of 75-100%.

   a. SLc:b - Closed low dwarf birch scrub typically occur on convex moderately well-drained sites. Dwarf birch dominates at least 75% of the total shrub canopy cover value. Willow occasionally occurs in the shrub overstory but with less than 25% cover. Other associated species are _Vaccinium uliginosum_, _Spirea beauverdiana_, _Festuca altaica_, _Empetrum nigrum_, _Vaccinium vitis-idaea_, _Stereocaulon_ spp. and _Hylocomium splendens_.

   b. SLc:w - Closed low willow scrub communities occur on wet concavities, on wet flat benches, and on slopes and along streams at higher elevations. Understory species include _Carex_ spp., _Rumex arcticus_, _Arctagrostis latifolia_, _Potentilla fruticosa_, _Equisetum_ spp., _Pinguicula vulgaris_, _Saussurea angustifolia_ and _Polygonum bistorta_.

   c. SLc:bw - The closed low dwarf birch-willow scrub occurs on moist, ombotrophic, convex areas. Both dwarf birch and willow have greater than 25% cover value in the low shrub overstory. Species in the understory are _Equisetum silvaticum_, _Vaccinium uliginosum_, _Vaccinium vitis-idaea_, _Ledum groelandicum_, _Empetrum nigrum_, _Arctostaphylos rubra_, and _Hylocomium splendens_.

d. SLc:e - The closed low ericaceous shrub communities occur on steep dry slopes above treeline. The ericaceous shrubs _Ledum palustre_ and _Vaccinium uliginosum_ compose at least 75% of the shrub overstory. Species in the understory include _Vaccinium vitis-idaea_, _Arctostophylos_ spp. _Cassiope tetragona_, _Empetrum nigrum_, _Salix reticulata_, _Lycopodium_ sp.
and _Diapensia lapponcia_.

2. The open low shrub types have canopy cover values of 25-75%.

a. SLo:b - Open low dwarf birch scrub occurs on well-drained convex minerotrophic areas. Dwarf birch occupies at least 75% of the total shrub overstory cover. Other important associated species are _Salix_ sp., _Ledum groelandicum_, Vaccinium uliginosum, _Vaccinium vitis-idaea_, _Carex_ sp., Arctostaphylos rubra, Rubus chamaemorus, Rubus arcticus, Festuca altaica, Stereocaulon spp., Cladonia spp., Nephroma spp. and Hylocomium splendens.

b. SLo:w - The open low willow shrub communities occur on wet flat or concave benches, along drainages and on sloping cornices. Willow occupies at least 75% of the total shrub overstory cover. Associated species are Hierochloe odorata, Festuca altaica, Salix reticulata, Sanguisorba officinalis, Anenome parviflora, Senecio lugens, Swertia perennis, Rumex arcticus, Rubus chamaemorus, Potentilla fruticosa, Vaccinium uliginosum and Stereocaulon spp.

c. SLo:bw - Open low dwarf birch-willow shrub occurs on moist slopes. Both dwarf birch and willow have cover values of at least 25% of the total shrub cover. Species occurring in the understory are Vaccinium uliginosum, Equisetum silvaticum, Carex sp, Ledum groelandicum, Petasites hyperboreus, Festuca altaica, Arctagrostis latifolia, Epilobium latifolium, Salix reticulata, Artemesia arctica and Poa sp.

d. SLo:1 - The open low alder scrub contains alder which has a cover value of at least 75% of the total shrub cover. This type occurs along streams and on slopes at higher elevations. Understory species include _Salix_ spp., _Calamagrostis canadensis_, _Carex_ spp., _Spiraea beauverdiana_, _Vaccinium ulignosum_, _Vacinium vitis-idaea_, _Linnaea borealis_ and _Cassiope tetragona_.

e. SLo:eu - Low ericaceous shrub-sphagnam bog occurs in depressions and on poorly drained flats. Ericaceous shrubs have a cover value of at least 75% of the total shrub cover value. Sphagnum typically has cover values of at least 25%. Species common to this type are _Ledum palustre_, _Vaccinium uliginosum_, _Vaccinium vitis-idaea_, _Empetrum nigrum_, _Eriophorum_ spp., _Carex_ spp. and _Sphagnum_ spp.

f. SLo:wg - Open low willow-grass tundra occurs on wet flat benches along drainages and on slight slopes at higher elevations. Willow has a cover value of at least 75% of the total shrub cover value. Graminoid species have a cover value of at least 25%. When this type occurs on poorly drained flat areas the associated species are Salix planifolia ssp. pulchra, Salix fuscescens, Sphagnum spp., Calamagrostis canadensis, Carex sp. and Equisetum spp. When this type occurs on slight slopes above treeline, the associated species are Salix planifolia ssp. pulchra, Salix rotundifolia, Carex bigelowii, Salix reticulata, Equisetum spp. Luzula confusa, Festuca rubra, Petasites frigidus, Calamagrostis purpurascens and Polytrichium spp.

g. SLo:be - Open low dwarf birch and ericaceous scrub occurs on well-drained convex slopes. Neither dwarf birch nor ericaceous shrubs have cover values of at least 75% of the total shrub cover value. The species of this type are Betula nana, Ledum palustre, Vaccinium uliginosum, Vaccinium vitis-idaea, Empetrum nigrum, Arctagrostis latifolia, Poa arctica, Festuca altaica, Arctostaphylos spp., Artemesia arctica, Carex spp. Salix reticulata, Salix arctica and Hylocomium splendens.

h. SLo:e - Open low ericaceous shrub communities occur on steep dry slopes above treeline. The ericaceous shrubs Ledum palustre and Vaccinium uliginosum have cover values of at least 75% of the total shrub cover value. Associated species are Salix arctica, Salix planifolia ssp. pulchra, Betula nana, Empetrum nigrum, Vaccinium vitis-idaea, Carex spp., Festuca altaica, Dryas octopetala, Artemesia arctica, Arctostaphylos spp., Arctagrostis latifolia, Hylocomium splendens and Polytrichium spp.

i. SLo:eg - The open low ericaceous-shrub-grass tundra occurs on steep dry slopes above treeline. The ericaceous shrubs Ledum palustre and Vaccinium uliginosum have cover values of at least 75% of the total shrub cover value. The ground layer species are similar to the open low ericaceous shrub community, but the graminoid species have a cover value of at least 25%.

j. SLo:beg- Open low shrub birch-ericaceous-grass tundra occurs on well-drained convex slopes above treeline. Both dwarf birch and ericaceous shrubs have cover values of at least 25% of the total shrub cover value. The ground layer species are similar to the open low dwarf birch and ericaceous scrub, but the graminoid species have a cover value of at least 25%.

k. SLo:bwg- The open low shrub birch-willow-grass tundra occurs on moist slopes above treeline. Both dwarf birch and willow have cover values of at least 25% of the total shrub cover value. The ground layer species are similar to the open low dwarf birch-willow shrub, but the graminoid species have a cover value of at least 25%.

D. The dwarf shrub scrub are communities with 25% or more cover in dwarf shrubs less than 20cm tall. If tall and low shrubs are present, their combined cover should be less than 25%.

1. SMc (75%-100% dwarf shrub cover) - The closed dwarf shrub communities are found on dry slopes and ridges at higher elevations.

a. SMc:s - The major species of this mat and cushion - sedge tundra are _Carex bigelowii_, _Carex_ sp., _Salix reticulata_, _Salix arctica_, _Dryas octopetala_, _Vaccinium vitis-idaea_, Eriophorum spp., Luzula spp., Hylocomium splendens, Polytrichium spp., Peltigera apathosa and Cladonia sp.

b. SMc:g - The major species of this mat and cushion-grass tundra are Festuca rubra, Calamagrostis purpascens, Festuca altaica, Empetrum nigrum, Dryas octopetala, Salix arctica, Vaccinium vitis-idaea, Deschampsia caespitosa, Petasistes hyperboreus, Salix rotundifolia, Alectoria sp., Oxytropis nigrescens, and Cladonia sp.

c. SMc:j - Cassiope tundra occurs on more mesic slopes at higher elevations. The associated species are Cassiope tetragona, Vaccinium uliginosum, Vaccinium vitis-idaea, Salix rotundifolia, Salix reticulata, Lycopodium spp., Carex spp., Calamagrostis purpurascens and Festuca rubra.

d. SMc:e - The major species of closed dwarf ericaceous shrub tundra are Vaccinium uliginosum, Vaccinium vitis-idaea, Empetrum nigrum, Diapensia lapponica, Salix arctica, Cassiope tetragona, Ledum palustre, Salix reticulata, Poa alpina, Arctostaphylos alpina, Festuca rubra and Loiseleuria procumbens.

e. SMo (25-75% dwarf shrub cover) - The open dwarf shrub communities are found on dry windy ridges and rocky areas usually above treeline.

a. SMo:w - The major species of dwarf open willow tundra are Salix rotundifolia, Salix reticulata, Salix polaris, Salix arctica, Carex spp., Empetrum nigrum, Festuca rubra, Dryas octopetala, Silene acualis, Poa arctica, and Cassiope tetragona.

b. SMo:e - The common species of open dwarf ericaceous shrub tundra are Empetrum nigrum, Cassiope tetragona, Arctostaphylos alpina, Dryas octopetala, Diapensia lapponica, Lycopodium spp., Carex spp., Salix polaris, Salix rotundifolia, Silene acualis, Saxifraga tricuspidata, Vaccinium vitis-idaea, Ledum decumbens, Polytrichium spp., and Cladonia sp..

III. Herbaceous

The herbaceous communities have less than 25% cover of woody plants, but 2% or more cover values for vascular and nonvascular flora.

A. Graminoid herbaceous communities are herbaceous communities with the greatest percentage of cover in grasses or sedges.

1. HGd - Dry graminoid herbaceous communities are grasslands on well-drained dry rocky slopes and steep south facing slopes. Typical species of this type are Festuca altaica, Festuca rubra, Calamagrostis purpurascens, Carex podocarpa, Deschampsia caespitosa, Phleum commutatum, Artemesia arctica, Salix reticulata, Dryas octopetala and Vaccinium vitis-idaea.

2. HGm - Mesic graminoid herbaceous communities occur on moist flat areas typically without standing water. Associated species are Calamagrostis canadensis, Carex bigelowii, Eriophorum vaginatum, Salix planifolia ssp. pulchra, Betula nana, Ledum palustre, Vaccinium uliginosum, Vaccinium vitis-idaea and Poa arctica.

3. HGw - Wet graminoid herbaceous communities occur on wet concave sites typically with standing water.

a. HGw:s - The wet sedge meadow tundra is generally in very wet permafrost areas and predominately composed of Eriophorum angustifolium, Carex aquatilis, Carex rostrata and Trichophorum caespitosum.

b. HGw:sh - The wet sedge-herb meadow tundra is found on very wet, poorly drained sites with standing water. The predominate species of this type are Carex aquatilis, Menyanthes trifoliata, Potentilla palustris and Eriophorum angustifolium.

c. HGw:sm - The wet sedge-moss bog occurs on permafrost peat-filled depressions and the predominate species are Sphagnum spp., Carex aquatilis, Menyanthes trifoliata and Equisetum fluviatile.

B. Forb herbaceous communities have the greatest percentage of cover composed of broadleafed herbs or forbs.

1. HFd - Dry forb herbaceous communities occur on dry rocky well-drained tundra slopes and as sparse vegetation on rocky slopes. The typical species of this type are Saxifraga tricuspidata, Artemesia arctica, Diapensia lapponica, Silene acualis, Polygonum viviparum, Campanula

lasiocarpa, Potentilla hyparctica and Epilobium latifolium.

2. HFm - Mesic forb herbaceous communities occur on moist well-drained slopes and stream banks. Typical species of this type are Epilobium angustifolium, Heracleum lanatum, Sanguisorba stipulata, Aconitum delphinifolium and Polygonum viviparum.

3. HFw - Wet forb herbaceous communities occur on wet concavities typically with standing water. The predominate species are Equisetum fluviatile, Menyanthes trifoliata and Hippuris vulgaris.

C. Bryoid Herbaceous communities have the greatest percentage of cover composed of mosses or lichens.

1. HBm - Moss communities in the study area are typically dry moss on rocky slopes. Typical species are Rhacomitrium spp. and Dicranum spp.

2. HBl - Lichen communities occur on rocky slopes. Typical species are Cladowa spp., Cetraria spp. and Stereocaulon spp.

D. HAf - Freshwater aquatic herbaceous communities occur where the vegetation is submerged or floating on fresh water. The common species of this type are *Nuphar polysepalum*, *Hippuris vulgaris* and *Sparangium angustifolium*.

IV. Sparse Vegetation

Sparse vegetation communities are typed when only 5-10% of a barren area is vegetated with Forest (Pf), Scrub (Ps) or herbaceous communities (Ph).

V. Barren

An area is classified barren (O) or barren bedrock (Ob) if less than 5% of the area is vegetated.

VI. Cultural or Urban

Cultural or urban developed areas are typed "U".

VII. Agricultural

Agricultural areas are typed "C".

VIII. Water

Water is typed "W".

7.0 CONVERSION BETWEEN R. A. KREIG & ASSOCIATES, INC. AND UNIVERSITY OF ALASKA VEGETATION MAPPING LEGENDS

As discussed before, previous project area vegetation mapping by University of Alaska, Agricultural Experiment Stations at Palmer (AES) was based on Level II and III of the 1980 Preliminary Classification for Vegetation of Alaska (Viereck et al. 1980). The R. A. Kreig & Associates vegetation mapping is based primarily on Level IV of the 1982 Revision of Preliminary Classification for Vegetation of Alaska (Viereck et al. 1982) with modifications made as a result of the Alaska Vegetation Classification Workshop (1984) and fieldwork done by R. A. Kreig & Associates, Inc.

Several significant differences in the legend of the AES Palmer group and the present legend are due to the major changes made in the Preliminary Classification for Vegetation of Alaska (Viereck et al. 1980):

1. Dwarf tree scrub has been separated from the forest types. These are dwarf or stunted trees found commonly at treeline and on very poor sites such as treed bogs. This unit includes all types in which tree species will attain less than 5 meters in height.

2. The AES Palmer Legend types, sedge grass tundra, sedge shrub tundra, birch shrub and willow shrub are all Level III tundra categories of the Viereck 1980 version. These

tundra categories have been eliminated in the 1982 Viereck Revision and they are now separated out at Level IV of the scrub and herbaceous categories. Tundra is now considered to be a landscape term. Users of the Viereck (1980) classification had difficulty separating tundra types from both shrub and herbaceous types.

The otner major differences in the AES Palmer mapping is its use of more general types in Level II and Level III of the Viereck 1980 version. The AES Palmer legend for the 1:63,360 mapping was based on 25 types. The present mapping is all based on Level IV of the 1982 Revision of Viereck (98 types) and further refined by the three part forage shrub cover value code. The three part forage cover value code has 60 possible understory code combinations which may be associated with anyone of 69 overstory types. The legend used in the present study achieves a large increase in the number of different types and a higher level of resolution. A table listing the R. A. Kreig legend (after Viereck, 1982) and the corresponding types used in the AES Palmer Mapping (after Viereck, 1980) is included as Table 8.

Table 8 - Cross Reference Between Alaska Vegetation Classification and University of Alaska (AES) Legend.

Alaska Vegetation Classification Unit Name (Viereck et al. 1982)				Susitna Vegetation Mapping Unit Symbol	University of Alaska A.E.S. Vegetation Key			
1. Forest	A. Conifer	1. Closed	K) White Spruce	Cc:w	CS	Closed Spruce		
		(60-100%)	L) Black Spruce	Cc:m		(50-100%)		
			M) Black & White Spruce	Cc:mw				
		2. Open	F) White Spruce	Co:w	OS	Open Spruce	a) white	OSW
		(25-60%)	G) Black Spruce	Co:m		(25-50%)	b) black	OSB
			H) Black & White Spruce	Co:mw				
		3. Woodland	C) White Spruce	Cw:w	WS	Woodland Spruce	a) white	WSW
		(10-25%)	D) Black Spruce	Cw:m		(10-25%)	b) black	WSB
			E) Black & White Spruce	Cw:mw				
	B. Broadleaf	1. Closed	B) Black Cottonwood	Dc:o	CD	Closed Deciduous		
		(60-100%)	C) Balsam Poplar	Dc:p		(50-100%)	a) Balsam poplar	CP
			D) Paper Birch	Dc:b			b) Paper Birch	CBF
			E) Aspen	Dc:a				
			F) Birch - Aspen	Dc:ba				
		2. Open	A) Paper Birch	Do:b	OD	Open Deciduous	a) birch	OBF
		(25-60%)	B) Aspen	Do:a		(25-50%)	b) poplar	OP
			C) Balsam Poplar	Do:p				
			D) Paper Birch - Poplar	Do:bp				
		3. Woodland	A) Paper Birch	Dw:b				
		(10-25%)	B) Poplar	Dw:p				
			C) Paper Birch - Poplar	Dw:bp				
	C. Mixed	1. Closed	A) Spruce - Birch	Mc:sb	CM	Closed Mixed Forest		
		(60-100%)	B) Spruce - Birch - Poplar	Mc:sbp		(50-100%)		
			C) Spruce - Birch - Aspen	Mc:sba				
			D) Aspen - Spruce	Mc:as				
			E) Spruce - Poplar	Mc:sp				
		2. Open	A) Spruce - Birch	Mo:sb	OM	Open Mixed Forest		
		(25-60%)	B) Aspen - Spruce	Mo:as		(25-50%)		
			C) Spruce - Birch - Poplar	Mo:sbp				
			D) Spruce - Poplar	Mo:sp				
		3. Woodland	A) Spruce - Birch	Mw:sb	WM	Woodland Mixed Forest		
		(10-25%)	B) Spruce - Poplar	Mw:sp		(10-25%)		
			C) Spruce - Birch - Poplar	Mw:sbp				
			D) Spruce - Birch - Aspen	Mw:sba				

Table 8 - Cross Reference Between Alaska Vegetation Classification and University of Alaska (AES) Legend. (cont'd)

2. Scrub	A. Dwarf Tree (<5m)	Conifer						
		1. Closed (60-100%)		FCc	CS	Closed Spruce (50-100%)		
		2. Open (25-60%)		FCo	OS	Open Spruce (25-50%)		
		3. Woodland (10-25%)		FCw	WS	Woodland Spruce (10-25%)		
		Broadleaf						
		1. Closed (60-100%)		FDc	CD	Closed Deciduous (50-100%)		
		2. Open (25-60%)		FDo	OD	Open Deciduous (25-50%)		
		3. Woodland (10-25%)		FDw				
		Mixed						
		1. Closed (60-100%)		FMc	CM	Closed Mixed Forest (50-100%)		
		2. Open (25-60%)		FMo	OM	Open Mixed Forest (25-50%)		
		3. Woodland (10-25%)		FMw	WM	Woodland Mixed Forest (10-25%)		
	B. Tall Shrub	1. Closed (75-100%) (>1.5m)	A) Willow	STc:w			a) Willow	W
			B) Alder	STc:l	CTS	Closed Tall Shrub (50-100%)		
			C) Shrub Birch	STc:b			c) birch	B
			D) Alder - Willow	STc:lw	CTS	Closed Tall Shrub		
			E) Shrub Birch - Willow	STc:bw				
			*) Alder - Shrub Birch - Willow	STc:lbw	CTS	Closed Tall Shrub		
		2. Open (25-75%) (>1.5m)	A) Willow	STo:w			a) Willow	W
			B) Alder	STo:l	OTS	Open Tall Shrub (10-50%)		
			C) Shrub Birch	STo:b			b) Birch	B
			D) Alder - Willow	STo:lw	OTS	Open Tall Shrub		
			E) Shrub Birch - Willow	STo:bw				
			*) Alder - Shrub Birch	STo:lb	OTS	Open Tall Shrub		
	C. Low Shrub	1. Closed (75-100%)	A) Dwarf Birch	SLc:b	LS	Low Shrub	a) Birch	B
			B) Low Willow	SLc:w			b) Willow	W
			C) Dwarf Birch - Low Willow	SLc:bw				
			D) Ericaceous Shrub Tundra	SLc:e				
			*) Birch-Ericaceous-Grass	SLc:beg				
			*) Ericaceous - Grass	SLc:eg				
			*) Low Alder	SLc:l				
			*) Low Alder - Willow	SLc:lw				
			*) Low Willow - Grass	SLc:wg				

Table 8 - Cross Reference Between Alaska Vegetation Classification and University of Alaska (AES) Legend. (cont'd)

		2. Open (25-75%) (<1.5m)	A) Dwarf Birch	SLo:b	LS	Low Shrub (10-100%)
			B) Low Willow	SLo:w		
			C) Dwarf Birch - Willow	SLo:bw		
			D) Low Alder	SLo:l		
			J) Ericaceous Shrub - Sphagnum Bog	SLo:eu	SST	Sedge Shrub Tundra (<10% Low Shrub)
			S) Willow Grass Tundra	SLo:wg		
			T) Birch & Ericaceous Shrub	SLo:be		
			*) Ericaceous Shrub	SLo:e		
			*) Ericaceous Shrub - Grass	SLo:eg		
			*) Birch-Ericaceous-Grass	SLo:beg	LS	Low Shrub (10-100%)
			*) Birch - Willow - Grass	SLo:bwg		
			*) Birch - Grass	SLo:bg		
			*) Low Alder - Willow	SLo:lw		
	D. Dwarf Shrub (<20cm)	1. Closed (75-100%)		SMc		
			A) Mat & Cushion - Sedge	SMc:s	MCT	Mat and Cushion Tundra
			B) Mat & Cusion - Grass	SMc:g		
			D) Cassiope	SMc:j	SST	Sedge Shrub Tundra (<10% low shrub) (<30cm tall)
			G) Low Ericaceous Shrub	SMc:e		
		2. Open (25-75%)		SMo		
			E) Low Willow	SMo:w		
			*) Ericaceous Shrub	SMo:e		
3. Herbaceous	A. Graminoid	1. Dry		HGd	G	Grassland
		2. Mesic		HGm	SGT	Sedge Grass Tundra
		3. Wet		HGw	WSG	Wet Sedge Grass
			A) Wet Sedge Meadow	HGw:s		
			C) Wet Sedge - Herb	HGw:sh		
			M) Sedge - Moss Bog	HGw:sm		
	B. Forb	1. Dry		HFd	H	Herbaceous
			C) Alpine Herbs	HFd:h		
		2. Mesic		HFm		
		3. Wet		HFw		
	C. Bryoid	1. Mosses		HBm		
		2. Lichens		HBl		
	D. Aquatic	1. Fresh water		HAf	LE	Lacustrine Emergent
4. Sparse Vegetation (5-10%)	A. Forest			Pf	PF	Palustrine Forested
	B. Scrub			Ps	PSS	Palustrine Scrub-Shrub
	C. Herbaceous			Ph	PE	Palustrine Emergent
5. Barren (<5%)				O	S	Snow and Ice
	A. Bedrock			Ob	R	Rock
6. Cultural-Urban Developed				U	D	Disturbed, Developed
7. Agricultural				A	C	Crop
8. Water				W	L	Lakes and Streams

8.0 DIGITIZING & DATA STORAGE FORMATS

Rectification of the mapping to a controlled topographic base and the preparation of an automated data file was done by Resource Data Consultants of Bountiful, Utah under subcontract. After the delineation of vegetation units on overlays to the CIR aerial photography, 50-200 control points were identified per photo. The unit boundaries were digitized and unit names were entered into the database. The automated map data was then computer rectified to fit USGS topographic quads of the study area. Nine track data tapes were prepared in MOSS format. Symtem Integrators, Inc. performed several data conversion operations on the data prior to submittal to ADF&G for their use.

A set of IBM-PC disks was also prepared that contains a seperate file for each quadrangle in the study area. Each file contains a seperate record for each polygon. Each record contains the polygon (vegetation map unit) number, polygon name, UTM X coordinate, UTM Y coordinate. The polygon names have been broken down into four seperate fields which compose the fractional parts of complex vegetation unit names. The fields are named: N1 (numerator of the first fraction), D1 (denominator of the first fraction), N2 (numerator of the second fraction), and D2 (denominator of the second fraction). These disks contain the database with the most complete error correction and editing; they are in quoted, basic compatable, format.

9.0 BASE MAP

A controlled orthophoto base would normally have been the ideal way to present the final vegetation maps. Orthophotos allow direct plotting from a digitizied database, without additional scale transformation or rectification. They also can be more easily used in the field for point and site location. Unfortunately, none existed for the map area and time and budget limitations precluded their preparation.

Other base mapping alternatives considered included:

1) Closely controlled airphoto mosaic which is then rephotographed to provide the base map mylar. This approach is expensive and it approaches or exceedes the cost of controlled orthophotography.

2) A less expensive uncontrolled airphoto mosaic.

3) Compile the completed map on US Geological Survey quad sheet reverse mylars (a commonly used approach). Like orthophotography, a prime advantage is that this map base is true to scale and can be plotted directly from a digitized database. The major disadvantage is that there

is a lack of an aerial photographic base that provides the user with a better natural prospective of the map area which allows a reference to features for identification of unit boundaries in the field.

4) Individual, unrectified small scale photographic enlargements. This alternative can be used when photography of sufficiently small scale is available so that individual prints cover a sizeable portion of the project area so that each print can be enlarged to the desired scale and serve as a map sheet. For the Susitna project there are two suitable coverages of photography, a) 1:120,000 scale CIR (referred to above) flown in 1976, b) 1:120,000 black and white coverage available flown 1979-1981 with east-west trending flight lines. With either of these coverages enlarged two times to 1:63,360, each photo enlargement then covers the equivalent of four 1:63,360 prints. This reduces the number of map sheets for the project area to a manageable size (in this case, about 20).

Shortly after award of the contract, we investigated these different base mapping alternatives. After consideration of the cost (including the need to ultimately have a base suitable for digitizing), it was decided that 1) it was not appropriate to proceed with the preparation of an orthophotography base and 2) that the most suitable and cost effective approach was the fourth alternative above (individual, unrectified small scale photographic enlargements).

The color infrared photography was used rather than black and white because better definition in the preparation of mylars is possible from color infrared because of its superior haze penetrating capability. A slight disadvantage of the CIR flights is that the flight lines were not laid out in cardinal directions; they are skewed approximately 55° east of north. The resulting layout of map sheets is shown in Figure 2. This alternative is the only one that does not require second generation copying of the photography. The mylars are first generation prints from aerial negatives therefore it does not suffer the image degradation inherent in the process by which each of the above alternatives is constructed.

10.0 DISCUSSION

10.1 Mapping Methodology Discussion

As stated previously, our legend is based on the Alaska Vegetation Classification (Viereck et al. 1982) and its updates. The Viereck classification was developed as an "on the ground" vegetation classification system. A prime advantage of our map legend is that it is applicable over extensive areas and it has a proven track record of its adaptability for ground surveys. The percentages for canopy cover and the height categories adopted have proven to be realistic for field inventory and mapping in the Susitna area. Since the legend has categories that can be directly obtained from the ground, the map has proven to correlate effectively with the Browse Inventory Study. Although the primary emphasis of the map was on moose forage vegetation, the categorical community classification is adopted from the multipurpose statewide Vegetation Classification System used on the Department of Natural Resources, Alaska Resource Mapping Project. The symbology used was developed by R. A. Kreig & Associates, Inc. for mapping done on that project. The fractional legend symbology allowed the superposition of the moose forage cover values on the multipurpose categorical classification. Therefore, these maps should be compatible for multipurpose statewide comparison studies and future habitat-based impact studies.

Another advantage of the legend is the hierarchical nature of the Alaska Vegetation Classification System which allows a multilevel approach to the mapping, verification and subsequent use of the map. Its capacity for aggregation or further breakdown of categories allows variable scale ground data collection, photo interpretation, map production and analysis to be accomplished efficiently. The classification system may be entered at the particular level appropriate to the individual user and the information generated by others to form an aggregate category at the next higher level. If it is necessary to produce the map at a larger or smaller scale, the polygon typing may be aggregated or broken down without losing categorical information.

Due to the hierarchical nature of the legend, there is no vegetation type-forage cover class ambiguity or overlap. Repetitive, consistent results can be obtained between interpreters with proper quality control and supervision. The Alaska Vegetation Classification, upon which the legend is based, has widespread use and the Browse Inventory crew successfully utilized the legend classification and the advance map products in their 1984 field data collection effort. The particular forage cover class percentage breakdown was chosen after examination of three existing field data sets for the study area, field experience and user consultation. The cover class breakdown ranges used are broad enough to maintain a consistent definition of shrub canopy cover values between users, but is narrow enough to preserve necessary detail.

Users of the legend and map should be aware that classifiers of vegetation working on the ground are more sensitive to plant density, in contrast to, photointerpreters who tend to place more emphasis on canopy cover as determined from site signature. Ground classifiers also have a tendency to classify much smaller, pure vegetation types. When mapping, the interpreter must have a way to represent, not only the pure vegetation types, but also the occurrence of mosaics of these pure types. Our legend system accommodates these mosaics of vegetation types by using complexes. These complexes are also used in the legend to accomodate ecotones. The Alaska Vegetation Classification System (Viereck et al. 1982) contains mixture types and as a result of field experience, we have also added additional mixture types to accomodate these ecotones which appear where any of the vegetation types merge along an environmental gradient. Often there will be species in ecotones that are not normally present in communities on either side. In some cases, such as a low shrub willow community and an herbaceous graminoid community, the types will mosaic and will be mapped as a complex (SLo:w/200 + HGm). Where different life form communities merge as tall shrub alder and low shrub willow, both communities may be complete, one above the other and will be mapped as a mixture type (STc:lw/103).

10.2 Mapping Accuracy Discussion

Internal quality assurance proceedures were followed to maintain accuracy in vegetation type-forage cover class calls boundary placement, and minimum map unit size consistancy. All the photo maps were cross-checked between the two interpreters to maintain consistency and accuracy in the vegetation type-forage cover class mapping. The senior consultant, Ken Winterberger, has many years of field experience in South Central Alaska as well as knowledge of the terrain and vegetation of the Susitna Mapping area. He reviewed the vegetation maps before their finalization. The Alaska Department of Fish and Game evaluated the accuracy of the photo maps at several stages of refinement as they worked with the browse inventory field data.

The seasonal variations in the appearance of vegetation on the photos are substantial. The date of the photography and the phenological development of the overstory and understory species tends to affect the estimation of the proportion and the identification of the vegetation components. The wide variation in the physiography and climate of the study area also creates a great variation in the phylogeny of the vegetation and resultant photosignature. Much of the 1:60,000 CIR photography used as a map base is of variable quality and flight date, therefore, site/signature relationships were frequently radically different from one flight line to another. The field data and fall color aerial oblique stereo photo (35 mm) documentation was very important in understanding the differences in photo signature due to phylogeny and were extremely useful for maintaining consistent area-wide uniformity and accuracy in mapping throughout the diverse study area.

The multilevel approach to photo interpretation, that this study was based on, utilized aerial photography of several different scales, stereo oblique low level aerial photography and ground photography. The photo interpreters had the benefit of a large amount of ground data from US Forest Service, AES Palmer Study, BLM Denali Study, ADF&G Browse Inventory, and R. A. Kreig & Associates, data collected for this study (Table 1). Therefore it is felt that this substantial semiquantitative database has resulted in a high level of accuracy and consistency for the photo interpretation performed for this study.

11.0 SUMMARY

This forage vegetation mapping product has created a detailed map data base which will support habitat-based impact assessment and mitigation planning for the Susitna Hydroelectric Project Area. The vegetation mapping was used as the basis for stratification and statistical analysis for the ADF&G Browse Inventory Study.

Maximum vegetation information was mapped at 1:63,360 scale using stereoscopic photo interpretation and multiscale mapping techniques. The highest level of resolution categorically achieved was the assessment of the important moose forage shrub species (willow, dwarf birch and alder). A mnemonic alpha code labeling system for the vegetation classification at Level IV (Viereck et al., 1982) was used in combination with a numeric code to represent the percentage cover for the understory content of the shrub species willow, dwarf birch and alder. In vegetation mosaics, where cartographic separation of the vegetation types was not possible, complexes were used. The mosaic complexes provide meaningful information on vegetation pattern and species distribution to increase the accuracy of the sampling and variation assessment for the Browse Inventory.

An interactive approach to the development of the mapping methodology and legend involved several iterative stages of refinement. As part of this development process, legend map test areas were prepared for the user at two scales (1:24,000 and 1:60,000). A pre-field advance mapping of five test areas allowed an early review of the adequacy of the potential mapping accuracy and its scale.

Thorough review, collection and analysis of all available reference and ground plot data provided a very substantial amount of large scale photo coverage useful for the demonstration of site/signature relationships which aided in prefield mapping and legend development. An efficient field sampling program, which did not duplicate existing information, allowed concentration on the most complex areas. This made it possible to obtain greater accuracy and categorical detail (in some cases beyond the limitations of the photography). By interacting closely with the Browse Inventory study, map product types were developed which accurately assisted the sampling stratification and data analysis. The Browse Inventory study in turn provided the mapping project with a large amount of ground data that was used to improve the accuracy and quality of the map product. 35mm oblique stereo low level aerial natural color photos were taken during the optimum fall color separation of the forage shrub elements providing additional detail on the effect of phylogeny on photo signature and increasing the accuracy and resolution of the map product.

The mapping of variation in percentage cover of the three understory forage species superimposed with overstory cover mapping resulted in a uniquely high level of complexity and resolution.

12.0 REFERENCES

Harza-Ebasco Susitna Joint Venture (1984) Susitna Hydroelectric Project. Vegetation Mapping Request for Proposals.

Dingman, S. Lawrence and Koutz, Fleetwood R. (1974), Relations among vegetation, permafrost, and potential insolation in Central Alaska. Arctic and Alpine Research, Vol. 6, No. 1, pp 37-42.

Viereck, L. A. and C. T. Dyrness (1980), A preliminary classification for vegetation of Alaska, Pacific Northwest Forest and Range Experiment Station, General Technical Report, PNW-106, 38 p.

Viereck, L.A., C. T. Dyrness, and A. R. Batten (1982), 1982 Revision of Preliminary Classification for Vegetation of Alaska.

Lee, R. (1962), Theory of the "equivalent slope." Monthly Weather Rev. 90:165-166.

Lee, R. (1964), Potential insolation as a topoclimatic characteristic of drainage basins. Int. Assoc. Sci. Hydrol. Bull., 9(1):27-41.

McKendrick, J. et al. (1982), Plant ecology studies. Susitna

Hydroelectric Project. Phase 1 Final Rep., University of Alaska.

Steigers, W. et al. (1983) Plant ecology studies. Susitna Hydroelectric Project. Final Rep., University of Alaska.