

ALASKA LEGISLATURE SPECIAL COMMITTEE / SUBJECT FILES 8672

1007 SCOMM44: HOUSE POWER ALTERNATIVES STUDY COMM. 1979-8007

Appendix II Table 7.

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY
624941149221500 - SUSITNA R AB PORTAGE C NR GOLD CREEK AK

PROCESS DATE 02/11
DISTRICT CODE 02

WATER QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

DATE	SUS. SED. FALL DIAM. % FINER THAN (70338)	SUS. SED. FALL DIAM. % FINER THAN (70339)	SUS. SED. FALL DIAM. % FINER THAN (70340)	SUS. SED. FALL DIAM. % FINER THAN (70341)	SUS. SED. FALL DIAM. % FINER THAN (70342)	SUS. SED. FALL DIAM. % FINER THAN (70343)	SUS. SED. FALL DIAM. % FINER THAN (70344)	SUS. SED. FALL DIAM. % FINER THAN (70345)	SUS. SED. FALL DIAM. % FINER THAN (70346)	TOTAL MERCURY (MG) (UG/L) (71900)	SUS- PENDE SEDIM ENT (MG/L) (80154)
JUN 14...	3	6	11	22	39	59	82	98	100	.4	956

DIS- SOLVED MAN- GANESE (MN) (UG/L) (01056)	TOTAL MOLYB- DENUM (MO) (UG/L) (01062)	TOTAL NICKEL (NI) (UG/L) (01067)	TOTAL SILVER (AG) (UG/L) (01077)	TOTAL ZINC (ZN) (UG/L) (01092)	TOTAL ALUM- INUM (AL) (UG/L) (01105)	TOTAL SELE- NIUM (SE) (UG/L) (01147)	DIS- SOLVED SOLIDS (RESI- DUE AT 180 C) (MG/L) (70300)	DIS- SOLVED SOLIDS (SUM OF CONSTI- TUENTS) (MG/L) (70301)	DIS- SOLVED SOLIDS (TONS PER DAY) (70302)	DIS- SOLVED SOLIDS (TONS PER AC-FT) (70303)	SUS. SED. FALL DIAM. % FINER THAN (70337)
20	1	100	<10	110	9500	1	50	51	6750	.07	2

Appendix II Table 7.

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY
624941149221500 - SUSITNA R AB PORTAGE C NR GOLD CREEK AK

PROCESS DATE 02/10/74
DISTRICT CODE 02

WATER QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

TIME	TYPE	TEMPER- ATURE (DEG C) (00010)	INSTAN- TANEOUS DIS- CHARGE (CFS) (00061)	COLOR (PLAT- INUM- COBALT UNITS) (00080)	SPE- CIFIC CON- DUCT- ANCE (MICRO- MHOS) (00095)	DIS- SOLVED OXYGEN (MG/L) (00300)	PH (UNITS) (00400)	CARBON DIOXIDE (CO2) (MG/L) (00405)	ALKA- LINITY AS CACO3 (MG/L) (00410)	BICAR- BONATE (HCO3) (MG/L) (00440)	CAR- BONATE (CO3) (MG/L) (00445)
130	2	8.0E50000		55	80	12.8	7.2	3.7	30	37	0
			</								

Appendix II Table 7.
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CENTRAL LABORATORY, DENVER, COLORADO

WATER QUALITY ANALYSIS
LAB ID # 291069 RECORD # 42798

SAMPLE LOCATION: SUSITNA R AB PORTAGE C NR GOLD CREEK AK
STATION ID: 624941149221500 LAT.LONG.SEO.: 624941 1492215 00
DATE OF COLLECTION: BEGIN--771005 END-- TIME--1300
STATE CODE: 02 COUNTY CODE: 170 PROJECT IDENTIFICATION: 470200350
DATA TYPE: 2 SOURCE: SURFACE WATER GEOLOGIC UNIT:
COMMENTS:
FIELD VALUE USED FOR BICARB & CARBONATE.

AIR TEMP (DEG C)		8.0	MOLYBDENUM TOTAL	UG/L	4
ALK.TOT (AS CaCO3)	MG/L	45	NICKEL TOTAL	UG/L <	50
ALUMINUM TOTAL	UG/L	410	NO2+NO3 AS N DISS	MG/L	0.07
ARSENIC TOTAL	UG/L	1	OXYGEN DISSOLVED	MG/L	13.9
BARIUM TOTAL	UG/L	200	PH FIELD		7.2
BICARBONATE	MG/L	55	PHOS ORTHO DIS AS P	MG/L	0.00
CADMIUM TOTAL	UG/L <	10	PHOSPHATE DIS ORTHO	MG/L	0.00
CALCIUM DISS	MG/L	20	POTASSIUM DISS	MG/L	1.6
CARBONATE	MG/L	0	RESIDUE DIS CALC SUM	MG/L	98
CHLORIDE DISS	MG/L	17	RESIDUE DIS TON/AFT		0.12
CHROMIUM TOTAL	UG/L	10	RESIDUE DIS TON/DAY		1530
COLOR		8	RESIDUE DIS 180C	MG/L	87
COPPER TOTAL	UG/L	20	SAR		-0.4
FLUORIDE DISS	MG/L	0.1	SELENIUM TOTAL	UG/L	0
HARDNESS NONCARB	MG/L	17	SILICA DISSOLVED	MG/L	8.7
HARDNESS TOTAL	MG/L	62	SILVER TOTAL	UG/L <	10
IRON DISSOLVED	UG/L	40	SODIUM DISS	MG/L	7.1
IRON TOTAL	UG/L	730	SODIUM PERCENT		19
LEAD TOTAL	UG/L <	100	SP. CONDUCTANCE FLD		165
MAGNESIUM DISS	MG/L	3.0	SP. CONDUCTANCE LAB		170
MANGANESE DISSOLVED	UG/L	0	STREAMFLOW (CFS) -INST	SS/	6500
MANGANESE TOTAL	UG/L	40	SULFATE DISS	MG/L	13
MERCURY TOTAL	UG/L	0.0	WATER TEMP (DEG C)		2.0
			ZINC TOTAL	UG/L	20

CATIONS			ANIONS		
	(MG/L)	(MEQ/L)		(MG/L)	(MEQ/L)
CALCIUM DISS	20	0.946	BICARBONATE	55	0.90
MAGNESIUM DISS	3.0	0.247	CARBONATE	0	0.00
POTASSIUM DISS	1.6	0.041	CHLORIDE DISS	17	0.48
SODIUM DISS	7.1	0.309	FLUORIDE DISS	0.1	0.00
			SULFATE DISS	13	0.27
			NO2-NO3 AS N D	0.07	0.00
TOTAL		1.545	TOTAL		1.66

PERCENT DIFFERENCE = -2.07

Appendix II Table 7.

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY
15292000 - SUSITNA RIVER AT GOLD C AK

PROCESS DATE 01
DISTRICT CODE 02

WATER QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

DATE	TIME	TYPE	TEMPER- ATURE (DEG C) (00010)	AIR TEMPER- ATURE (DEG C) (00020)	SURFACE AREA (SQUARE MILES) (00049)	INSTAN- TANEOUS DIS- CHARGE (CFS) (00061)	COLOR (PLAT- INUM- COBALT UNITS) (00080)	SPE- CIFIC CON- DUCT- ANCE (MICRO- MHOS) (00095)	DIS- SOLVED OXYGEN (MG/L) (00300)	PH (UNITS) (00400)	CARBON DIOXIDE (CO2) (MG/L) (00405)	ALKA- LITY AS CACO3 (MG/L) (00410)
OCT 01...	1400	2	3.5	--	6160	5330	--	--	--	--	--	--
MAY 10...	1830	2	1.0	--	6160	3730	--	--	--	--	--	--
18...	1000	2	--	--	6160	14200	--	--	--	--	--	--
JUN 14...	1630	2	8.0	17.0	6160	52000	45	102	12.2	6.8	7.1	23
JUL 28...	1730	2	14.0	--	6160	21000	--	--	--	--	--	--
AUG 10...	1430	2	12.0	--	6160	20000	25	163	11.1	7.9	1.1	45

DATE	SUS. SED. FALL DIAM. % FINER THAN .062 MM (70342)	SUS. SED. FALL DIAM. % FINER THAN .125 MM (70343)	SUS. SED. FALL DIAM. % FINER THAN .250 MM (70344)	SUS. SED. FALL DIAM. % FINER THAN .500 MM (70345)	SUS. SED. FALL DIAM. % FINER THAN 1.00 MM (70346)	TOTAL MERCURY (UG/L) (71900)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE MSL) (72000)	SUS- PENDE SEDIM- ENT (MG/L) (80154)	SUS- PENDE SEDIM- ENT DIS- CHARGE (T/DAY) (80155)
OCT 01...	--	--	--	--	--	--	677	10	144
MAY 10...	--	--	--	--	--	--	677	120	1210
18...	--	--	--	--	--	--	677	1110	42600
JUN 14...	40	62	84	97	100	.2	677	915	128000
JUL 28...	--	--	--	--	--	--	677	394	22300
AUG 10...	--	--	--	--	--	.3	677	656	35400

Appendix II Table 7.

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY
15292000 - SUSITNA RIVER AT GOLD C AK

PROCESS DATE 0
DISTRICT CODE 02

WATER QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

DATE	BICAR- BONATE (HCO3) (MG/L) (00440)	CAR- BONATE (CO3) (MG/L) (00445)	DIS- SOLVED NITRITE PLUS NITRATE (N) (MG/L) (00631)	DIS- SOLVED ORTHO PHOS- PHATE (P04) (MG/L) (00660)	DIS- SOLVED ORTHO. PHOS- PHORUS (P) (MG/L) (00671)	HARD- NESS (CA,MG) (MG/L) (00900)	NON- CAR- BONATE HARD- NESS (MG/L) (00902)	DIS- SOLVED CAL- CIUM (CA) (MG/L) (00915)	DIS- SOLVED MAG- NE- SIUM (MG) (MG/L) (00925)	DIS- SOLVED SODIUM (NA) (MG/L) (00930)	SODIUM AD- SORP- TION RATIO (00931)	PERCENT SODIUM (00932)
OCT 01...	--	--	--	--	--	--	--	--	--	--	--	--
MAY 10...	--	--	--	--	--	--	--	--	--	--	--	--
18...	--	--	--	--	--	--	--	--	--	--	--	--
JUN 14...	28	0	.06	.06	.02	36	13	12	1.4	2.4	.2	12
JUL 28...	--	--	--	--	--	--	--	--	--	--	--	--
AUG 10...	55	0		.06	.02	75	30	23	4.3	3.6	.2	9

DATE	DIS- SOLVED PO- TAS- SIUM (K) (MG/L) (00935)	DIS- SOLVED CHLO- RIDE (CL) (MG/L) (00940)	DIS- SOLVED SULFATE (SO4) (MG/L) (00945)	DIS- SOLVED FLUO- RIDE (F) (MG/L) (00950)	DIS- SOLVED SILICA (SI02) (MG/L) (00955)	TOTAL ARSENIC (AS) (UG/L) (01002)	TOTAL BARIUM (BA) (UG/L) (01007)	TOTAL CAD- MIUM (CD) (UG/L) (01027)	TOTAL CHRO- MIUM (CR) (UG/L) (01034)	TOTAL COPPER (CU) (UG/L) (01042)	TOTAL IRON (FE) (UG/L) (01045)	DIS- SOLVED IRON (FE) (UG/L) (01046)
OCT 01...	--	--	--	--	--	--	--	--	--	--	--	--
MAY 10...	--	--	--	--	--	--	--	--	--	--	--	--
18...	--	--	--	--	--	--	--	--	--	--	--	--
JUN 14...	1.1	15	4.7	.1	5.2	5	0	<10	30	50	20000	100
JUL 28...	--	--	--	--	--	--	--	--	--	--	--	--
AUG 10...	4.4	5.4	14	.1	4.9	12	500	<10	40	50	18000	--

Appendix II Table 7.

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY
15292000 - SUSITNA RIVER AT GOLD C AK

PROCESS DATE 4.
DISTRICT CODE 02

WATER QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

DATE	DIS- SOLVED SOLIDS (TONS PER AQ-FT) (70303)	SUS. SED. SIEVE DIAM. % FINER THAN .062 MM (70331)	SUS. SED. SIEVE DIAM. % FINER THAN .125 MM (70332)	SUS. SED. SIEVE DIAM. % FINER THAN .250 MM (70333)	SUS. SED. SIEVE DIAM. % FINER THAN .500 MM (70334)	SUS. SED. SIEVE DIAM. % FINER THAN 1.00 MM (70335)	SUS. SED. SIEVE DIAM. % FINER THAN 2.00 MM (70336)	SUS. SED. FALL DIAM. % FINER THAN .002 MM (70337)	SUS. SED. FALL DIAM. % FINER THAN .004 MM (70338)	SUS. SED. FALL DIAM. % FINER THAN .008 MM (70339)	SUS. SED. FALL DIAM. % FINER THAN .016 MM (70340)	SUS. SED. FALL DIAM. % FINER THAN .031 MM (70341)
OCT 01...	--	--	--	--	--	--	--	--	--	--	--	--
MAY 10...	--	44	64	87	99	100	--	--	--	--	--	--
18...	--	63	76	90	99	100	--	7	9	17	27	44
JUN 14...	.09	--	--	--	--	--	--	2	4	6	11	22
JUL 28...	--	70	80	92	99	100	--	14	19	29	44	54
AUG 10...	.10	65	74	86	95	98	99	13	19	27	39	52

DATE	TOTAL LEAD (PB) (UG/L) (01051)	TOTAL MAN- GANESE (MN) (UG/L) (01055)	DIS- SOLVED MAN- GANESE (MN) (UG/L) (01056)	TOTAL MOLYB- DENUM (MO) (UG/L) (01062)	TOTAL NICKEL (NI) (UG/L) (01067)	TOTAL SILVER (AG) (UG/L) (01077)	TOTAL ZINC (ZN) (UG/L) (01092)	TOTAL ALUM- INUM (AL) (UG/L) (01105)	TOTAL SELE- NIUM (SE) (UG/L) (01147)	DIS- SOLVED SOLIDS (RESI- DUE AT 180 C) (MG/L) (70300)	DIS- SOLVED SOLIDS (SUM OF CONSTIT- TUENTS) (MG/L) (70301)	DIS- SOLVED SOLIDS (TONS PER DAY) (70302)
OCT 01...	--	--	--	--	--	--	--	--	--	--	--	--
MAY 10...	--	--	--	--	--	--	--	--	--	--	--	--
18...	--	--	--	--	--	--	--	--	--	--	--	--
JUN 14...	100	370	40	1	50	<10	80	14000	0	63	56	8050
JUL 28...	--	--	--	--	--	--	--	--	--	--	--	--
AUG 10...	<100	320	180	0	<50	<10	80	13000	1	76	130	4100

Appendix II Table 7.
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CENTRAL LABORATORY, DENVER, COLORADO

WATER QUALITY ANALYSIS
LAB ID # 291068 RECORD # 42795

SAMPLE LOCATION: SUSITNA RIVER AT GOLD C AK
STATION ID: 15292000 LAT.LONG.SEQ.: 624604 1494128 00
DATE OF COLLECTION: BEGIN--771004 END-- TIME--1600
STATE CODE: 02 COUNTY CODE: 170 PROJECT IDENTIFICATION: 470200350
DATA TYPE: 2 SOURCE: SURFACE WATER GEOLOGIC UNIT:
COMMENTS:
FIELD VALUE USED FOR BICARB & CARBONATE.

AIR TEMP (DEG C)		9.0	MOLYBDENUM TOTAL	UG/L	7
ALK.TOT (AS CaCO3)	MG/L	37	NICKEL TOTAL	UG/L <	50
ALUMINUM TOTAL	UG/L	500	NO2+NO3 AS N DISS	MG/L	0.11
ARSENIC TOTAL	UG/L	1	OXYGEN DISSOLVED	MG/L	12.6
BARIUM TOTAL	UG/L	200	PH FIELD		7.4
BICARBONATE	MG/L	45	PHOS ORTHO DIS AS P	MG/L	0.00
CADMIUM TOTAL	UG/L <	10	PHOSPHATE DIS ORTHO	MG/L	0.00
CALCIUM DISS	MG/L	18	POTASSIUM DISS	MG/L	1.4
CARBONATE	MG/L	0	RESIDUE DIS CALC SUM	MG/L	85
CHLORIDE DISS	MG/L	11	RESIDUE DIS TON/AFT		0.10
CHROMIUM TOTAL	UG/L	0	RESIDUE DIS TON/DAY		1740
COLOR		12	RESIDUE DIS 180C	MG/L	76
COPPER TOTAL	UG/L	50	SAR		0.4
FLUORIDE DISS	MG/L	0.1	SELENIUM TOTAL	UG/L	0
HARDNESS NONCARB	MG/L	20	SILICA DISSOLVED	MG/L	8.6
HARDNESS TOTAL	MG/L	57	SILVER TOTAL	UG/L <	10
IRON DISSOLVED	UG/L	40	SODIUM DISS	MG/L	6.5
IRON TOTAL	UG/L	850	SODIUM PERCENT		19
LEAD TOTAL	UG/L <	100	SP. CONDUCTANCE FLD		150
MAGNESIUM DISS	MG/L	3.0	SP. CONDUCTANCE LAB		154
MANGANESE DISSOLVED	UG/L	0	STREAMFLOW(CFS)-INST		8500
MANGANESE TOTAL	UG/L	20	SULFATE DISS	MG/L	14
MERCURY TOTAL	UG/L	0.2	WATER TEMP (DEG C)		3.5
			ZINC TOTAL	UG/L	30

CATIONS			ANIONS		
	(MG/L)	(MEQ/L)		(MG/L)	(MEQ/L)
CALCIUM DISS	18	0.899	BICARBONATE	45	0.73
MAGNESIUM DISS	3.0	0.247	CARBONATE	0	0.00
POTASSIUM DISS	1.4	0.036	CHLORIDE DISS	11	0.31
SODIUM DISS	6.5	0.283	FLUORIDE DISS	0.1	0.00
			SULFATE DISS	14	0.29
			NO2+NO3 AS N D	0.11	0.00
TOTAL		1.464	TOTAL		1.35

PERCENT DIFFERENCE = 3.94

Appendix II Table 7.

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY
15292780 - SUSITNA R AT SUNSHINE AK

PROCESS DATE 03/16/78
DISTRICT CODE 02

WATER QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

DATE	TIME	TYPE	TEMPER- ATURE (DEG C) (00010)	INSTAN- TANEOUS DIS- CHARGE (CFS) (00061)	COLOR (PLAT- INUM- COBALT UNITS) (00080)	SPE- CIFIC CON- DUCT- ANCE (MICRO- MHOS) (00095)	DIS- SOLVED OXYGEN (MG/L) (00300)	PH (UNITS) (00400)	CARBON DIOXIDE (CO2) (MG/L) (00405)	ALKA- LITY AS CACO3 (MG/L) (00410)	BICAR- BONATE (HCO3) (MG/L) (00440)	CAR- BONATE (CO3) (MG/L) (00445)		
JUN 15...	1630	2	8.0	115000	100	100	12.0	7.1	3.9	25	31	0		
AUG 10...	2100	2	12.0	70000	25	112	10.6	7.6	2.1	43	52	0		
DATE			DIS- SOLVED NITRITE PLUS NITRATE (N) (MG/L) (00631)	DIS- SOLVED ORTHO PHOS- PHATE (PO4) (MG/L) (00660)	DIS- SOLVED ORTHO. PHOS- PHORUS (P) (MG/L) (00671)	HARD- NESS (CA, MG) (MG/L) (00900)	NON- CAR- BONATE HARD- NESS (MG/L) (00902)	DIS- SOLVED CAL- CIUM (CA) (MG/L) (00915)	DIS- SOLVED MAG- NE- SIUM (MG) (MG/L) (00925)	DIS- SOLVED SODIUM (NA) (MG/L) (00930)	SODIUM AD- SORP- TION RATIO (00931)	PERCENT SODIUM (00932)	DIS- SOLVED PO- TAS- SIUM (K) (MG/L) (00935)	DIS- SOLVED CHLO- RIDE (CL) (MG/L) (00940)
JUN 15...			.13	.12	.04	37	11	12	1.6	1.9	.1	10	1.1	7.3
AUG 10...				.06	.02	72	29	23	3.5	2.7	.1	7	2.8	2.7

Appendix II Table 7.

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY
15292780 - SUSITNA R AT SUNSHINE AK

PROCESS DATE 03/1
DISTRICT CODE 02

WATER QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

DATE	SUS. SED. SIEVE DIAM. % FINER THAN .125 MM (70332)	SUS. SED. SIEVE DIAM. % FINER THAN .250 MM (70333)	SUS. SED. SIEVE DIAM. % FINER THAN .500 MM (70334)	SUS. SED. SIEVE DIAM. % FINER THAN 1.00 MM (70335)	SUS. SED. FALL DIAM. % FINER THAN .002 MM (70337)	SUS. SED. FALL DIAM. % FINER THAN .004 MM (70338)	SUS. SED. FALL DIAM. % FINER THAN .008 MM (70339)	SUS. SED. FALL DIAM. % FINER THAN .016 MM (70340)	SUS. SED. FALL DIAM. % FINER THAN .031 MM (70341)	TOTAL MERCURY (HG) (UO/L) (71900)	SUS- PENDE SED- MENT (MG/L) (80154)
------	---	---	---	---	--	--	--	--	--	---	--

JUN 15...	64	84	97	100	7	9	15	22	33	.2	1630
AUG 10...	83	92	99	100	16	28	40	51	64	.1	908

DATE	DIS- SOLVED MAN- GANESE (MN) (UO/L) (01056)	TOTAL HOLYB- DENUM (HO) (UO/L) (01062)	TOTAL NICKEL (NI) (UO/L) (01067)	TOTAL SILVER (AG) (UO/L) (01077)	TOTAL ZINC (ZN) (UO/L) (01092)	TOTAL ALUM- INUM (AL) (UO/L) (01105)	TOTAL SELE- NIUM (SE) (UO/L) (01147)	DIS- SOLVED SOLIDS (RESI- DUE AT 180 C) (MG/L) (70300)	DIS- SOLVED SOLIDS (SUM OF CONSTI- TUENTS) (MG/L) (70301)	DIS- SOLVED SOLIDS (TONS PER DAY) (70302)	DIS- SOLVED SOLIDS (TONS PER AC-FT) (70303)	SUS. SED. SIEVE DIAM. % FINER THAN .062 MM (70331)
------	---	---	--	--	--	---	---	---	--	---	---	---

JUN 15...	20	1	100	<10	150	22000	1	56	51	17400	.08	46
AUG 10...	--	0	<50	<10	120	15000	0	--	102	--	.09	76

DATE	DIS- SOLVED SULFATE (SO4) (MG/L) (00945)	DIS- SOLVED FLUO- RIDE (F) (MG/L) (00950)	DIS- SOLVED SILICA (SiO2) (MG/L) (00955)	TOTAL ARSENIC (AS) (UO/L) (01002)	TOTAL BARIUM (BA) (UO/L) (01007)	TOTAL CAD- MIUM (CD) (UO/L) (01027)	TOTAL CHRO- MIUM (CR) (UO/L) (01034)	TOTAL COPPER (CU) (UO/L) (01042)	TOTAL IRON (FE) (UO/L) (01045)	DIS- SOLVED IRON (FE) (UO/L) (01046)	TOTAL LEAD (PB) (UO/L) (01051)	TOTAL MAN- GANESE (MN) (UO/L) (01055)
------	---	---	---	---	--	--	---	--	--	---	--	--

JUN 15...	5.7	.1	4.9	25	200	<10	60	200	37000	180	300	790
AUG 10...	11	.1	4.0	24	500	<10	40	40	24000	--	<100	540

Appendix II Table 7.

UNITED STATES DEPARTMENT OF THE INTERIOR GEOLOGICAL SURVEY CENTRAL LABORATORY, DENVER, COLORADO

WATER QUALITY ANALYSIS LAB ID # 291070 REC'D NO # 42801

SAMPLE LOCATION: SUSITNA R AT SUNSHINE AK
STATION ID: 15292780 LAT.LONG.SED.: 621035 1501018 00
DATE OF COLLECTION: BEGIN--771004 END-- TIME--0915
STATE CODE: 02 COUNTY CODE: 170 PROJECT IDENTIFICATION: 470200350
DATA TYPE: 2 SOURCE: SURFACE WATER GEOLOGIC UNIT:
COMMENTS:
FIELD VALUE USED FOR BICARB & CARBONATE.

AIR TEMP (DEG C)		6.8	MOLYBDENUM TOTAL	UG/L	3
ALK.TOT (AS CaCO3)	MG/L	43	NICKEL TOTAL	UG/L <	50
ALUMINUM TOTAL	UG/L	2200	NO2+NO3 AS N DISS	MG/L	0.23
ARSENIC TOTAL	UG/L	3	OXYGEN DISSOLVED	MG/L	12.8
BARIUM TOTAL	UG/L	200	PH FIELD		7.4
BICARBONATE	MG/L	52	PHOS ORTHO DIS AS P	MG/L	0.00
CAOMIUM TOTAL	UG/L <	10	PHOSPHATE DIS ORTHO	MG/L	0.00
CALCIUM DISS	MG/L	17	POTASSIUM DISS	MG/L	1.2
CARBONATE	MG/L	0	RESIDUE DIS CALC SUM	MG/L	78
CHLORIDE DISS	MG/L	6.0	RESIDUE DIS TON/AFT		0.09
CHROMIUM TOTAL	UG/L	10	RESIDUE DIS TON/DAY		4880
COLOR		8	RESIDUE DIS 180C	MG/L	66
COPPER TOTAL	UG/L	20	SAR		0.3
FLUORIDE DISS	MG/L	0.1	SELENIUM TOTAL	UG/L	0
HARDNESS NONCARB	MG/L	12	SILICA DISSOLVED	MG/L	7.4
HARDNESS TOTAL	MG/L	55	SILVER TOTAL	UG/L <	10
IRON DISSOLVED	UG/L	60	SODIUM DISS	MG/L	4.4
IRON TOTAL	UG/L	3700	SODIUM PERCENT		15
LEAD TOTAL	UG/L <	100	SP. CONDUCTANCE FLD		135
MAGNESIUM DISS	MG/L	3.0	SP. CONDUCTANCE LAB		133
MANGANESE DISSOLVED	UG/L	0	STREAMFLOW (CFS) -INST		27400
MANGANESE TOTAL	UG/L	100	SULFATE DISS	MG/L	12
MERCURY TOTAL	UG/L	0.0	WATER TEMP (DEG C)		4.0
			ZINC TOTAL	UG/L	30

CATIONS			ANIONS		
	(MG/L)	(MEQ/L)		(MG/L)	(MEQ/L)
CALCIUM DISS	17	0.349	BICARBONATE	52	0.853
MAGNESIUM DISS	3.0	0.247	CARBONATE	0	0.000
POTASSIUM DISS	1.2	0.031	CHLORIDE DISS	4.0	0.170
SODIUM DISS	4.4	0.192	FLUORIDE DISS	0.1	0.006
			SULFATE DISS	12	0.250
			NO2-NO3 AS N O	0.23	0.017
TOTAL		1.317	TOTAL		1.293

PERCENT DIFFERENCE = 0.42

APPENDIX III

The following appendix is a synopsis of ADF&G's recommended plan of study for the aquatic environment. Yearly objectives and cost estimates are included.

AQUATIC BIOLOGY STUDIES

Introduction

The proposed Susitna River hydroelectric project will have various impacts on both the indigenous organisms and the natural conditions within the aquatic environment. The fish populations are the most obvious aspects of the aquatic community where impacts will be evident due to their economic and recreational importance to the people of Alaska and the nation. However, studies cannot be limited to the fishery resource alone due to the complex interrelationships between all biological components of, and within, the aquatic community and the associated habitat. The majority of the impacts on fish species will likely result from changes in the natural regimes of the river rather than direct impacts on the fish in the vicinity. Primary areas of concern are reduction of stream flow, increased turbidity levels during winter months, and thermal and chemical pollution. Alterations of the habitat may adversely affect the existing fish populations and render portions of the drainage either nonproductive or unavailable in future years.

Baseline fisheries inventories were conducted by the Alaska Department of Fish and Game in the upper Susitna River during the 1974-1977 field seasons. The Susitna Basin is the major coho, pink, chum, and chinook salmon production area within the Cook Inlet area. Although total escapement estimates have not been derived for this system, it is probably the second or third largest sockeye salmon production area within Cook Inlet. Grayling, rainbow trout, Dolly Varden, lake trout, whitefish, and burbot are among the important resident fish species present.

The interrelationships within the biological communities and between their habitats must be clearly defined to protect the aquatic ecosystem from losses incurred by hydroelectric development. The effects on the anadromous and resident fish populations are of primary concern to the Alaska Department of Fish and Game fisheries divisions. Aquatic studies will, therefore, concentrate on the seasonal life histories and critical habitat requirements of fish species present.

Seasonal fluctuations in the physiochemical composition of the aquatic habitat are apparently the major factors influencing distribution of fish within the upper drainage. Any alterations resulting from hydroelectric project activities which restrict or reduce quality or quantity or required habitat will also reduce fish populations and associated members of the aquatic community.

Each aquatic community is dependent upon various river mechanics to provide the necessary habitat for its existence. Depth, width, and velocity of the stream flow determine the quality and quantity of habitat available to aquatic organisms. High water discharge associated with spring and summer run-off results in important physical habitat alterations. Unregulated flowing waters dilute and transport natural and man-generated pollutants. A flushing or scouring action occurs during periods of high flows and removes deposited sediments and fines, resulting in an annual cleansing of the river bottom. This is an important factor in rivers like the Susitna

which transport large amounts of glacial silt. Deposition of sediment without the annual scouring could change the overall productivity of the river, eventually suffocating some of the aquatic organisms.

Individual study proposals are designed to provide the necessary background information to enable proper evaluation of impacts. Six general objectives have been outlined:

- 1) Determine the relative abundance and distribution of anadromous fish populations within the drainage.
- 2) Determine the distribution and abundance of selected resident fish populations.
- 3) Determine the seasonal habitat requirements of anadromous and resident fish species during each stage of their life histories.
- 4) Determine the economic, recreational, social, and aesthetic values of the existing resident and anadromous fish stocks and habitat.
- 5) Determine the impact the Devils Canyon project will have on the aquatic ecosystems and any required mitigation prior to construction approval.
- 6) Determine a long term plan of study, if the project is authorized, to monitor the impacts during and after project completion.

Fisheries and physiochemical sampling techniques and equipment for large rivers similar to the Susitna are in the early stages of development. Research and development must accompany the study to modify equipment and techniques to the habitat conditions of the specific environment to be evaluated.

The large drainage areas encompassed by the project are divided and categorized by location and activity. The three major study areas are:

- 1) The Susitna River basin between Denali Highway and Cook Inlet.
- 2) The proposed transmission line corridor and construction road drainage areas.
- 3) The Cook Inlet estuarine area.

All proposed studies are interrelated and have been coordinated to produce specific results. The elimination of any segment of a project will require revision of study plans. Investigations have been arbitrarily divided into anadromous and resident species studies. To insure precise and adequate aquatic data are collected each study is limited to a specific geographic area. A sufficient number of personnel must therefore be distributed throughout the study areas to insure a cross-section of habitat conditions are examined and movements of fish populations are monitored.

Title: Impact of the Proposed Devils Canyon-Watana Hydropower Projects On Anadromous Fish Populations Within the Susitna River Drainage.

Objectives: Determine the abundance and distribution of anadromous fish populations.

Determine the seasonal freshwater habitat requirements of adult and juvenile salmon, including spawning, incubation, rearing, and migration.

Background: The salmon stocks of the Susitna River drainage are major contributors to the Cook Inlet area fishery. Determining total escapement into this system is greatly complicated by the glacial conditions of the major streams and the enormity of the area. Management of the northern Cook Inlet salmon stocks has been difficult due to the mixed stock commercial fishery in Cook Inlet and the lack of adequate tools to provide accurate in season escapement estimates for the drainage.

The major hydroelectric project impacts on the anadromous fish species are expected to be due to changes in habitat. Alteration of the normal flow regimes and the physical and chemical water characteristics will probably be the most critical impacts. It is difficult at this time to determine the distance downstream from the proposed dams that changes will occur. Studies conducted by Townsend (1975) in the Peace River demonstrate that effects were observed 730 miles downstream from the Bennett Dam.

The Alaska Department of Fish and Game has conducted fisheries investigations in the area of proposed dam construction downstream since 1974. Emphasis has been on the inventory of adult and juvenile salmon stocks and habitat assessment. Current research investigations have concentrated on determining total escapement of salmon species into the Susitna drainage and intrasystem migrations of fry. Successful tag and recovery projects were operated in the lower river during 1975 and 1977 and the feasibility of sonar operation was tested in the mainstem Susitna River approximately 25 miles upstream from Cook Inlet during 1976.

Only through complete stock assessment will it be possible to determine what portion of the Susitna River anadromous fish runs will be affected by the project and determine the level of mitigative measures which will ultimately be required. It is essential to know what portion the affected stocks contribute to the total Susitna River salmon escapement in order to determine potential losses of fish populations and numbers. Economic values and relative importance can be determined after establishing this. Pink, chum, and chinook salmon are the dominant species utilizing the upper reaches of the drainage although sockeye and coho salmon are also observed.

Adults

Population estimates of salmon species utilizing the Susitna River above the Chulitna River confluence were estimated during the 1974, 1975, and 1977 field seasons based on tagging and subsequent recovery of fish. These studies indicate a portion of the salmon tagged are not destined to spawn above the tagging site, but rather below it. The importance and extent

of this milling behavior in the upper river areas requires definition. The alterations in flow and water quality in the mainstem river after project completion could significantly affect this behavior and consequently spawning success. Behavior modifications and disorientation of fish due to tagging and handling may have been a contributing factor.

Observations of spawning areas between the Chulitna and Susitna river confluence upstream to Portage Creek during fall surveys indicate that a reduction in flow to proposed post-construction levels would prevent access to many important spawning areas.

The degree of impact of reduced flows will be dependent on the total area affected. The distance affected downstream would depend partially on the contribution of the natural Susitna River flow regimes to that of each major tributary and the drainage as a whole.

Studies conducted during the late 1950's indicate that Cook Inlet salmon stocks are unable to ascend the Susitna River beyond Devils Canyon, the latter being a natural water velocity barrier to migration (U.S. Department of the Interior, 1957). Reports from local residents on salmon observations above Devils Canyon indicate that this should be investigated further.

Juveniles

Previous studies have defined important clearwater streams and spring fed sloughs within the Susitna River drainage which support juvenile anadromous fish species. Investigations have, however, concentrated primarily on summer rearing areas. Surveys indicate these populations are not static, but vary in abundance and distribution. Studies conducted during the winter of 1974-1975 revealed that juvenile anadromous species also utilize the mainstem Susitna River.

Data collected since 1974 provide only baseline information. Generalizations may be made, but sufficient information is not available to determine specific impacts of dam construction and operation on incubating and rearing anadromous species.

Adults

Procedures: Emphasis should be on determining total salmon escapement into the drainage, stock separation, and habitat evaluation. Types of sampling gear which can be utilized in the upper area of the river and catchability of adult salmon migrating upstream greatly affect the success of a tag and recovery program. Recent developments and improvements in sonar salmon counters are a viable option. A sonar counting system suitable for operation in the upper Susitna River would have to be designed and tested. Installation of weirs or counting towers to determine escapements would be feasible on most clearwater tributaries.

Commercial Fisheries Division will operate side-scanning sonar salmon counters in the lower Susitna River during 1978 as part of their ongoing studies. A salmon tag and recovery program to provide an alternate escapement estimate could be funded through Devils Canyon studies to provide additional data and supplement sonar escapement information. The duration of this project is dependent on correlation of population estimates and sonar counts. Data obtained from these studies would be correlated with population estimates in the upper Susitna River. Through these studies the importance of the Susitna River salmon stocks to the Cook Inlet area as a whole could be determined.

Evaluation of milling behavior of adult salmon in the upper Susitna River will require new sampling techniques. Obtaining escapement samples and marking them to determine migrational characteristics without causing some modification of normal behavior is difficult. Internal sonic transmitters may be utilized to evaluate this. The effectiveness of this type of tag in heavily silt laden waters would have to be tested. Recently developed stock separation techniques based on salmon scale characteristics may eventually enable researchers to assign unknown stocks to specific areas. This technique is still in the developmental research stage, but preliminary data indicate that samples obtained from Cook Inlet can be assigned to one of the three major salmon producing systems with ± 14 percent confidence. A large data base of scale characteristics from tributary systems would have to be established before analysis could be made.

Surveys and escapement sampling should be conducted in the proposed impoundment areas between the Denali Highway and Devils Canyon during periods of peak adult salmon abundance. Initial observations would be conducted by aerial surveys to document the presence or absence of adult salmon. Surveys would be done in conjunction with resident fish investigations. Data obtained would be utilized to determine necessary mitigation measures.

Water quality, quantity, and biological studies to predict the effects on spawning and migration habitat are described in the habitat study section.

Juveniles

Year-round studies are required to determine complete juvenile salmon distribution and habitat utilization data.

Surveys of all rearing areas defined in previous studies should be continued. The distribution, species composition, and growth characteristics of juvenile salmonids should be monitored. Additional sampling equipment should be employed to assure representative samples are being collected. These include seines, minnow traps, small fyke traps, and dip nets. Fore-gut sample analysis should be continued and related to invertebrate studies. Winter sampling should be initiated on selected sloughs and clearwater tributaries that support significant populations of rearing fish during the summer and are also accessible during the winter months. Physiochemical parameters of the aquatic habitat will be monitored during each survey.

The timing of migration of juvenile fish from sloughs and tributaries to the mainstem river and the extent of mainstem utilization should be documented. Factors which trigger the outmigration will be determined through habitat monitoring. These will include water temperature, ice cover, relative water levels, dissolved oxygen, pH, and conductivity. Fish samples will be collected primarily by traps. Coded wire tags and/or pigment dye marking may be effective methods of determining intrasystem migrations after initial documentation of this phenomenon.

The quantity and quality of water within the mainstem Susitna River will be monitored year round. Data will be obtained from U.S.G.S. gauging stations and at additional sites by field crews monitoring fry distribution. (See Habitat Section).

Schedule: Following is a preliminary schedule of anadromous fish project activities. The initiation of some segments of the studies will be dependent on testing of sampling equipment and delivery time required for more complex equipment, i.e., sonar counters.

The fiscal years (FY) outlined encompass the period of July 1 through June 30.

FY 79 Determine total salmon escapement estimate for the Susitna River drainage.

Determine total escapement in selected streams in the upper drainage.

Monitor abundance, distribution, characteristics, and habitat requirements of adult and juvenile salmonids.

Monitor physical, chemical and hydrological parameters of the mainstem Susitna River, sloughs, and clearwater tributaries.

Evaluate the feasibility of operation of various types of sampling gear for use in the upper river areas.

Begin building data base for stock separation studies.

FY 80 Continue salmon escapement estimates.

Continue fry and habitat studies.

Evaluate milling behavior of adult salmon.

Continue water quantity and quality monitoring.

Continue impoundment surveys, if salmon are observed during FY 79.

Continue stock separation studies and begin detailed analysis.

FY 81 Continue all FY 80 studies and revise programs as necessary.

FY 82 Continue ongoing field projects (FY 81) and begin final
analysis of projects.

FY 83 Continue field monitoring and prepare final report.

Cost:

FY 79 \$909,800

FY 80 \$592,700

FY 81 \$592,700

FY 82 \$592,700

FY 83 \$592,700

Literature Cited:

Townsend, G.H. 1975. Impact of the Bennett Dam on the Peace-Athabasca
Delta. J. Fish. Res. Board Can. Vol. 32 (1). pp. 171-176.

U. S. Dept. of the Interior. 1957. (Unpublished). Progress Report 1956
field investigation Devils Canyon Dam Site, Susitna River Basin.
15 pp.

Title: Impact of the Susitna Hydroelectric Project on Resident Fish Species

Objectives: Determine species present and distribution.

Determine seasonal abundance of selected populations.

Determine seasonal habitat requirements necessary to sustain the species present.

Background: The Alaska Department of Fish and Game has conducted limited fisheries investigations in the Susitna River and its tributaries, both upstream and downstream of the proposed dam sites and in lakes near the impoundment area. The general distribution of resident species was monitored and basic seasonal life history and habitat observations were conducted during portions of the spring, summer, fall, and winter seasons. Some resident species make major migrations from lake and tributary systems into the mainstem Susitna for purposes of overwintering. The importance of this intrasystem migration and the role of the mainstem Susitna River is not understood at this time. Surveys conducted between 1974 and 1977 document that a high quality sport fishery is provided by the Susitna River, its tributaries, and nearby lakes.

Procedure: Seasonal life history, distribution, population abundance, and habitat requirement investigations of selected resident fish species will be continued and expanded. These studies will be closely coordinated with the anadromous fish studies. Special attention will be given to those areas important to resident fish which may not coincide with anadromous fish habitat. The study area for resident fish investigations may be considerably greater, extending along the Susitna River from the mouth of the Tyone River to Cook Inlet, including tributaries bisected by transmission and road corridors.

Of particular importance in this study will be the determination of winter distribution, migrational and habitat requirements within areas subject to project impact. Studies will be made of the tributaries where resident fish predominately spawn and reside during the summer months, and the mainstem Susitna River where many of these same fish may winter. Emphasis will also be given to streams impacted by inundation. Human utilization of resident species will also be determined.

This study will be conducted in two parts, with results of the first two years of effort being compiled and analyzed for use in related studies and as a basis for determining areas where efforts should be concentrated during the remaining years of the study.

Due to difficulty in capturing fish from the Susitna River through the winter ice cover, high velocities and turbid water conditions in the summer, considerable equipment and sampling technique adaptations will be necessary. Boom and backpack electrofishing, side scanning sonar, sonar, angling, radio tags, anchor tags, coded wire tags, fyke nets, seines, gill nets, fixed traps, fish wheels, weirs, and ground surveys will be among the techniques to be employed.

Those elements of the physiochemical and trophic makeup of the existing natural habitat which will be analyzed are discussed under the Habitat Studies Section.

Schedule:

- FY 79 Organize Susitna River Basin study team and coordinate work schedule with other study teams where necessary.
- Establish base camps and begin fisheries inventory, seasonal life history, and associated habitat investigations.
- FY 80 Continue field activities and relocate various personnel as dictated by data which are generated. Areas of investigation include impoundment, transmission and road corridors, and downstream of Devils Canyon to Cook Inlet.
- FY 81 Continue field activities and relocate various personnel as dictated by data which are generated.
- FY 82 Continue field activities and relocate various personnel as dictated by data which are generated.
- Initiate report writing process.
- FY 83 Continue field activities and relocate various personnel as dictated by data which are generated, and integrate and summarize all data collected into final report.

Cost:

FY 79	\$462,900
FY 80	\$416,600
FY 81	\$416,600
FY 82	\$416,600
FY 83	\$416,600

Title: Investigations of the Cook Inlet Estuarine Area and Potential Effects of Hydroelectric Development.

Objectives: Identify the fisheries resources of the lower Susitna River and the Cook Inlet estuary.

Determine the existing water quality and biological productivity of the lower Susitna River and the Cook Inlet estuary.

Determine the contribution and importance of the Susitna River to the Cook Inlet estuary.

Background: Cook Inlet is approximately 170 miles long and 60 miles wide at its mouth, with a total volume of 1.7×10^{13} feet³. It can be divided into two natural regions, a northern and southern portion, by a natural topographic feature, the East and West Forelands. The Susitna River and the major streams and rivers entering Knik Arm represent about 70-80 percent of the total freshwater entering the Inlet (Rosenberg, 1967).

Estuaries generally have exceptional usefulness in support of fisheries as rearing areas. It is generally a high food production area for primary consumers such as clams and other filter feeding organisms and the secondary and tertiary level consumers, including finfish and shellfish species. Migratory fishes such as salmon must pass through the estuarine area to reach their spawning grounds.

The estuary is, in many ways, the most complicated and variable of the aquatic ecosystems. Current and salinity shape the life of the estuary where the environment is neither fresh nor salt water. Estuarine currents result from the interaction of one-direction flow which varies with seasonal run-off, oscillating tides and the winds. The unique assemblages of organisms utilizing the estuarine habitat have evolved to survive these rigorous conditions.

Oceanographic data from the Cook Inlet estuarine area is limited. The extent to which juvenile and adult salmon species utilize this estuarine area is unknown. If natural flow regimes and water quality are altered by the hydroelectric project, adverse effects would possibly be observed within the Inlet. Baseline studies to determine existing physiochemical habitat conditions and biological productivity should be conducted. Parameters which need to be evaluated include: temperature, salinity, pH, nutrients, sedimentation processes, water stage and velocity, and biological activities.

Investigations of estuarine areas are more difficult than for river systems and will require elaborate equipment and use of large vessels.

Procedures: Baseline aquatic biology, and habitat studies and a thorough investigation of existing data available on the Cook Inlet area will be conducted prior to initiation of any comprehensive field investigations. This environmental data will provide an adequate data base for determining the direction and level of future field studies necessary to project the effects of the hydroelectric project on the estuarine ecosystem.

Schedule:

- FY 79 Conduct field research and analyze the data collected.
- Review and evaluate existing environmental data of the Cook Inlet area.
- Develop comprehensive study plan.
- FY 80 Activities will depend on FY 79 findings. Ongoing monitoring and previous studies may provide sufficient data. If not, additional field investigations will have to be initiated.

Cost:

- FY 79 \$75,000
- FY 80-83 Open. Will depend on FY 79 results. Overall allocation may have to be amended.

Literature Cited:

Rosenberg, D.H., S.C. Burrell, K.V. Matarajan, and D.W. Hook, 1967. Oceanography of Cook Inlet with special reference to the effluent from the Collier Carbon and Chemical Plant. Institute of Marine Science, University of Alaska. Report No. R67-5. 80 pp.

Title: Susitna River Basin Habitat Investigations

Objectives: Identify seasonal habitat characteristics associated with the Susitna River Basin anadromous and resident fisheries.

Define the complex interrelationships between the various components of the habitat.

Determine which habitat components are critical to the sustenance of the existing fisheries, and why.

Background: Maintenance of anadromous and resident fish populations within the Susitna River Basin will require a thorough understanding of their life sustaining habitat. Impacts by the hydroelectric project which alter or reduce the quantity or quality of the critical spawning, incubation, rearing, and migration habitat of these species will reduce or eliminate their populations. Major changes may take place in the biotic community with only a subtle change in the habitat.

Baseline physiochemical and biological aquatic habitat data were collected between 1974 and 1977 by the Alaska Department of Fish and Game at selected sites within the Susitna River drainage. The United States Geological Survey and other agencies have also monitored physiochemical parameters of the drainage.

Literature on the physiochemical and biological composition of aquatic habitat in lotic and lentic environments and its relationships to aquatic communities is also available.

Procedure: Personnel conducting seasonal fisheries life history investigations within the Susitna River Basin will concurrently collect the majority of the associated physiochemical field habitat data. In situ water velocity, width, depth, gradient, temperature, conductivity, pH and dissolved oxygen measurements will be collected with sophisticated electronic and mechanical instrumentation. Water samples will also be collected for laboratory analyses of basic metals, dissolved solids, total suspended solids, alkalinity, hardness, pH, conductivity, and total recoverable solids. Additional investigations by fisheries personnel will include water surface and sedimentation profiles. The U.S.G.S. will be contracted to install stream gauging stations at selected sites.

Biological habitat investigations will include primary productivity, benthos species composition and diversity, forage fish, pathological, and bioassay studies. Benthos, forage fish and fish pathology investigations will be integrated with fisheries life history studies. The remaining three will be conducted as individual studies.

To define the complex interrelationships of the dynamic habitat conditions of the Susitna River Basin it will be necessary to collect data over an extended period of time. Because of the precise measurements required, equipment for this investigation will be costly.

Schedule:

FY 79	Organize field staff and procure equipment. Establish field camps, install equipment, and initiate field and office research.
FY 80	Continue field and office research.
FY 81	Continue field and office research.
FY 82	Continue field and office research.
FY 83	Continue field and office studies, analyze data, and write report.

Cost: Personnel and their associated expenses are included in the fisheries investigations.

FY 79	\$191,000
FY 80	\$149,000
FY 81	\$149,000
FY 82	\$149,000
FY 83	\$149,000

Title: Transmission Corridors, Access Road Corridor, and Construction Pad Sites Fisheries Investigations

Objectives: Identify all fishery resources within the four proposed transmission corridors, the access road corridor, and the construction pad sites.

Identify species present in these waters and determine seasonal presence.

Identify the habitat associated with these species.

Background: Four transmission corridor routes, one access road corridor, gravel and fill sites, and numerous building site pads are under consideration. The corridors will provide human access to previously inaccessible areas. This access will concentrate sportsman efforts in certain areas which may result in adverse impacts to aquatic life. Uncontrolled removal of gravel and fill for construction activities will also adversely affect the aquatic habitat. No hydroelectric related fishery investigations of these areas have been conducted. Other sources of fisheries data in these drainages are insufficient.

Procedures: Fishery resources, their seasonal presence and associated habitat will be identified within these areas. Ground surveys, fish trapping, fish marking, benthic species collection and physiochemical water quality measurement techniques will be conducted. Backpack electro-fishing, nets, traps, anchor and radio tags, electrophoresis instrumentation, weirs, benthic samplers, sophisticated water quality measurement devices, water quantity measurement equipment, and survey equipment are among the equipment which will be utilized.

Schedule:

- | | |
|-------|--|
| FY 79 | Organize corridor and building site study teams, procure equipment, and coordinate schedules with other study teams where necessary. |
| | Establish base camps and initiate fisheries resource identification, species identification, and seasonal presence and habitat investigations. |
| FY 80 | Continue field activities. |
| FY 81 | Continue field activities and relocate various personnel as dictated by data and overall study findings. |
| FY 82 | Continue field activities and relocate various personnel as dictated by data and overall study findings. |
| FY 83 | Conduct concentrated studies if necessary and integrate and summarize all data collected. |

Cost:

FY 79	\$130,500
FY 80	\$125,500
FY 81	\$125,500
FY 82	\$125,500
FY 83	\$125,500

Title: Existing Economic, Recreational, Social and Aesthetic Evaluations of the Susitna River.

Objectives: Determine the economic values of the aquatic and terrestrial ecosystems.

Determine the recreational values of the aquatic and terrestrial ecosystems.

Determine the social values of the aquatic and terrestrial ecosystems.

Determine the aesthetic values of the aquatic and terrestrial ecosystems.

Background: Economic, recreational, social, and aesthetic values of the project drainages must be determined in order to project whether the project will enhance or diminish these values. The close proximity of municipalities containing half the human population of Alaska emphasizes the need to assess these values. The Susitna drainage is highly used and important to the sport and commercial fisherman, the recreational enthusiast, industry, and municipalities. The popularity of Denali State Park and nearby Mt. McKinley National Park further attests to the high social, recreational, and aesthetic qualities of the area. Specific data on these subjects in the hydroelectric project area watersheds are incomplete or lacking.

Procedure: The four objectives will be accomplished through statistical surveys and analyses. Some of the methods employed will be literature searches, mail surveys, creel surveys, personal interviews, and fish tag return data.

Schedule:

FY 79	Organize personnel, procure equipment, and begin literature searches, and develop survey approaches.
FY 80	Continue literature searches, analyze data, and begin surveys.
FY 81	Continue literature searches, analyze data, and continue surveys.
FY 82	Continue literature searches, analyze data, and continue surveys.
FY 83	Continue data collection and analyses and write report.

Costs:

FY 79	\$200,000
FY 80	\$200,000
FY 81	\$100,000
FY 82	\$100,000
FY 83	\$100,000

Title: Predict Project Impacts

Objectives: Determine the direct, indirect, and magnitude of effects the Devils Canyon/Watana project will have on the Susitna River Basin fisheries and other drainages prior to construction approval.

Background: Susitna River Basin investigations to date have not generated sufficient data to predict the impacts of this project on the aquatic ecosystem. Scientific literature is available on the ecological effects of hydroelectric dams which have been constructed in other areas.

Procedure: This study culminates all previously outlined studies. An evaluation of data obtained from the proposed fisheries related biological, habitat, socio-economic, and recreational studies will be combined with other engineering and design studies. A predictive model of the aquatic ecosystem with and without the hydroelectric project will be constructed. Concerns will not be limited to fisheries; secondary effects and how humans will be affected will also be addressed. Information required in this analysis includes seasonal life history habitat requirements of the existing aquatic community, a thorough understanding of the interrelationships between physical, chemical, and biological components of the habitat, and recreational and socio-economic values. Project engineering and design models will also be required, especially those concerned with sedimentation, temperature, dissolved gasses, discharge, and other related physiochemical characteristics.

Literature searches and various project data will be continually analyzed to insure all sources of pertinent data are included.

Schedule:

FY 79	Literature research.
FY 80	Literature research, analyze data.
FY 81	Literature research, analyze data.
FY 82	Literature research, analyze data.
FY 83	Literature research, analyze data, predict impacts.

Cost:

FY 79	\$ 5,000
FY 80	\$ 5,000
FY 81	\$20,000
FY 82	\$60,000
FY 83	\$60,000

Title: Mitigative Measures for Lost Aquatic Habitat

Objective: To identify and evaluate the Devils Canyon/Watana Dam project fisheries mitigation requirements and implementation costs prior to construction approval.

Background: Critical habitat for various life history stages of aquatic species could be eliminated or reduced in quality and quantity by the Susitna Hydropower project. For example, regulation will result in decreased flows downstream of the dams during the summer months which could eliminate critical rearing areas for salmonid fry. The proposed aquatic and related habitat studies should quantify the losses and resulting impact on the fisheries. This activity is designed to provide information to assess the feasibility of mitigation and to indicate long term studies which would direct actual mitigation efforts. Evaluation of these studies will go beyond phase I if the project is deemed feasible.

Procedure: Analyze all project data collected which relate to the fisheries and aquatic habitat of the Susitna River Basin and other impacted drainages. Conduct special studies where necessary and analyze. Conduct literature research to obtain aquatic impact data relating to existing and proposed hydroelectric projects.

Conduct preliminary site surveys which include reconnaissance and topographic analysis. Detailed site surveys and analysis will begin in the last two years of this study.

Schedule:

FY 79	Preliminary site surveys. Reconnaissance and topographic analysis Conduct literature research and review.
FY 80	Continue preliminary site surveys. Analyze data and identify potential areas for mitigation. Continue literature search and review. Report on findings.
FY 81	Detailed site surveys. Analyze surveys. Continue literature search and review.
FY 82	Continue literature search and review.
FY 83	Continue detailed site surveys and literature search and review. Report on findings.

Cost:

FY 79	\$26,000
FY 80	\$10,000
FY 81*	\$60,000
FY 82	\$50,000
FY 83	\$60,000

* Assumes \$10,000 per site survey.

Title: Plan of Study During and After Completion

Objective: Develop a plan of study to monitor the effects of the project to the aquatic ecosystems during and after completion.

Procedure: This ongoing activity will be dependant on the feasibility results. The data generated from all of the pre-authorization studies will provide the ground work for this plan. Flexibility must be built into this plan until the results of the biological and detailed feasibility studies are available.

Schedule: Complete plan within an additional 14 months after completion of the detailed feasibility studies.

Cost: \$50,000

Moose Movements and Habitat Use
Along the Upper Susitna River--A Preliminary Study of
Potential Impacts of the Devils
Canyon Hydroelectric Project

by
Kenton P. Taylor
and
Warren B. Ballard

Alaska Department of Fish and Game
Division of Game

Robert A. Rausch, Director

March 1978

CONTENTS

	Page
Summary	3
Background.	4
Description of Area	7
Procedures.	8
Findings	11
Numbers of Moose Captured.	11
Movements.	13
Devil Mountain Area	13
Watana Creek.	16
Susitna Bend Area	20
Maclaren River Area	22
Habitat Use.	24
Discussion.	26
Conclusions	31
Recommendations	34
Acknowledgements.	34
Literature Cited.	36
Appendix I.	39
Appendix II	76

SUMMARY

During October 1976 and March 1977, 18 radio and 21 visual collars were placed on moose along the Susitna River from the mouth of the Maclaren River downstream to Devil Creek. Radio tracking flights over 13 months yielded 270 observations of radio-collared moose. Visual collars were located 43 times. Movements were slight for radio-collared moose between Jay Creek and Devil Mountain, generally within 48 km². One visual collar from Devil Creek was seen near Lone Butte, 84 km east of her tagging location. Movements of moose collared east of Jay Creek were substantially longer, and migrations up to 103 km were observed. Radio-collared moose were found most often (70 percent) in spruce dominated habitats during all seasons. Seven of the eight cows that had calves gave birth in spruce vegetation. The bend of the Susitna River from Goose Creek to the mouth of Tyone River was identified as important winter habitat for moose from many areas of the Susitna River drainage. Lower elevations along the Susitna River were found to be important as both wintering and calving areas for resident populations, particularly on the south side, east of Stephan Lake. Collared moose crossed the Susitna a minimum of 26 times during this study, 15 of which were across that portion which would be inundated by dam construction.

Movement data gathered over a period of only 13 months are insufficient to accurately delineate separate moose populations. Evidence to date suggests that moose from many portions of the Susitna River drainage utilize habitats adjacent to or portions of the area which will be flooded by dam construction. Intensive vegetative studies and research

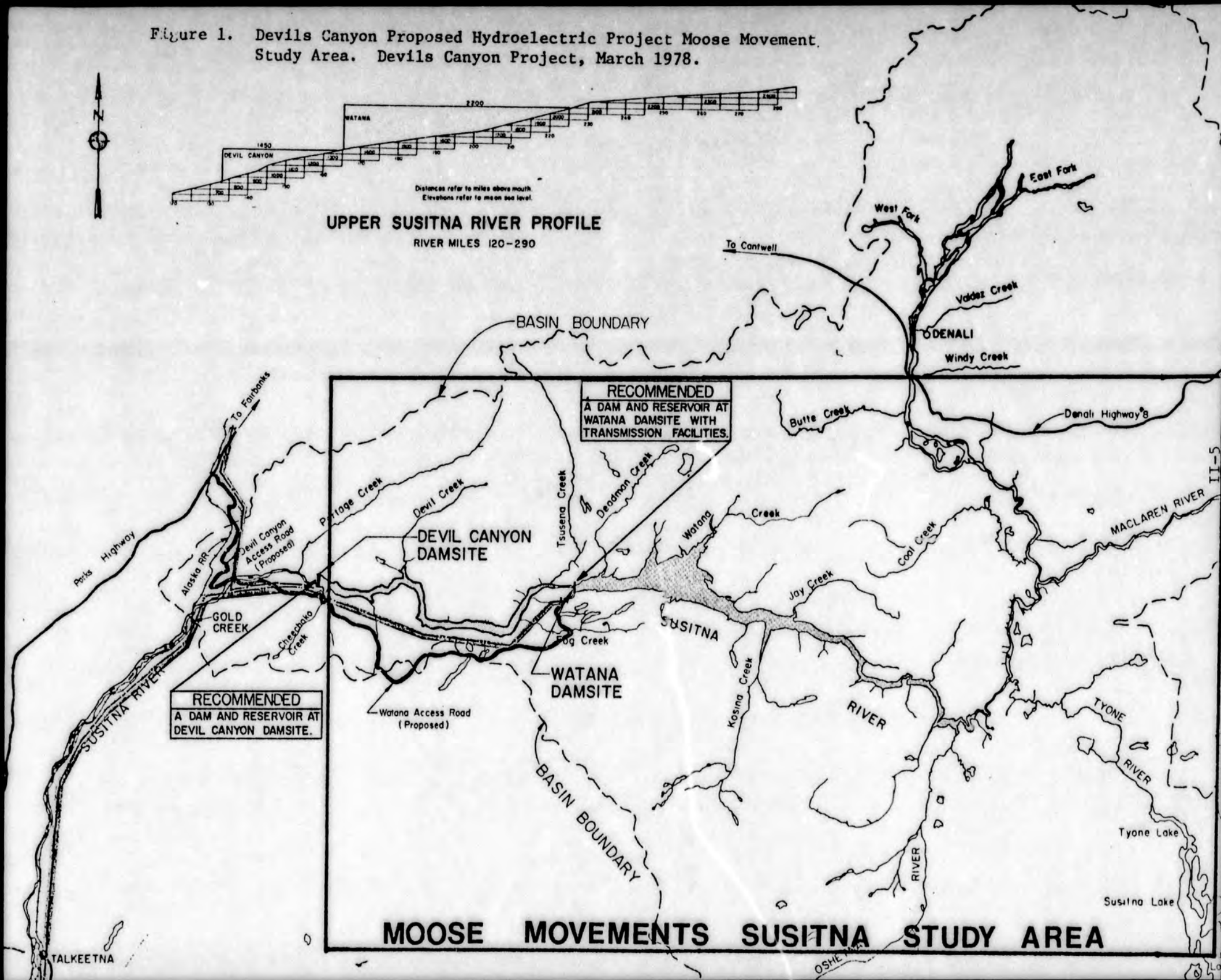
on movements both upstream and downstream are needed to adequately assess the impacts of the proposed construction (Appendix II).

BACKGROUND

Feasibility studies on providing hydroelectric power from the Susitna River to the railbelt area of southcentral Alaska have been conducted since 1948. Potential dam sites were identified by the U.S. Bureau of Reclamation, the Alaska Power Administration and the Henry J. Kaiser Company. Proposed hydroelectric projects have included from 2 to 12 dams within the Susitna River basin, along with associated maintenance facilities and transmission lines to Anchorage and Fairbanks (Dept. of Army 1975).

The Devils Canyon-Watana dam system has been selected by the Army Corps of Engineers as the most viable of several alternatives (Fig. 1). This system would theoretically provide 6.1 billion kilowatt-hours of electrical power annually from a dependable capacity of 1,568 megawatts (Army Corps of Engineers 1975). The Devils Canyon dam would be a concrete structure 193 m high, and the Watana dam would be a rock fill impoundment rising 247 m above the river bottom. A 103 km road from Chulitna to the Watana site including a 198 m bridge across the Sustina would be constructed for transporting materials and personnel to the dam sites. Five hundred eighty-six km of transmission line corridors, 57-64 m wide, would be cut across the mountains between Anchorage and Fairbanks. Warehouses, vehicle storage buildings and permanent living quarters would be erected at the dam sites. The total projected cost of completing this project

Figure 1. Devils Canyon Proposed Hydroelectric Project Moose Movement Study Area. Devils Canyon Project, March 1978.



is \$2,100,000,000 (Army Corps of Engineers 1977). The estimated annual cost for operation for 100 years following completion is \$104,000,000. Power on the line from the Watana site is scheduled for 1986 and from the Devils Canyon dam by 1990. Construction and maintenance of this system would constitute the largest hydro-power project in North America (Gravel 1977).

Construction of both proposed dam sites would inundate 51,000 acres of the river valley, 132 km upstream to a point between the Tyone and Oshetna Rivers (Fish and Wildl. Ser. 1975). Water levels of the Devils Canyon reservoir are expected to remain almost constant but may fluctuate up to 55 m (ob. cit.). The Watana reservoir is projected to have substantial seasonal fluctuations up to 78 m. Downstream flow is expected to be maintained at a constant rate between 8,000 and 10,000 cubic feet per second, eliminating the flooding action that presently occurs each spring when downstream flows may be as high as 90,000 cfs (Army Corps of Engineers 1975).

The Susitna River Basin has long been recognized as an extremely rugged wilderness area of high esthetic appeal and as an important habitat to a wide variety of wildlife species (ADF&G, unpubl. data). Most important to sport and subsistence users are moose (*Alces alces*) and caribou (*Rangifer tarandus*). Hydroelectric development has been under consideration in this area for a number of years and some very general ungulate population assessment work was begun in 1974 (USF&W 1975). Since then no studies were conducted in the project area until 1976 when limited funds were made available to begin acquiring baseline

information on moose and caribou populations within and adjacent to the project area. The purpose of this report is to present the findings of this one-year study and to discuss their implications in relation to the construction of the proposed hydroelectric project.

DESCRIPTION OF AREA

Moose movements and habitat use were studied in that portion of the Susitna River Basin lying between latitudes 60°30' - 63°15' north and longitudes 146°30' - 149° west (Figure 1). The landscape is primarily mountainous and ranges in elevation from 300 to 1900 m. Semi-arid conditions dominate this area of the basin. Temperatures are generally cool in the summer and overcast days are common. Snowfall is usually moderate and ground accumulation does not often exceed one meter. Prevailing winds are out of the east and north. High winds are common along the river during any season.

Along the banks of the Susitna and its tributaries from the Maclaren River to Devil Creek the dominant vegetative cover is black spruce (*Picea mariana*), interspersed with muskeg bogs on the basin floor. Occasional stands of black cottonwood (*Populus trichocarpa*) are found on the islands in the river. Understory vegetation in the lower elevations includes highbush cranberry (*Viburnum edule*), devil's club (*Echinopanax horridus*), blueberry (*Vaccinium* spp.), lowbush cranberry (*Vaccinium vitis-idaea*) and several representatives of the rose and grass families. Hardwoods such as aspen (*Populus tremuloides*) and birch (*Betula papyrifera*) are often found interspersed among the spruce, predominantly on south-

facing slopes. White spruce (*Picea glauca*) replaces the smaller, stunted black spruce on better drained soils. The understory above 300 m contains blueberry, lowbush cranberry, Labrador tea (*Ledum* spp.), fireweed (*Epilobium* spp.), crowberry (*Empetrum nigrum*), and several mosses and lichens.

Alder (*Alnus* spp.) dominates the reaches just above timberline, particularly along the headwaters of streams. Willow (*Salix* spp.) exists throughout the study area but occurs most frequently at timberline and on riparian sites. Alpine tundra extends above the alder-willow zone about 1200 m. A network of old caribou trails scars the tundra slopes of the mountain foothills throughout most of the area.

PROCEDURES

During October 1976 and March 1977, moose were captured along the Susitna River from its confluence with the Maclaren River downstream to Devil Creek. They were darted from a Bell Jet Ranger helicopter using standard techniques described by Franzmann et al. (1974) with doses of Anectine (Succinylcholine chloride), ranging from 23 to 29 mg. All captured moose were marked with plastic flagging affixed with metal ear tags and with either a radio collar, visual collar, or both. Radio collars were manufactured by AVM Instrument Company (Champaign, Illinois). These collars weighed 1.1 kg and were constructed of machine belting 13 mm thick and 65 mm wide with an adjustable inner circumference of 101 to 106 cm. The belting surrounded the radio components which were encased in dental acrylic, making the unit waterproof. Each radio was equipped with a SB-2 transmitter powered by cold resistant lithium batteries.

All radios operated on frequencies between 150.700 and 151.875 MHz. Each visual collar (as described by Franzmann et al. 1974) had three sets of numerals, one on top and one on each side, to facilitate identification from the air. Visual collars were placed over many of the radios to enable observers to more easily pick out the radioed individual from a group of moose.

When conditions permitted, a lower front incisor was removed from each moose for age analysis using techniques developed by Sargent and Pimlott (1959). Blood and hair samples also were collected to aid in assessing physiological condition using methods described by Franzmann et al. (1975). Several physical measurements were taken when time permitted and general physical condition was assessed according to criteria developed by Franzmann and Arneson (1973). Cows captured in March were rectally palpated using techniques described by Greer and Hawkins (1967) to determine pregnancy.

Radio tracking flights were made monthly in a Piper PA-18 Supercub equipped with two three-element Yagi antennas connected to a four band, 12 channel portable receiver manufactured by AVM Instrument Company. Tracking methods were similar to those described by Mech (1974). Radio locations, vegetation type and miscellaneous notes were recorded for each observation (Fig. 2). During parturition, flights were increased to approximately every 3 to 5 days to more adequately assess initial production and survival of calves.

Figure 2. Survey form used to record data during radio tracking flights along the Susitna River. Devils Canyon Project, 1978.

SUSITNA STUDY

MOOSE RADIO OBSERVATION FORM

Observer:

Weather:

Time off:

Temp.:

Time On:

Radio #	Channel	Seen	Calves	Location	Vegetation	Notes
8583	4-7-4.0					
8584	4-8-2.0					
8586	4-10-3.2					
8589	4-12-3.0					
8580	4-6-2.0					
8038	4-3-2.8					
8573	2-9-3.5					
8576	3-6-0.0					
8022	1-4-2.5					
8588	4-12-2.4					
8040	4-11-.5					
8578	4-4-3.9					
8579	4-5-1.9					
8031	3-8-2.5					
8035	3-12-1.4					
8018	1-2-3.8					
8030	3-7-1.5					
8575	2-12-4.2					

FINDINGS

Numbers of Moose Captured

Thirty-nine moose were captured and collared during October 1976 and March 1977 along the Susitna River in the vicinity of that portion of the river which would be inundated by the construction of the proposed dams at Devils Canyon and Watana Creek. Although the 13 moose collared in October were not originally part of this study, the data from these animals is included in this report. Collaring location and other pertinent tagging statistics are summarized in Table 1. Eighteen moose were fitted with radio transmitters and 21 wore numbered visual collars only. Twenty-seven incisor teeth were collected during the collaring operation, and cementum layer analysis indicated the average age for females was 6.7 years with a range from 2 to 13 years. Yearlings were generally avoided during the collaring operation. Of 21 females palpated, 18 were pregnant (85.7 percent).

Blood and physical measurement data were combined with those from other moose studies and were presented elsewhere (Ballard and Taylor, in prep.). Briefly, the pooled blood parameters tested were very comparable to values obtained from other studies of populations considered to be in good condition. Some parameters tested (hemoglobin and pack cell volume) from the Devil Mountain area were lower than those from the other tagging sites, but it is not known if those differences were statistically significant since no tests have as yet been performed.

Table 1. Date, location and general information of female moose radio and visual collared along the Susitna River. Devils Canyon Project, March 1978.

Collar Number	Collaring Date	Location	Anectine Dosage	Cementum Age (years)	Condition*	Pregnant**
8583	3/18/77	E. of Devil Mtn.	27 mg.	4	6	No
8584	3/18/77	E. of Devil Mtn.	25 mg.	-	6	Yes
8586	3/18/77	Devil Mtn.	23 mg.	10	4	Yes
8589	3/18/77	E. of Devil Mtn.	27 mg.	-	-	No
8580	3/18/77	Devil Mtn.	23 mg.	-	-	--
8038	10/27/76	Watana	-- --	9	-	--
8573	3/19/77	Susitna-Watana	27 mg.	-	7	Yes
8576	3/19/77	Susitna-Watana	28 mg.	8	6	--
8022	10/28/76	Upper Watana	29 mg.	10	7	--
8588	3/19/77	Upper Jay Creek	29 mg.	8	7	--
8040	10/28/76	Upper Watana	29 mg.	-	7	--
8578	3/20/77	Susitna-Tyone	27 mg.	2	5	No
8579	3/20/77	Susitna-Tyone	25 mg.	3	6	Yes
8031	10/22/76	S. Bend-Susitna	27 mg.	-	7	--
8035	10/27/76	S. MacLaren Flats	-- --	-	7	--
8018	10/27/76	Butte Creek	29 mg.	2	6	--
8030	10/22/76	W. of Ballard L.	25 mg.	6	6	--
8575	3/21/77	Lower Maclaren	29 mg.	11	7	Yes
2 Blue	10/22/76	N. Oshetna R.	-- --	9	-	--
4 Blue	10/22/76	Susitna-Tyone	-- --	4	-	--
5 Blue	10/22/76	Susitna-Tyone	27 mg.	6	7	--
6 Blue	10/22/76	Susitna-Tyone	27 mg.	5	-	--
7 Blue	10/22/76	Susitna-Tyone	25 mg.	6	-	--
71 Blue	10/28/76	Jay Creek	29 mg.	3	-	--
50 Blue	3/22/77	Lower Maclaren R.	27 mg.	8	6	Yes
51 Blue	3/22/77	Lower Maclaren R.	25 mg.	3	6	Yes
52 Blue	3/22/77	Lower Maclaren R.	27 mg.	7	7	Yes
53 Blue	3/22/77	Lower Maclaren R.	27 mg.	-	5	Yes
54 Blue	3/22/77	Lower Maclaren R.	25 mg.	4	-	Yes
56 Blue	3/22/77	Lower Maclaren R.	27 mg.	7	7	Yes
58 Blue	3/22/77	Lower Maclaren R.	27 mg.	12	7	Yes
60 Blue	3/20/77	Susitna N. of Tyone	28 mg.	13	-	--
61 Blue	3/20/77	Susitna N. of Tyone	25 mg.	-	7	Yes
63 Blue	3/20/77	Susitna Bend	27 mg.	5	7	Yes
64 Blue	3/20/77	Susitna Bend	27 mg.	11	7	Yes
75 White	3/19/77	Jay Creek	28 mg.	-	-	Yes
79 White	3/19/77	Jay Creek	28 mg.	-	-	--
80 White	3/18/77	E. Devil Mtn.	25 mg.	4	-	Yes
81 White	3/18/77	E. Devil Mtn.	27 mg.	-	7	Yes

*Condition was determined by general appearance and relative amount of fat over rump and ribs. Scale of 1-10, 10= excellent. See Franzmann et al. (1974) for criteria.

**Only cows collared in March and palpated are included in this column.

A total of 270 observations were recorded for 18 radio collared moose between late October 1975 and mid November 1977. One radio collared moose was found dead two weeks after collaring. The cause of death was undetermined; we suspect, however, that it was drug related. Another moose was lost from the sample when we were unable to relocate it after one month of tracking. Its loss was attributed to a faulty transmitter.

Movements

Radio-collared moose occupied areas ranging from 21 km² to 520 km² (Table 2). Significantly smaller areas were occupied in the rugged terrain between Jay Creek and Devils Canyon than east of Jay Creek where the terrain becomes more open and level. The correlation between the number of sightings and size of range for each moose was $r = 0.50$. Observed locations and detailed movements of each radio-collared moose are presented in Appendix I. A brief description of radioed moose movements follows.

Devil Mountain Area

Three moose (#s 8583, 8584 and 8586) were radio-collared on Devils Mountain on 18 March 1977, approximately 3 km north of the Susitna River (Fig. 3). All three remained in the vicinity of their tagging location until spring when #8583 moved 8 km east. Both #8584 and #8586 remained on their winter range through April. At the end of May, during the peak of calving, #8584 and #8586 were located 10-11 km to the southeast on the other side of the Susitna River within 2 km of each other. Three

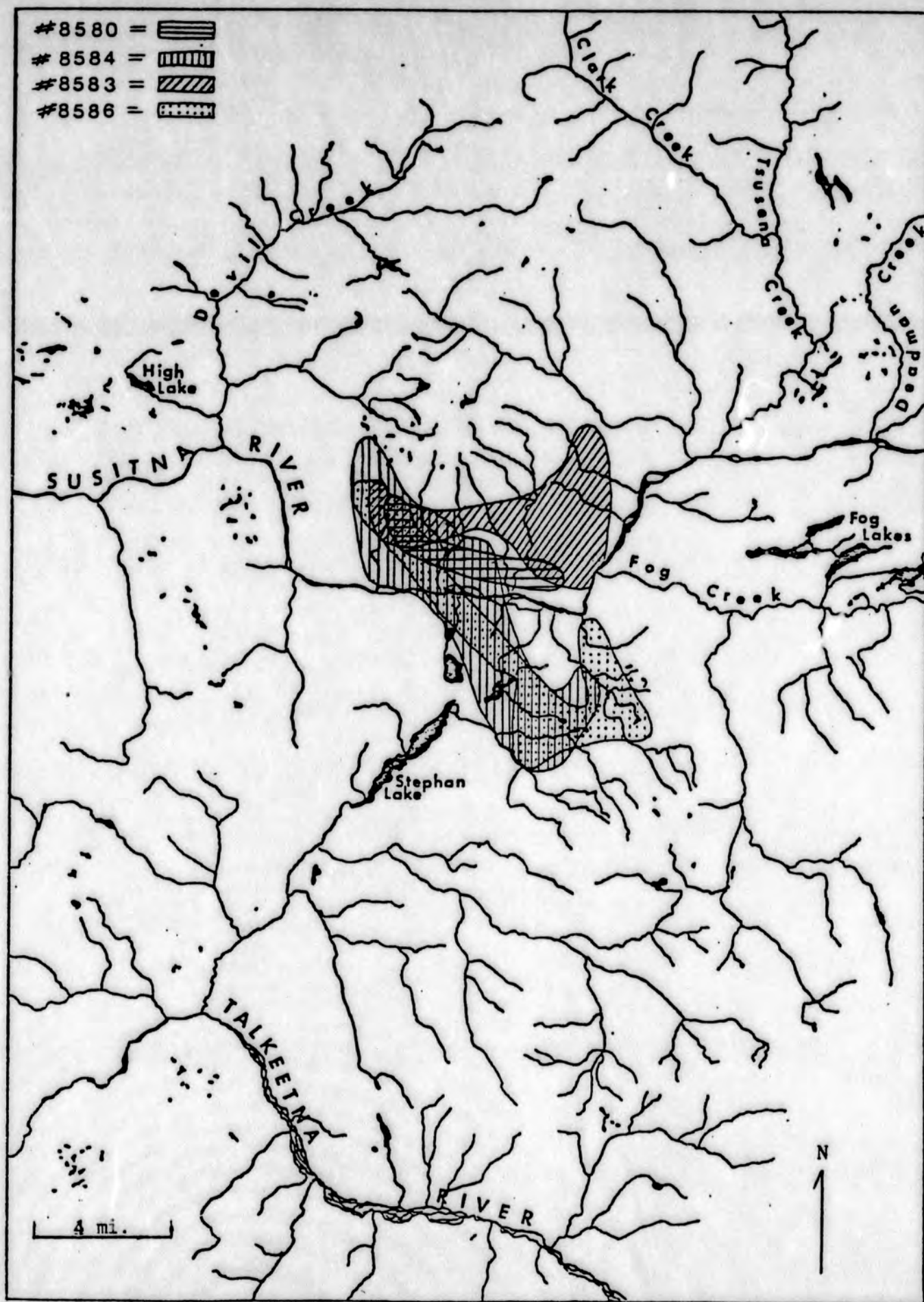
Table 2. Range size, number of locations and minimum number of river crossings of radio collared moose along the Susitna River. Devils Canyon Project, March 1978.

<u>Collar Number</u>	<u>Number of Locations</u>	<u>Range Length km.</u>	<u>Range Width km.</u>	<u>Total Area km²</u>	<u>Minimum number of river crossings</u>
8583	12	11.6	4.8	30.9	0
8584	12	17.7	4.5	37.3	3
8586	10	17.7	5.3	30.9	1
8589	2	--	--	--	-
8580	3	--	--	--	-
8038	19	14.2	9.3	51.5	0
8573	14	14.8	7.9	47.6	2
8576	12	6.9	6.4	20.6	0
8022	18	24.8	17.2	180.2	1
8588	11	13.5	8.2	39.9	1*
8040	19	17.1	6.4	49.9	0
8578	17	14.3	5.5	32.2	1
8579	10	30.6	11.9	173.2	2
8031	26	16.1	12.1	74.7	0
8035	23	62.3	14.0	373.4	0
8018	18	65.0	18.7	520.1	2
8030	24	55.5	21.2	415.8	2
8575	<u>20</u>	103.0	10.5	<u>291.4</u>	<u>0</u>
270 Total		Ave. range size 148.1 km ²			15 Total

* Cow observed on island.

Correlation between number of sightings and size of range for each moose = .50.

Figure 3. Location and General Range Size for Radio-Collared Moose Along the Susitna River near Devil Mountain. Devils Canyon Project, March 1978.



days later #8584 was seen with two new calves and #8586 was seen with one. Number 8583 was not pregnant when palpated in March. She remained on the north side of the river within a 3 km radius of her April location. Number 8586 lost her calf within two weeks and remained through the fall within 6 km of her calving location. Moose #8584 lost one calf within the first two weeks and the other prior to the first week in July. She was found on the north side of the river on 28 June and on the south side on 5 July where she remained through the fall. All three moose remained at elevations below 950 m during the time they were monitored. Some seasonal fluctuation in elevation occurred just prior to calving as #8584 and #8586 moved down from the south facing slope of the riverbank and crossed the river to calve. Seasonal home ranges for all three moose appeared to be small, probably not in excess of 20 km².

Watana Creek Area

Three radios were placed on cows along upper Watana Creek in October. Two of these females, #8040 (Fig. 4) and #8022 (Fig. 5), were collared together. Both moved to lower elevations as winter progressed and remained there until June. Number 8040 was seen with twins on 8 June but on 16 June the calves were missing and were never seen again. The cow returned to upper Watana Creek and remained within a 2 km radius throughout the fall. Number 8022 traveled considerably farther than #8040 as she crossed the Susitna sometime in February and returned in March. On 1 June she was seen in the same vicinity as #8040 on lower Watana Creek. On 16 June they were again found in close proximity. Her movements indicated no distinct migration between winter and summer

Figure 4. Location and General Range of Radio Collared Moose Numbers 8038, 8040 and 8573 Along Watana Creek. Devils Canyon Project, March 1978.

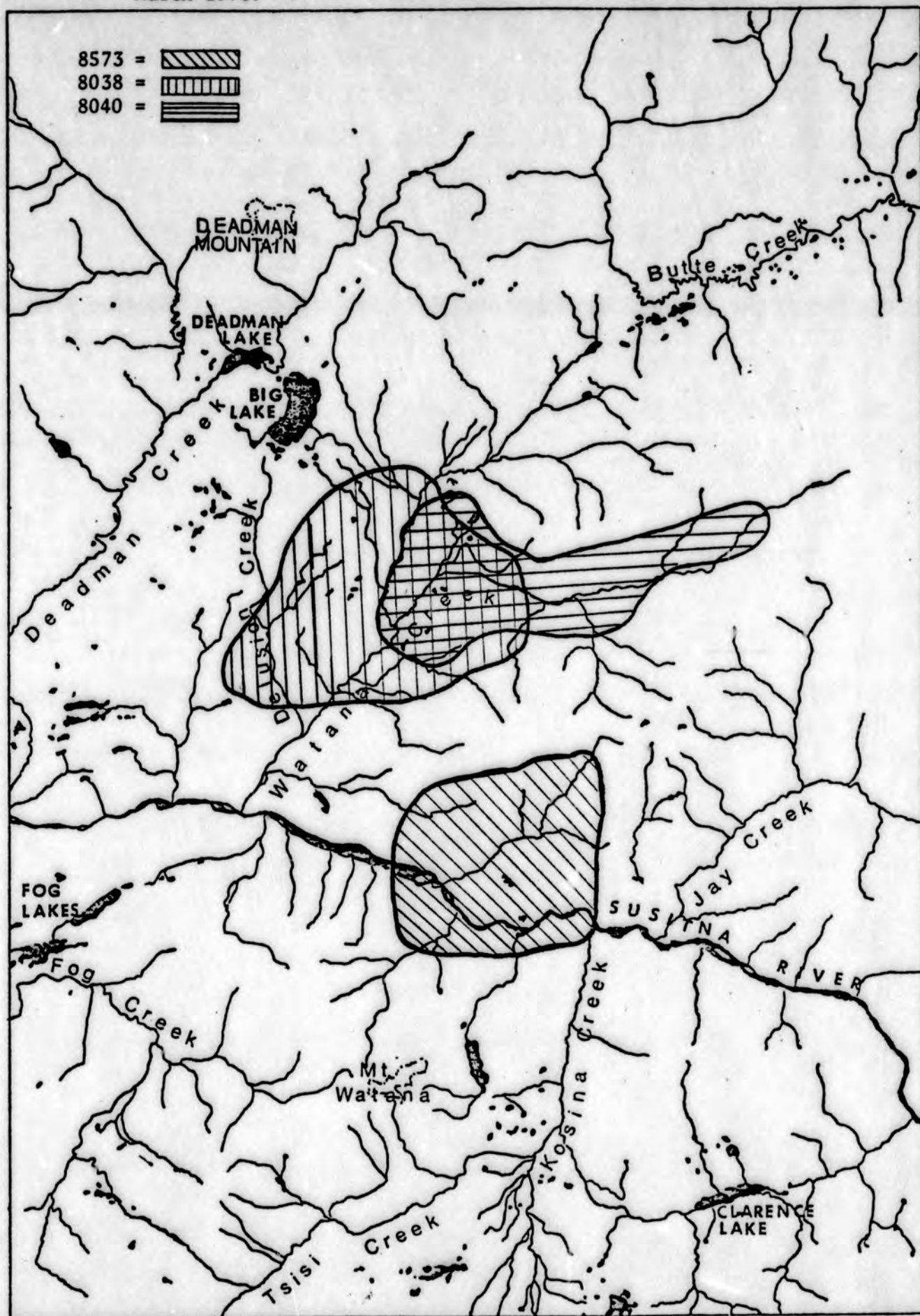
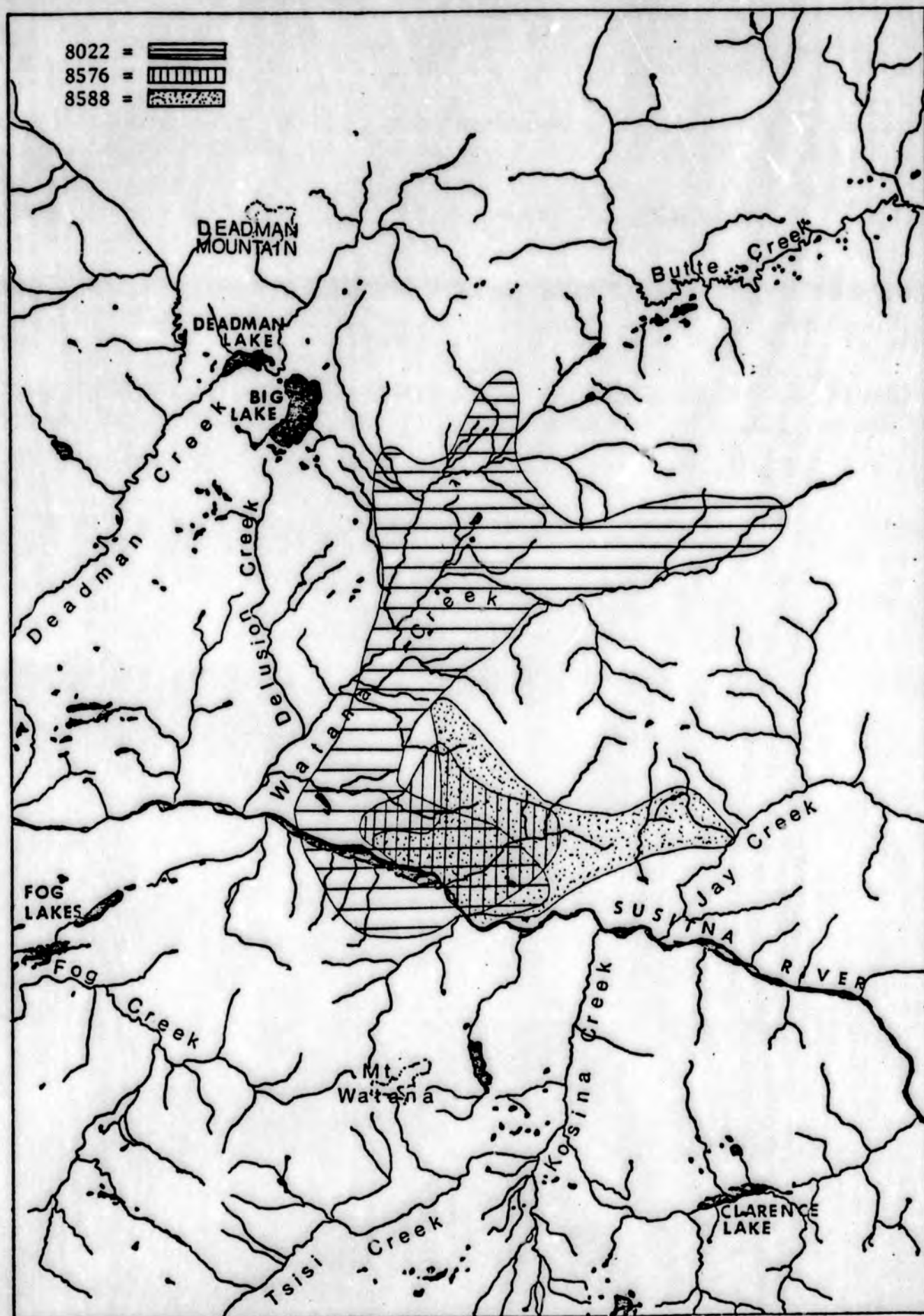


Figure 5. Location and General Range of Radio Collared Moose Numbers 8022, 8576 and 8588 Along Watana Creek. Devils Canyon Project, March 1978.



ranges. Number 8022 was never seen with a calf. During the calving season she was found in four different locations.

Number 8038 was collared 5 km south of Big Lake. During all 19 observations this moose was between 600 m and 950 m elevation (Fig. 4). Although she was observed with a new calf on 26 May, when checked again on 31 May the calf was missing. From June through fall she appeared to move constantly, and ranges used throughout this period overlapped that of winter observations.

On 19 March three females (#s 8573, 8576 and 8588) were collared on the north side of the Susitna between Watana and Jay Creeks. Number 8576 moved less extensively than any of the other radio collared females (Fig. 5). She was observed 12 times, all on the north side of the river within an area of approximately 28 km². When last observed on 30 November she was within 2 km of her tagging location. Female #8588 also wintered along the north bank of the Susitna. She moved to an island in the river in early June and was observed again on the north bank on 8 June where she remained through November (Fig. 5). Number 8573 wintered along the north shore of the Susitna and crossed to the south bank during calving season (Fig. 4). She was never observed with a calf, although it was determined that she was pregnant when collared. However, she was not visually observed between 26 May and 3 June. She remained on the south side of the river until July when she returned to her collaring location. She stayed there until 30 November when, after a moderate snowfall, she moved to lower elevations near the mouth of Watana Creek.

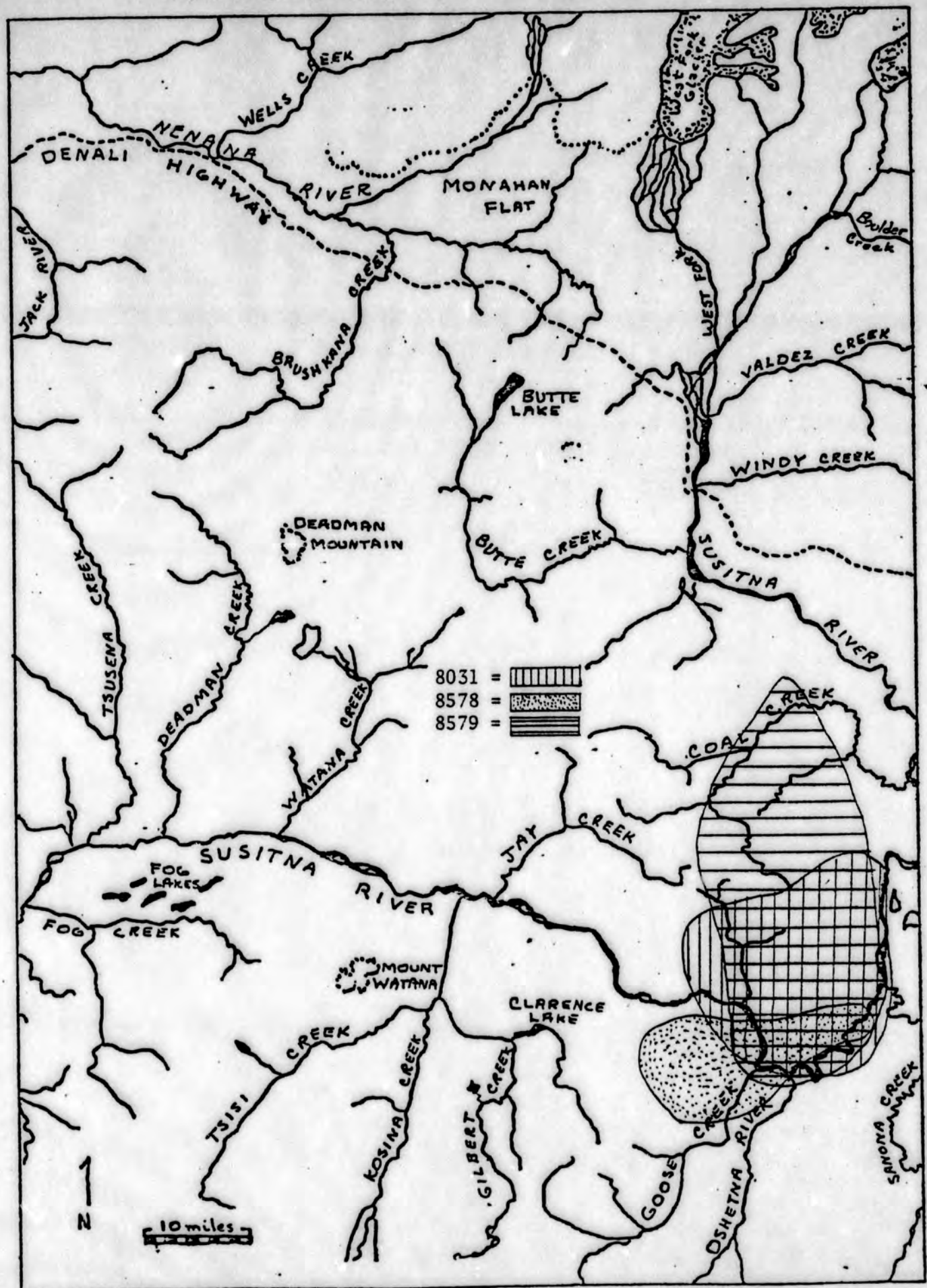
Susitna Bend Area

Movements were more extensive for those moose collared east of Jay Creek. Number 8031 was collared in October 1976 on the north side of the Susitna near the mouth of the Tyone River. Two others, #s 8578 and 8579, were collared in the same vicinity in March 1977. Number 8031 was observed almost exclusively between 600 m and 950 m in spruce habitats along the north and west banks of the Susitna (Fig. 6). She was never observed on the south bank of the river. She had a calf when tagged which survived the winter, but she was never observed with a calf the following spring. No seasonal range preference is discernible from her movement pattern.

Number 8579 was once found 30 km from where she was collared (Fig. 6). She wintered along the Susitna and crossed to the mouth of Goose Creek in May. She returned to the north side and moved to higher elevations near the headwaters of Coal Creek during calving where she remained through November. She was not located during June and was not observed with a calf in July, although it had been determined in March that she was pregnant. She remained in the high country through November.

Cow #8578 wintered in the same vicinity as 8579 and then crossed the Susitna to the mouth of the Cahetna River (Fig. 6). She never returned to the north side and spent the remaining summer months and fall in an area of approximately 7 km², west of the mouth of Goose Creek. Number 8578 was not pregnant when collared in March.

Figure 6. Location and General Range of Radio Collared Moose Numbers 8031, 8578 and 8579 Downstream from the MacLaren River. Devils Canyon Project, March 1978.

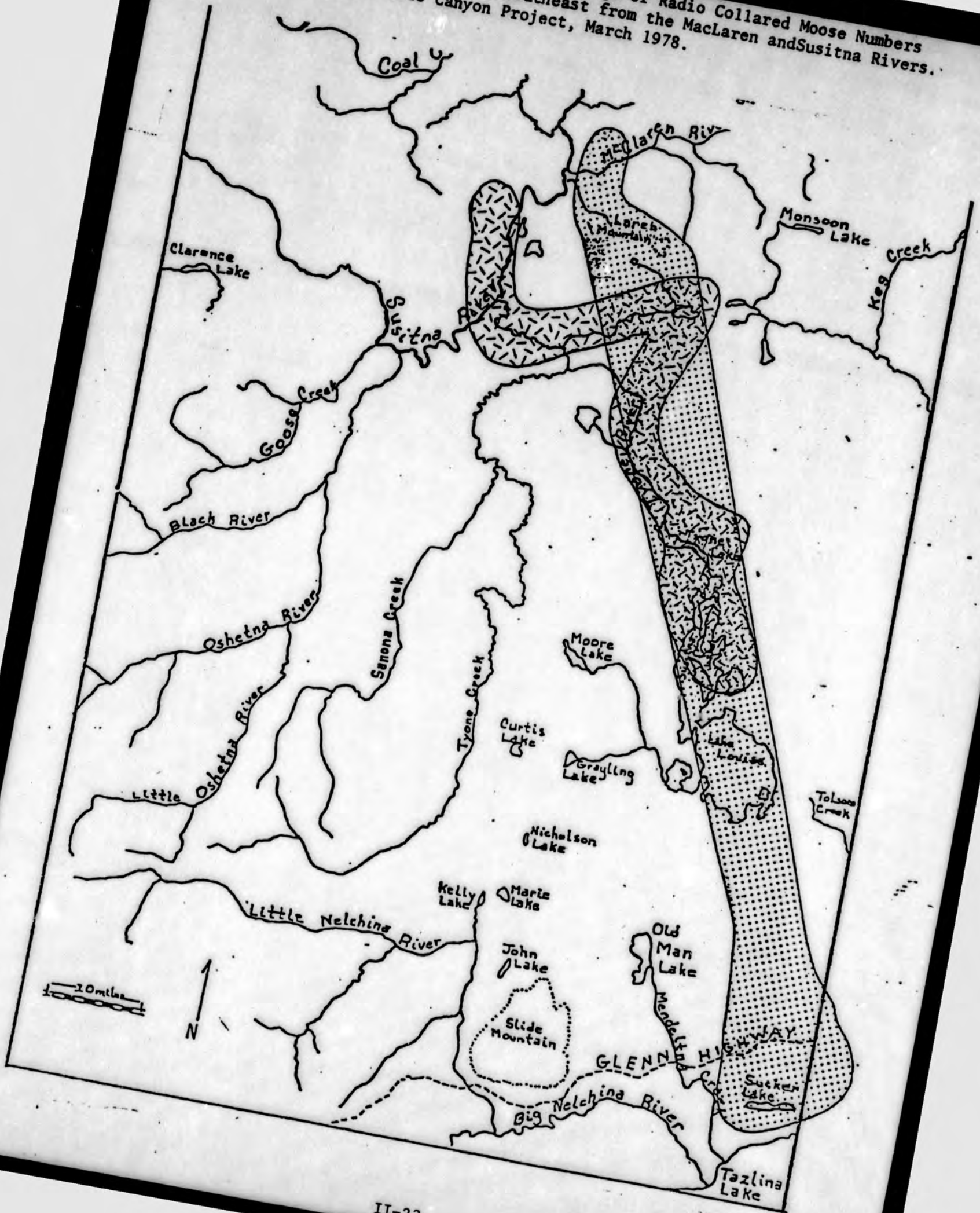


Number 8030 was collared very close to #s 8031, 8578 and 8579, but her movement patterns were totally dissimilar (Fig. 7). She moved south across the Susitna River and wintered along the drainage of the Tyone River. By 10 May she had moved 2 km to an island in Susitna Lake and was observed there with a calf on 30 May. She remained with her calf through August in the vicinity of Tyone Village and returned on 5 October to within 1 km of her collaring location.

Maclaren River Area

Two females, #s 8035 and 8575, were collared along the Maclaren River. Number 8035, collared on 27 October 1976, moved 59 km during November and early December to the mouth of the Oshetna River where she remained through March (Fig. 8). On 22 April she was observed returning to the vicinity of her tagging location. She was observed on several occasions in this area without a calf throughout the summer and fall. By 22 November she had returned to the mouth of the Oshetna River, 50 km from her previous location. During April 1977, #8575 migrated 103 km, the longest movement recorded during this study, from the lower Maclaren River to Sucker Lake south of the Glenn Highway near Tazlina Lake (Fig. 7). She was pregnant when collared in March but was never observed with a calf. This moose remained near Sucker Lake through May and moved 11 km north to Tolsona Ridge during June where she spent most of July and August. She returned once to Sucker Lake and made one trip to Lost Cabin Lake, but both times moved back to Tolsona Ridge. On 30 September she was observed moving back towards her tagging location on the Maclaren. By 5 October she had returned 82 km and was within 9 km of her collaring location.

Figure 7. Location and General Range of Radio Collared Moose Numbers 8030 and 8575 Southeast from the MacLaren and Susitna Rivers. Devils Canyon Project, March 1978.



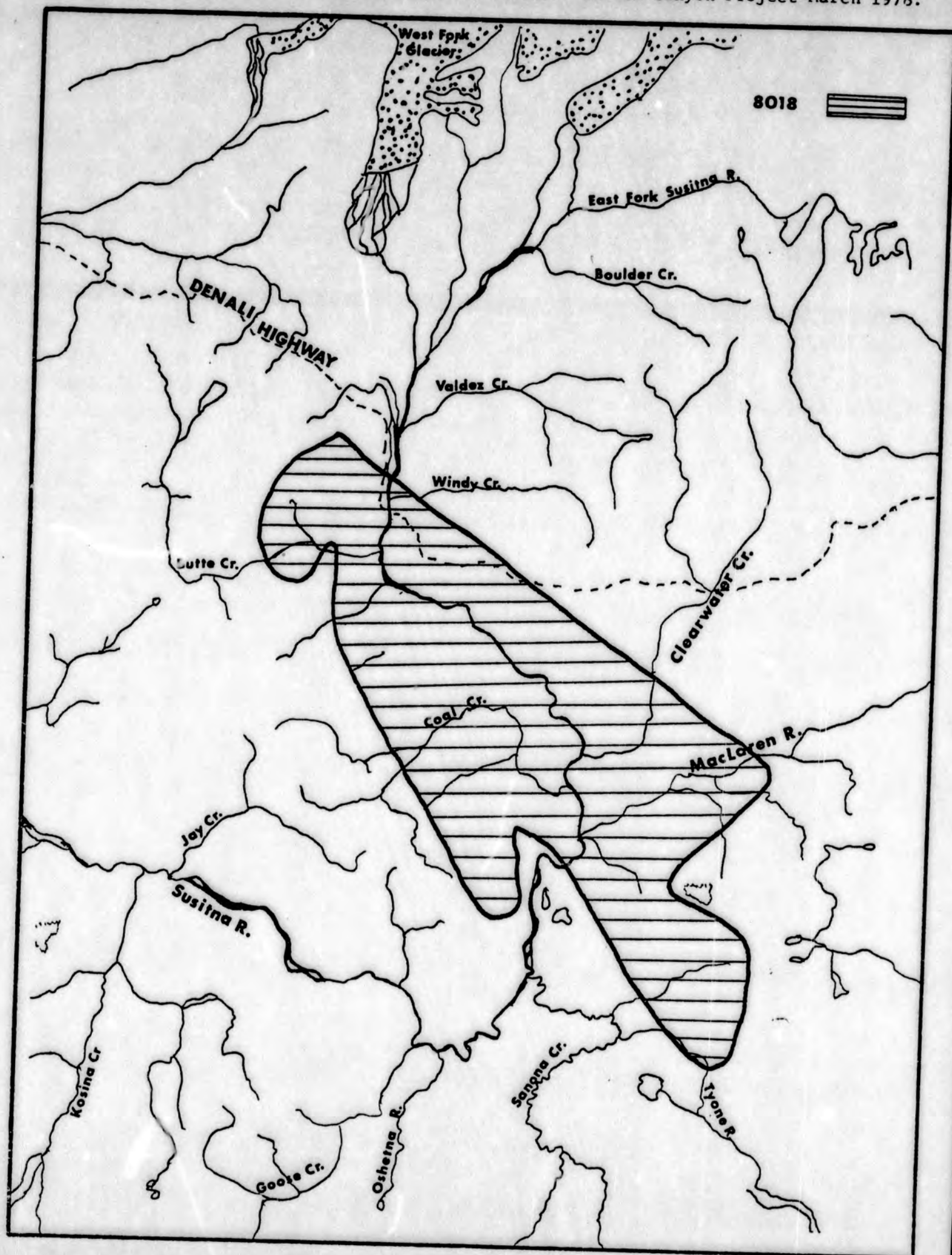
Female #8018 was collared in October along Butte Creek. She was accompanied by a calf and remained in the Butte Creek vicinity through January (Fig. 9). On 7 February she and her calf were observed across the Susitna, 43 km away on the north side of Kelley Lake. She wintered there with her calf and began moving up the Maclaren in April. On 30 May she was seen with a new calf which was observed until 10 June. By 12 July she had returned 30 km in the direction of her tagging location and remained in the same vicinity she had inhabited the previous fall through November.

Radio-collared moose movement data were supplemented somewhat by incidental observations of visually collared moose. Eleven additional river crossings were documented and possible migratory directions were identified (Fig. 10). The second longest movement during this study occurred when the moose wearing visual collar #80 was found near Lone Butte, 84 km southeast of her tagging location at Devils Mountain. Of the moose collared west of Jay Creek, she alone showed any migratory movement of significant distance. Collar number 60 was tagged in March 1977 just north of the mouth of Tyone Creek and was found 78 km to the northwest between the Nenana River and West Fork Glacier in August. One moose, #10, collared along Butte Creek in October 1976 moved down Watana Creek to the Susitna where she was found in August. Another, #67, was collared near Susitna Lodge in March 1977 and was located in November at the headwaters of Jay Creek.

Habitat Use

Habitat types being utilized by collared moose were noted during

Figure 9. Location and General Range of Radio Collared Moose Number 8018
Along the Maclaren and Susitna Rivers. Devils Canyon Project March 1978.



radio-tracking flights, and observations were categorized in nine groups (Table 3). Because spruce is the dominant vegetation over much of the study area and is widely variable in density, three categories were used to describe it. One hundred and seventy-two habitat observations of radio-collared moose were noted during tracking flights. Seventy percent of all observations were in spruce dominated habitats. Moose were most often (29.7 percent of observations) found in medium spruce areas where trees ranged from six to 15 m high in stands of moderate density.

Calving took place primarily in open spruce areas, most often at lower elevations where stands of trees four to 14 m high were interspersed with openings. Eight calves, including one set of twins, were born in spruce habitats while one cow gave birth to a set of twins in alder dominated habitat. Alder and willow areas at and above timberline were utilized during the rutting season until late in the fall when snow depths approached one meter.

Between Devil Creek and Watana Creek, radio-collared moose remained throughout the year almost exclusively at the lower spruce dominated elevations. Moose collared along upper Watana Creek were observed more often in willow-alder communities except during late winter when they were generally found in spruce habitats at lower elevations.

DISCUSSION

Movement patterns of moose are highly variable. Studies throughout North America (Edwards and Ritcey 1956, Houston 1968, Goddard 1970,

Table 3. Number of observations of radio collared moose in vegetation types along the Susitna River between October 1976 and December 1977. Devils Canyon Project, March 1978.

<u>Collar Number</u>	<u>Total Sightings</u>	<u>Open Spruce*</u>	<u>Medium Spruce</u>	<u>Dense Spruce</u>	<u>Spruce/ Hardwood**</u>	<u>Alpine Tundra</u>	<u>Alder</u>	<u>Willow</u>	<u>Riparian Willow</u>	<u>Open</u>
8583	10	4	2	1	3					
8584	9	5	2	1	1					
8586	7	3	4							
8589	1			1						
8580	2		1	1						
8038	13	5	4	1		1			1	1
8573	10		6	1	1		1	1		
8576	12		8				1			
8022	8	1	2				3	1	1	
8588	9	2	3	1			1	2		
8040	10	1					6	1	2	
8578	12	6		1	1	2	1	1		
8579	9	1	1	2	1	2		1	1	
8031	11	1	7	2				1		
8035	12	3	3	1		1		1	3	
8018	11	3	2			1	2	2	1	
8030	11	2	3	6						
8575	15	3	3	7			1		1	
	<u>172</u>	<u>43</u>	<u>51</u>	<u>26</u>	<u>7</u>	<u>7</u>	<u>16</u>	<u>11</u>	<u>10</u>	<u>1</u>
Percent of Total	100.0	25.0	29.7	15.1	4.1	4.1	9.3	6.4	5.8	.6

*Spruce categories include both white spruce (*Picea glauca*) and black spruce (*Picea mariana*).

**Hardwoods in this category include aspen (*Populus tremuloides*) and birch (*Betula papyrifera*).

LeResche 1972) support the hypothesis that movement patterns in moose may range from being sedentary to seasonal migrations of great distances. Peterson (1955) believed that many moose spend their whole lives in an area of 32-800 km². This appears to be true for many of the moose in the Susitna study area. Nine of the 16 moose radio-collared and tracked for 13 months along the Susitna River occupied areas smaller than 52 km². All but one of these were collared west of Jay Creek where the river valley is fairly narrow and is surrounded by mountains.

LeResche (1974) found that home range seldom exceeds 5-10 km² during a given season. Because radio-collared moose were only monitored for 8 to 13 months during this study, data were inadequate to allow computation of seasonal home range sizes. It was noticed, however, that several of the radio-collared moose were found repeatedly in areas less than 10 km² in extent. Others appeared to be more nomadic, particularly those collared in the eastern portion of the study area where they wandered across areas up to 50 km² during the spring and summer.

Areas of low elevation are often inhabited by both migratory and nonmigratory moose during winter and spring (LeResche 1972). This was apparent in the Devil Mountain area where #80 was collared. Between March and September 1977 she moved a straight line distance of 84 km to the southeast while a cow collared at the same time in the same location remained within 11 km of her collaring site throughout the year. This was also true of the wintering area between the Tyone River and Goose Creek to which many moose migrated considerable distances. Number 8031 remained in this area throughout the 13 months of this study.

Edwards and Ritcey (1956) noted that increasing snow depths above timberline triggered moose migrations out of the high country to their wintering areas in the lowlands. Their observations have been supported in Alaska by Rausch (1958) and LeResche (1974), both of whom concluded that the fall migration in Interior Alaska is closely related to snow conditions. Snow depths along the Susitna River during the winter of 1976-77 were below normal until late March. They appeared to be greater along the eastern portion of the study area than west of Jay Creek. Shortly after accumulated snow reached its maximum depths, most collared moose east of Jay Creek either migrated short distances where a considerable drop in elevation was possible, or made long treks to their wintering areas, gradually moving to lower elevations. Except for #80, those west of Jay Creek showed no tendency to migrate at all. Radio collared moose in this area may be representative of a sedentary population, but it is recognized that data collections over a 13-month period which includes subnormal snow depths are inadequate to accurately assess the migratory nature of moose along this stretch of the Susitna River. If data from this small sample are representative of the moose population currently inhabiting this stretch of the Susitna River, construction of the Devils Canyon dam would have a highly detrimental effect on the population as the dam would inundate a major portion of the winter habitat presently available. Destruction of this winter range would substantially reduce the carrying capacity of a major portion of the Devil Creek drainages.

Some of the possible migratory routes represented by data accumulated thus far are illustrated in Fig. 10 and others are illustrated in Appendix I. The relative significance of each of these is unknown at this time,

although it is apparent that a substantial number of moose migrate to and utilize the area near the mouth of the Tyone and the Oshetna Rivers for winter range. Coady (1974) noted that the depth, density and hardness of snow are appreciably lower in coniferous and deciduous tree communities making them more favorable to moose under stress from severe winter snow conditions. The lower, spruce-covered reaches of the Watana Creek Valley are probably critical for the majority of moose inhabiting this area during a severe winter. A major portion of this area would be inundated by construction of the Watana dam. Additional observations of moose during normal or severe winter conditions are necessary to determine the importance of this area as winter range. If this area is used as winter range during more severe winters which would normally occur in this area, construction of the Watana Dam would substantially reduce the carrying capacity of this portion of the study area.

Present information indicates moose depend heavily upon the river bottoms and adjacent areas for winter habitat both above and below the Watana and Devils Canyon damsites. Lack of adequate wintering areas in the lower Susitna Valley has been a major limiting factor to moose population growth there in the past (Chatelain 1951). Most existing winter range is along the major rivers where periodic flooding has caused rechanneling of the main stream, allowing riparian willow to colonize the dry stream beds. Regulating the flow of water from the dam at Devils Canyon could have a highly detrimental effect on growth of riparian vegetation downstream to the mouth of the Susitna. It is possible that maintaining a steady flow of 8,000 to 10,000 cu. ft./sec. from the Devils Canyon dam would effectively prevent the flooding activity

that presently occurs periodically. This could create a short-term abundance of winter range along the riverbanks that might last 30 or more years. The net long-term effect could well be a negative one, however, as it is suspected that the present natural flooding activity of the Susitna River produces favorable conditions for browse production. Without these annual floods, these riparian areas could become mature stands of hardwoods after 25 or 30 years and provide little or no winter forage. Research on riparian vegetation habitat types and associated moose usage downstream of dam construction is essential to determine potential impacts on moose populations.

CONCLUSIONS

The emphasis of this telemetry study focused almost exclusively on the north side of the Susitna River upstream from the Devils Canyon dam site. Information on migratory routes and annual movement patterns was limited by the small sample of radio-collared moose (18), many of which were observed for less than nine months. Moose which were collared in October 1976 were monitored through the winter of 1976-77 which was considered to be mild. Information pertinent to identifying critical wintering areas is most appropriately obtained during winters of high to severe snow depths as moose tend to congregate in greater densities on the most vital ranges as snow depths increase. Acquisition of moose movement information downstream and on the south side of the Susitna River is essential in order to evaluate the full effects of the proposed hydroelectric project. Downstream effects on moose would be expected to be significant since vegetation composition would be altered substantially as a result of regulated water flow.

Annual moose harvests within the immediate drainages along the upstream portion of the Sustina River have averaged 146 moose since 1974 (ADF&G, unpublished data). Approximately 475-500 sportsmen participate in moose hunts in this area each fall (ob. cit.). How significantly dam construction might reduce or increase this level of activity is difficult to project with the limited data available. Construction of an access road to the Watana site would substantially increase hunter pressure in the area, creating a corresponding increase in total man days spent hunting. The quality of the hunting experience would probably decline, however, as well as the rate of hunter success. Dam construction and maintenance schedules are projected on a basis of a dam life of 100 years. If impacts of the project reduced local moose populations by 50 percent this would amount to a corresponding loss of harvest of 7,300 moose during the life of the dam.

Construction of the Devils Canyon dam would flood a 45 km portion of the Susitna River having a surface area of 7,500 acres (USF&WS, 1975). The riverbanks along this portion of the river are generally steep and provide marginal habitat for moose. The low density of moose tracks in this area throughout the winter of 1977-78 indicates that little utilization occurs during winters of moderate snowfall. Since water levels in the Devils Canyon reservoir are expected to remain fairly constant, low mortality rates associated with ice shelving and steep mud banks would be expected.

Construction of the Watana dam would result in inundation of 43,000 acres along Watana Creek and the Susitna River. Approxiamtely 35,000

acres sustain moderate to heavy utilization by moose during an average winter (USF&WS 1975). Much of it supports moderate moose densities during the spring and summer seasons as well. The preliminary movement data gathered thus far from radio collared moose indicate that moose from several surrounding areas of the Susitna Basin migrate across or utilize this portion of the river during some period of the year. The Alaska Department of Fish and Game recorded observations of 2,037 moose during their fall 1977 sex and age composition counts of these areas (ADF&G, unpublished data). LeResche and Rausch (1974) concluded that an observer generally sees between 43 to 68 percent of the moose in an area during an aerial census. Using 50 percent to extrapolate roughly, the resident population utilizing this portion of the basin probably falls between 4,000 and 5,000 moose. Random stratified counts weighted with an accurate sightability index are needed to accurately assess numbers of moose.

Effects of the construction of the Watana dam on these moose populations could be substantial. The resident nonmigratory segment of the population could be eliminated. The immediate loss of a major portion of the winter range along Watana Creek and parts of the Susitna River to flooding would have the effect of reducing the carrying capacity of the habitat at higher elevations used only during the warm seasons and mild winters. The Watana Reservoir would be 87 km long and may during some seasons prove to be an effective barrier to migrations. The resulting disruption of movements to traditional breeding grounds may adversely affect productivity. Increased mortality of neonates during post calving movements might occur. Since water levels are expected to fluctuate as much as 78 m, ice shelving could become a significant cause of mortality as well.

Calving is a common occurrence in these portions of the study area. The loss of calving habitat notwithstanding, fluctuating water levels would convert the presently timbered slopes from the Watana dam site to the Oshetna River to enormous mud banks. Calf mortality from slipping downhill or getting stuck in the mud could become a common occurrence.

RECOMMENDATIONS

Collection of baseline biological data and completion of resource assessment in the area affected by the proposed hydroelectric project in far greater depth than this study is an essential prerequisite to understanding the possible impacts of the proposed action (Appendix II). Identification of moose populations, movement patterns, and habitat use downstream and on the south side of the Susitna River is essential to predict both negative and beneficial impacts of the proposed project. Habitat studies should be conducted concurrently to determine seasonal use and degree of dependency of populations on habitat to be impacted by the project. Alternate areas suitable for habitat rehabilitation to mitigate range losses should be investigated as well as suitable methods for habitat enhancement.

ACKNOWLEDGEMENTS

Several biologists with the Alaska Department of Fish and Game gave freely of their time and expertise to assist us during the initial phase of this study. Drs. A. Franzmann and T. Bailey from the Moose Research Center participated in the collaring operation, and area biologists

S. Eide and T. Spraker provided their assistance during several phases of the study. Technician Tom Balland helped during all phases of field work. A. Cuning constructed figures for this manuscript. We wish to express our gratitude to the air taxi operators (Ken Holland, Rick Halford, Ken Bunch, Al Lee and Vern Loftstead) for their many safe hours of flying and their willingness to modify their aircraft to accommodate our telemetry equipment. We wish to give special thanks to all those whose comments and criticisms helped in the preparation of this manuscript.

LITERATURE CITED

- Alaska District, Army Corps of Engineers. 1975. Hydroelectric power and related purposes for the upper Susitna River Basin. Interim Feasibility Rept., 125 p.
- Alaska District, Army Corps of Engineers. 1977. Plan of study for Susitna hydropower, feasibility analysis. Prepared for the State of Alaska. 297 p.
- Ballard, W. B. and K. P. Taylor (In prep). Upper Susitna River moose population study. Alaska Dept. Fish and Game P-R Proj. Rept. W-17-10, Job IB-1.20.
- Chatelain, E. F. 1951. Winter range problems of moose in the Susitna Valley. Proc. Alaskan Sci. Conf., 2:343-347.
- Coady, J. W. 1974. Influence of snow on the behavior of moose. Naturaliste Can., 101:417-436.
- Edwards, R. Y. and R. W. Ritcey. 1956. The migrations of a moose herd. J. Mammal. 37(4):486-494.
- Franzmann, A. W., A. Flynn and P. D. Arneson. 1975. Levels of some mineral elements in Alaskan moose hair. J. Wildl. Mgmt. 39(2):374-378.

Franzmann, A. W., P. D. Arneson, R. E. LeResche and J. L. Davis. 1974.

Developing and testing new techniques for moose management. Alaska Dept. Fish and Game P-R Proj. Final Rept., W-17-2, W-17-3, W-17-4, W-17-5 and W-17-6. 54 p. (multilith).

Franzmann, A. W., and P. D. Arneson. 1973. Moose Research Center

studies. Alaska Dept. Fish and Game P-R Proj. Rept., W-17-5. 60 p (multilith).

Goddard, J. 1970. Movements of moose in a heavily hunted area of Ontario. J. Wildl. Mgmt. 34(2):439-445.

Gravel, M. 1977. Tapping Susitna's power. Sen. Mike Gravel Reports to Alaskans. July Newsletter. 4 p.

Greer, K. R. and W. W. Hawkins. 1967. Determining pregnancy in elk by rectal palpation. J. Wildl. Mgmt., 31:145-149.

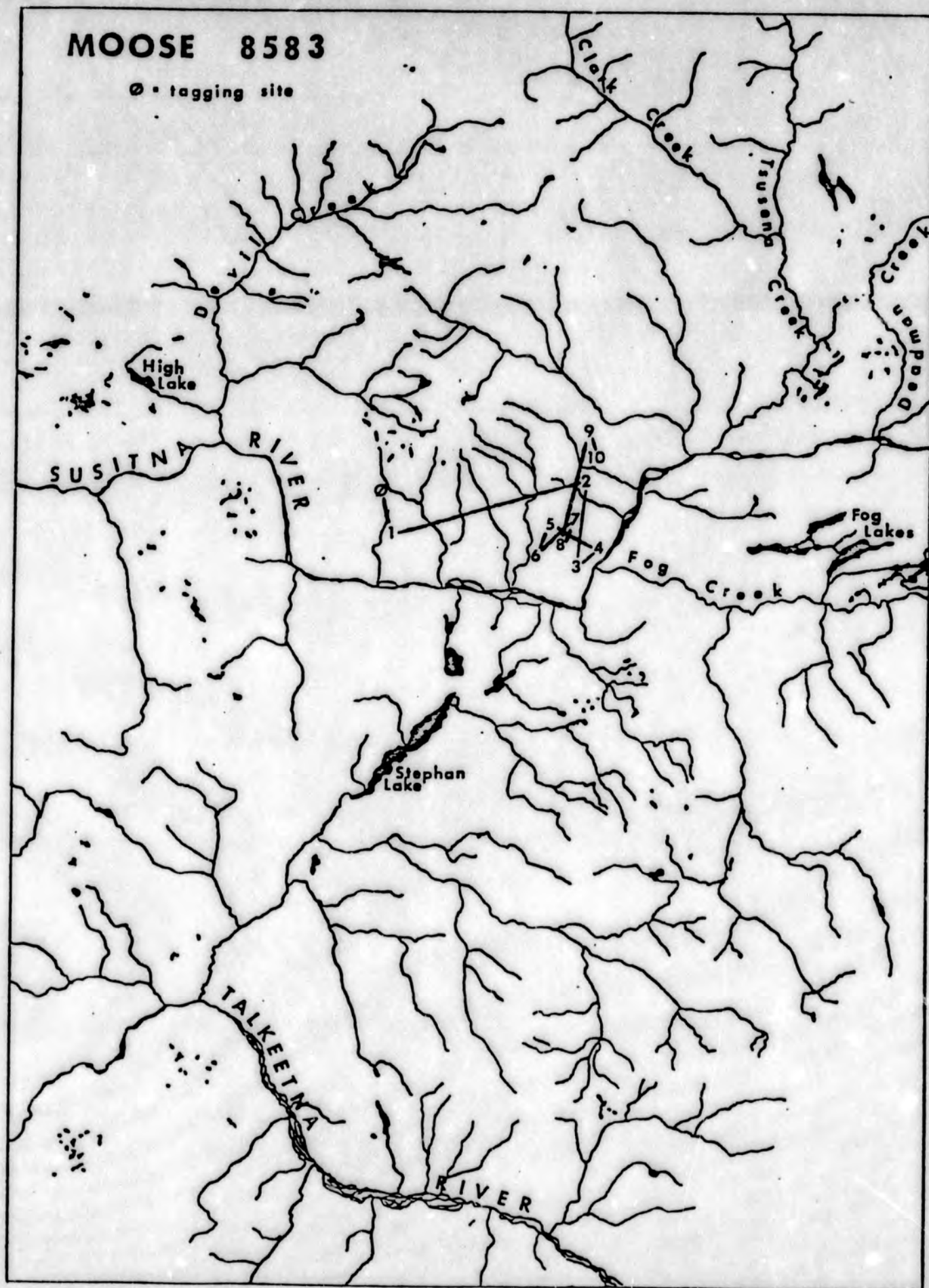
Houston, D. B. 1968. The Shiras moose in Jackson Hole, Wyoming. Grand Teton Nat. Hist. Assoc. Tech. Bull. No. 1. 110 p.

LeResche, R. E. 1972. Migrations and population mixing of moose on the Kenai Peninsula Alaska. 8th N. Am. Moose Conf. Works., Thunder Bay Ontario. Ont. Minist. Nat. Res., Toronto. p. 185-207.

LeResche, R. E. 1974. Moose migrations in North America with emphasis on Alaska. Naturaliste Can. 101:393-415.

- LeResche, R. E. and R. A. Rausch. 1974. Accuracy and precision of aerial moose censusing. J. Wildl. Mgmt. 38(2):175-182.
- Mech, L. D. 1974. Current Techniques in the study of elusive wilderness carnivores. Proc. XI Internat. Congress of Game Bio., pp. 315-322.
- Peterson, R. L. 1955. North American moose. Univ. Toronto Press, 280 p.
- Rausch, R. A. 1958. Moose management studies. Fed. Aid. Wildl. Restor. Job Completion Rept. Vol 12, Proj. W-3-R-12. Alaska Game Comm. Juneau, 138 p.
- Sargent, D. E. and D. H. Pimlott. 1959. Age determination in moose from sectioned incisor teeth. J. Wildl. Mgmt. 23(3):315-321.
- U.S. Fish and Wildlife Service. 1975. Southcentral railbelt area upper Susitna River Basin hydroelectric project two dam plan. U.S. Dept. Interior, Anchorage, AK. 25 p.

Appendix I. Individual Observations and Locations of each Radio Collared Moose Between October 1976 and November 1977. Devils Canyon Project, March 1978.



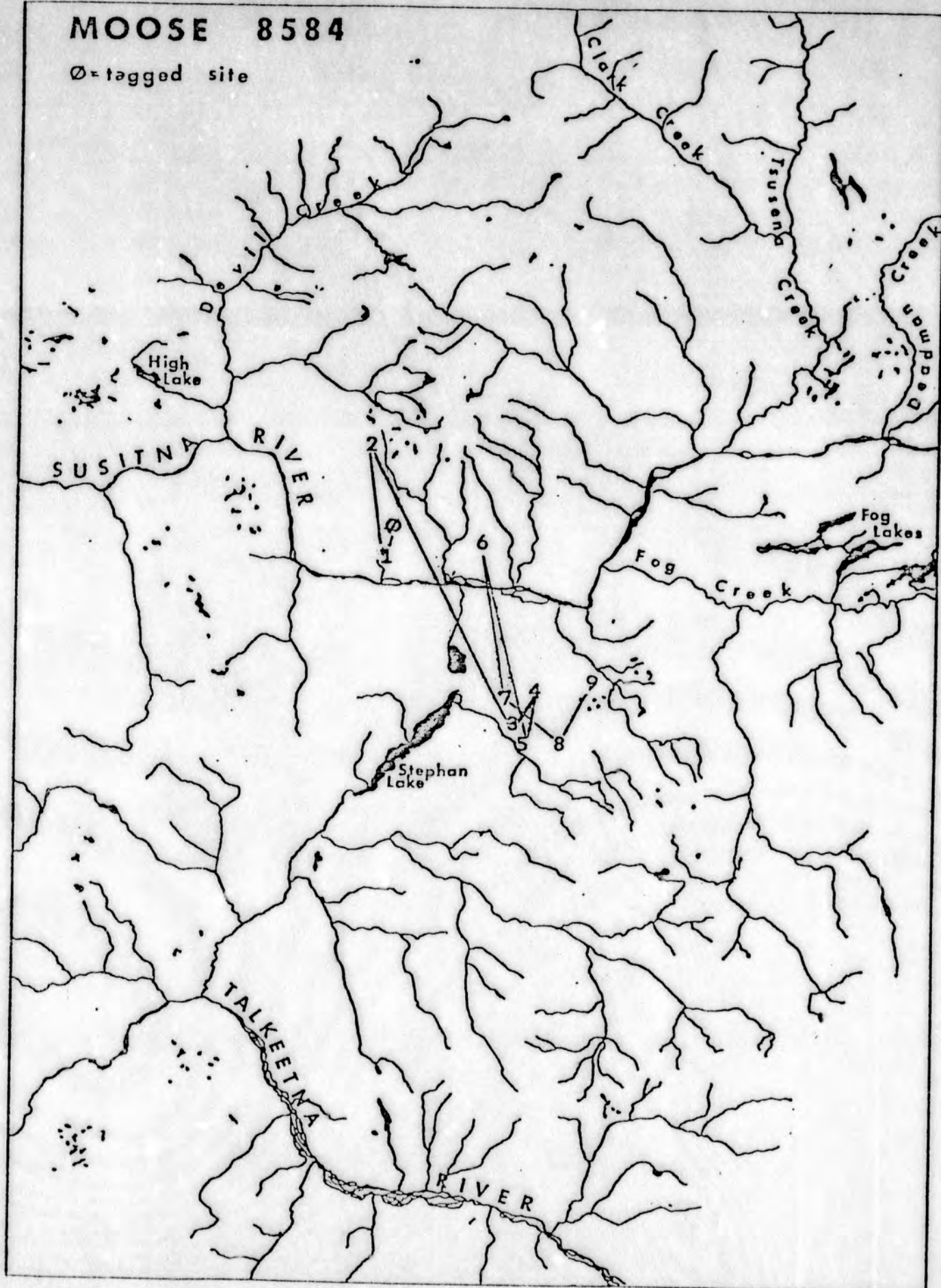
<u>Number</u>	<u>Collar Color</u>	<u>Collar Number</u>	<u>Date</u>	<u>Remarks</u>
8583	Orange	7	18 March 1977	Not pregnant, alone, snow 2" above moose belly

Observations

1	31 March 1977	With #8580, no visual observation (SE-KB)
2	22 April 1977	Alone and spooky, medium spruce-upland, condition 5 or 6 (WB-KB)
3	26 May 1977	Alone, 1600', riparian spruce (Egbert-KB)
4	31 May 1977	Alone, spruce/hardwood (?B)
5	3 June 1977	Alone, heavy spruce (KT)
6	8 June 1977	Alone, spruce (KT)
7	28 June 1977	Alone, spruce/hardwood (KT)
8	5 July 1977	Alone, open spruce (KT)
9	5 August 1977	Alone, tall open spruce/hardwood (TB)
10	5 October 1977	With large bull, spruce (KT)
11	30 November 1977	Alone, open medium spruce (KT)

MOOSE 8584

Ø = tagged site



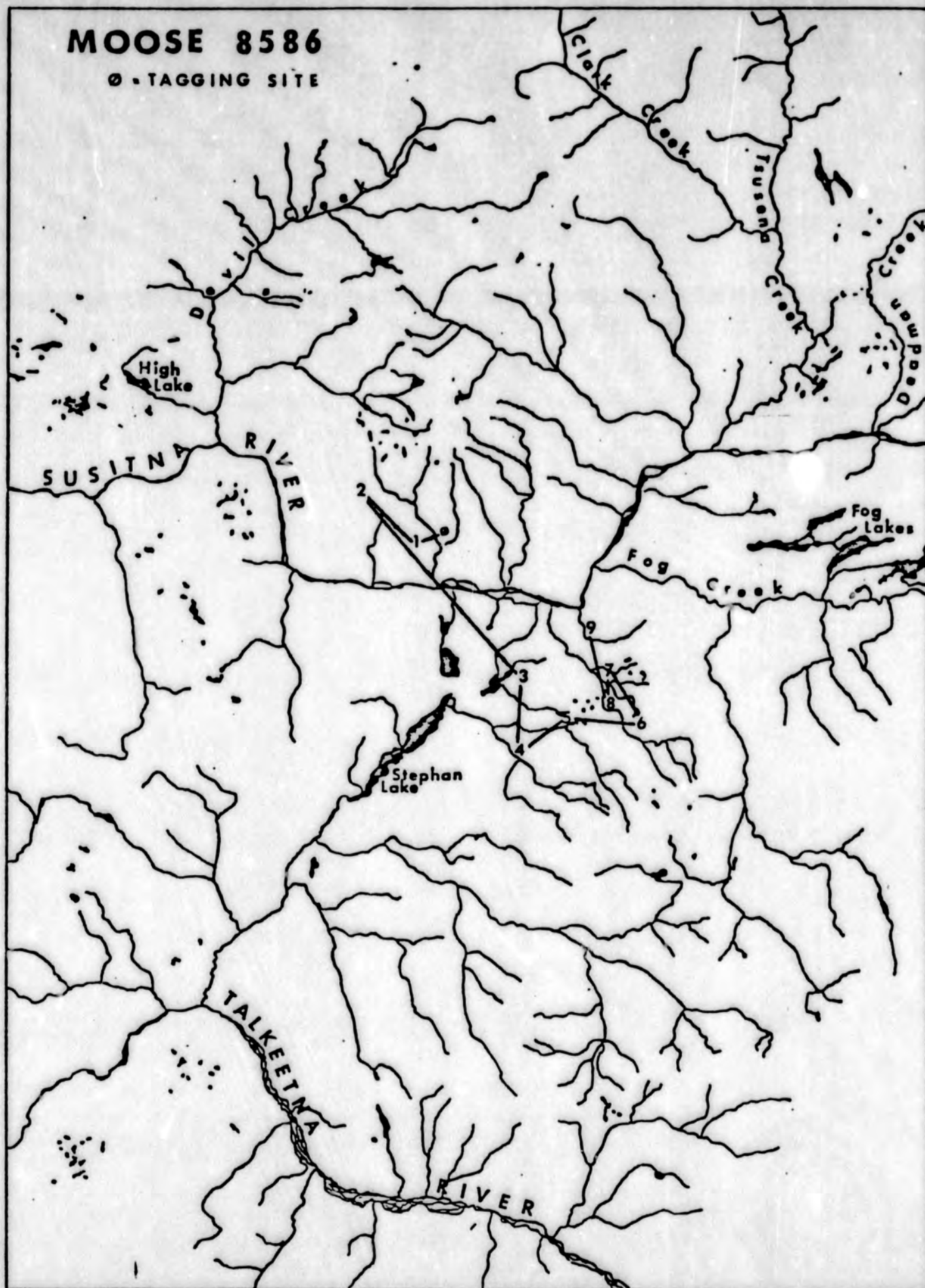
<u>Number</u>	<u>Collar Color</u>	<u>Collar Number</u>	<u>Date</u>	<u>Remarks</u>
8584	Orange	9	18 March 1977	Pregnant

Observations

1 (3:20 PM)	31 March 1977	Alone in spruce (SE-KB)
2 (8:30 AM)	22 April 1977	Alone, upland spruce and some willow, condition 7 (WB-KB)
3	31 May 1977	No calf seen tall spruce (TB)
4	3 June 1977	With 2 new calves, open spruce (KT)
5	8 June 1977	No visual (KT)
Ø	16 June 1977	With one calf, location not recorded (Erickson)
6	28 June 1977	No visual contact, spruce/hardwood (KT)
7	5 July 1977	Alone, open spruce (KT)
8 (11:30 AM)	5 August 1977	1/2 mile from bull and 2 cows, med. spruce (TB)
9	5 October 1977	With large bull and 3 cows, open spruce (KT)
10	30 November 1977	With one cow, open medium spruce (KT)

MOOSE 8586

○ • TAGGING SITE



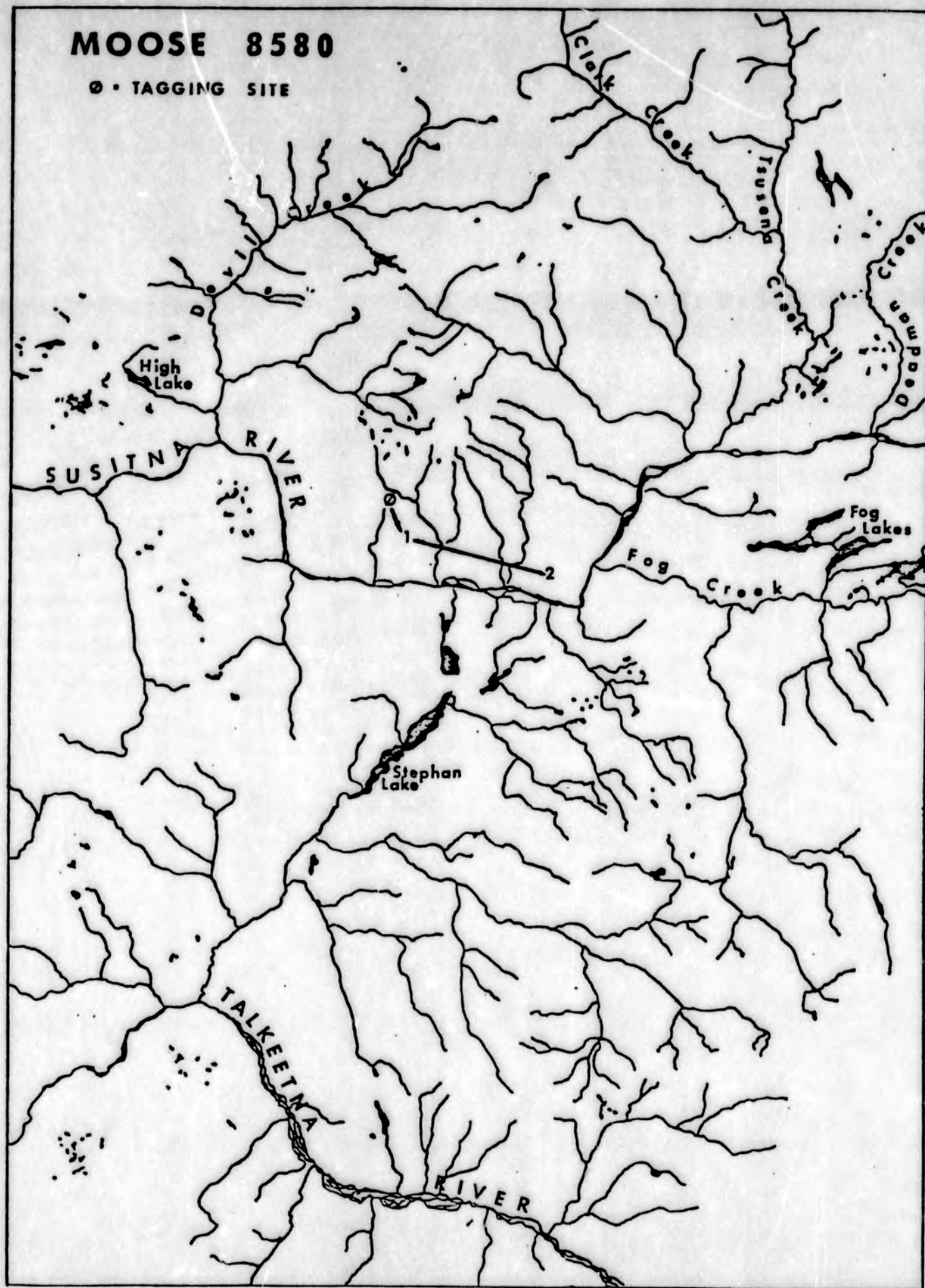
<u>Number</u>	<u>Collar Color</u>	<u>Collar Number</u>	<u>Date</u>	<u>Remarks</u>
8586	Orange	11	18 March 1977	Pregnant, with one calf and 3 cows 1/4 mile

Observations

1		31 March 1977	With 1 calf and 1 moose 1/4 mile away
2		22 April 1977	With 1 calf, 2 cows and 1 small bull within 100 yds medium spruce-riparian
3		3 June 1977	With one new calf, spruce
4		8 June 1977	With 1 calf, spruce
5		16 June 1977	Alone, open spruce
6		28 June 1977	Alone, open spruce
7		5 July 1977	Alone, spruce
8 (11:30 AM)		5 August 1977	With 3 cows
9		5 October 1977	Alone
10		30 November 1977	Could not pick up signal

MOOSE 8580

⊙ • TAGGING SITE



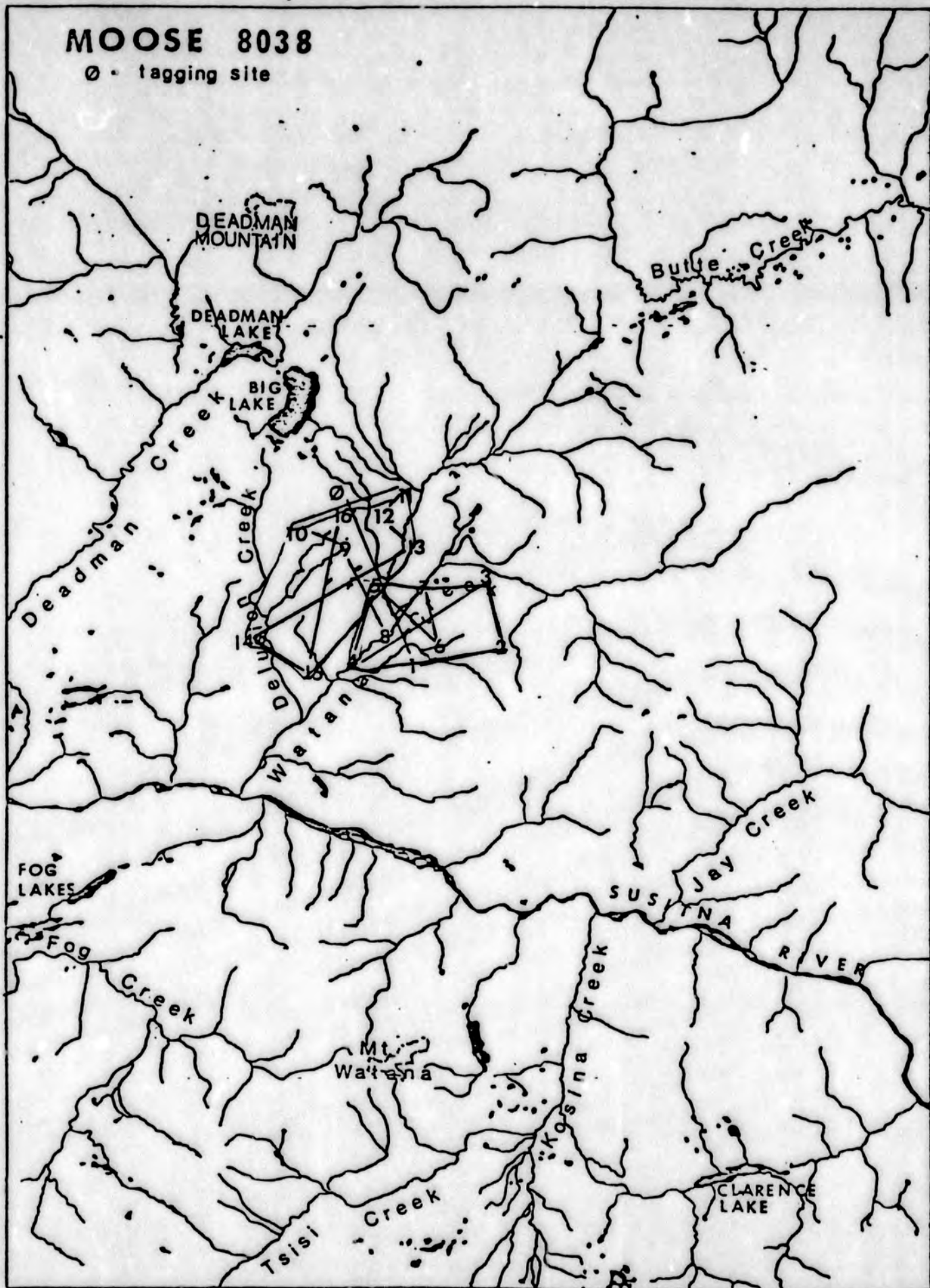
<u>Number</u>	<u>Collar Color</u>	<u>Collar Number</u>	<u>Date</u>	<u>Remarks</u>
8580	none	none	18 March 1977	Down only 5-10 minutes, collar too small, no pregnancy test, with cow and calf 1/4 mile and 2 others

Observations

1 (3:00 PM)	31 March 1977	With 1 adult, spruce (SE-KB)
2	22 April 1977	Alone, no ear tags, tall riparian spruce (WB-KB)

MOOSE 8038

○ - tagging site



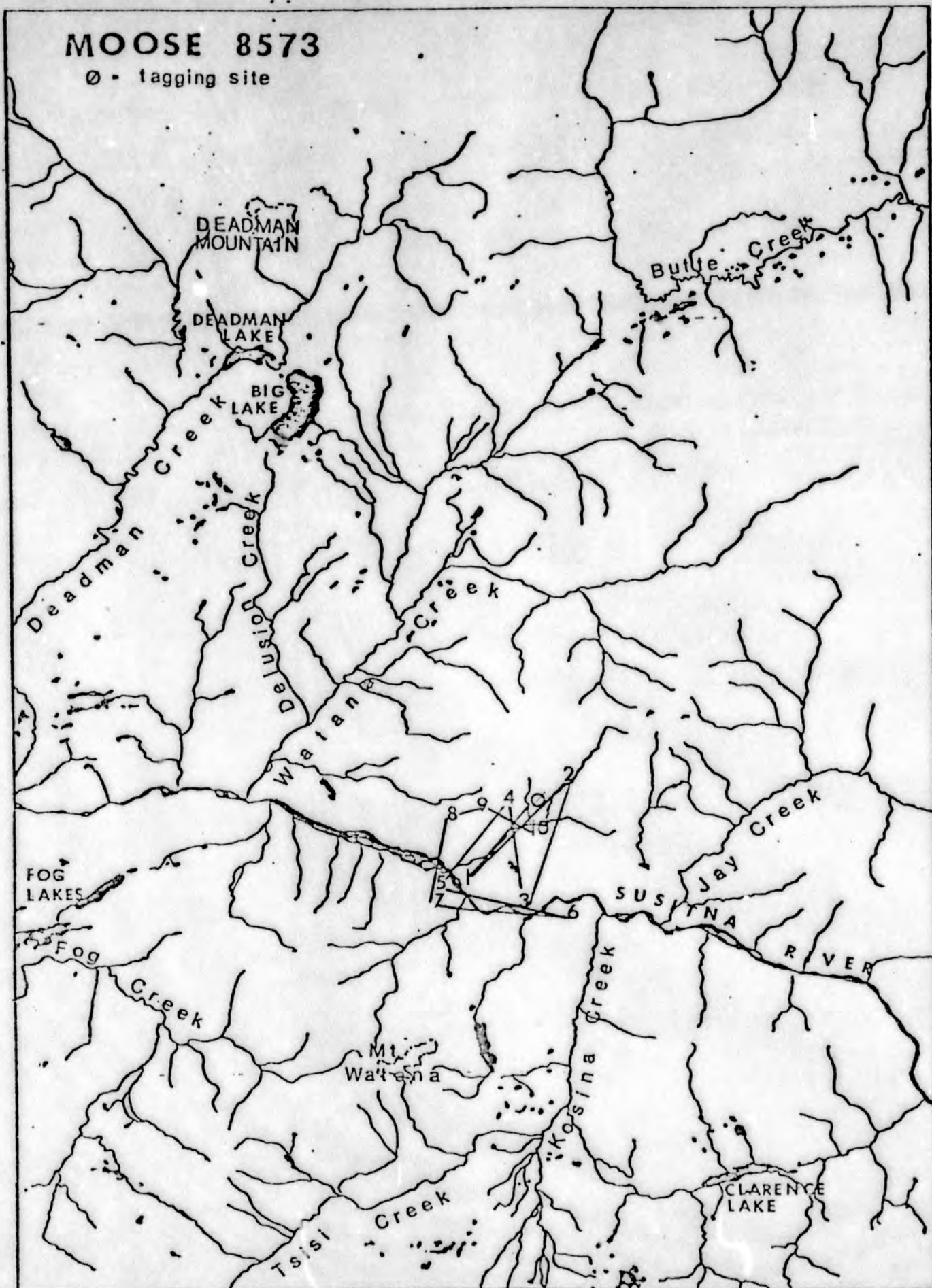
<u>Number</u>	<u>Collar Color</u>	<u>Collar Number</u>	<u>Date</u>	<u>Remarks</u>
8038	Red	NA	27 October 1976	With DA#3, 1 cow and one small bull

Observations

1 (11:40 AM)	22 November 1976	Unable to visually observe due to dense vegetation and poor snow.
2 (1:30 PM)	3 December 1976	Alone
3 (11:00 AM)	24 December 1976	With 2 cows
4 (9:35 AM)	19 January 1977	With 3 cows and 1 small bull
5	4 February 1977	Not visually observed due to high winds
6 (10:30 AM)	3 March 1977	With 1 cow
7 (6:05 PM)	6 April 1977	With 2 moose, sparse tall spruce
8 (9:15 AM)	22 April 1977	With 6 moose (1 bull), sparse tall spruce and cottonwood, condition 6
9	26 May 1977	With new calf, medium medium spruce
Ø	31 May 1977	Alone, medium medium spruce
10	3 June 1977	Alone, sparse medium spruce
11	8 June 1977	Alone, sparse medium spruce
12	16 June 1977	Alone, sparse medium spruce
13	28 June 1977	Alone, sparse medium spruce
14	5 July 1977	Alone, medium medium spruce
15	5 or 6 August 1977	With 1 bull, medium medium spruce
16	5 October 1977	With 2 cows and 1 bull, sparse medium spruce
17	30 November 1977	With 2 cows, small spruce

MOOSE 8573

Ø - tagging site



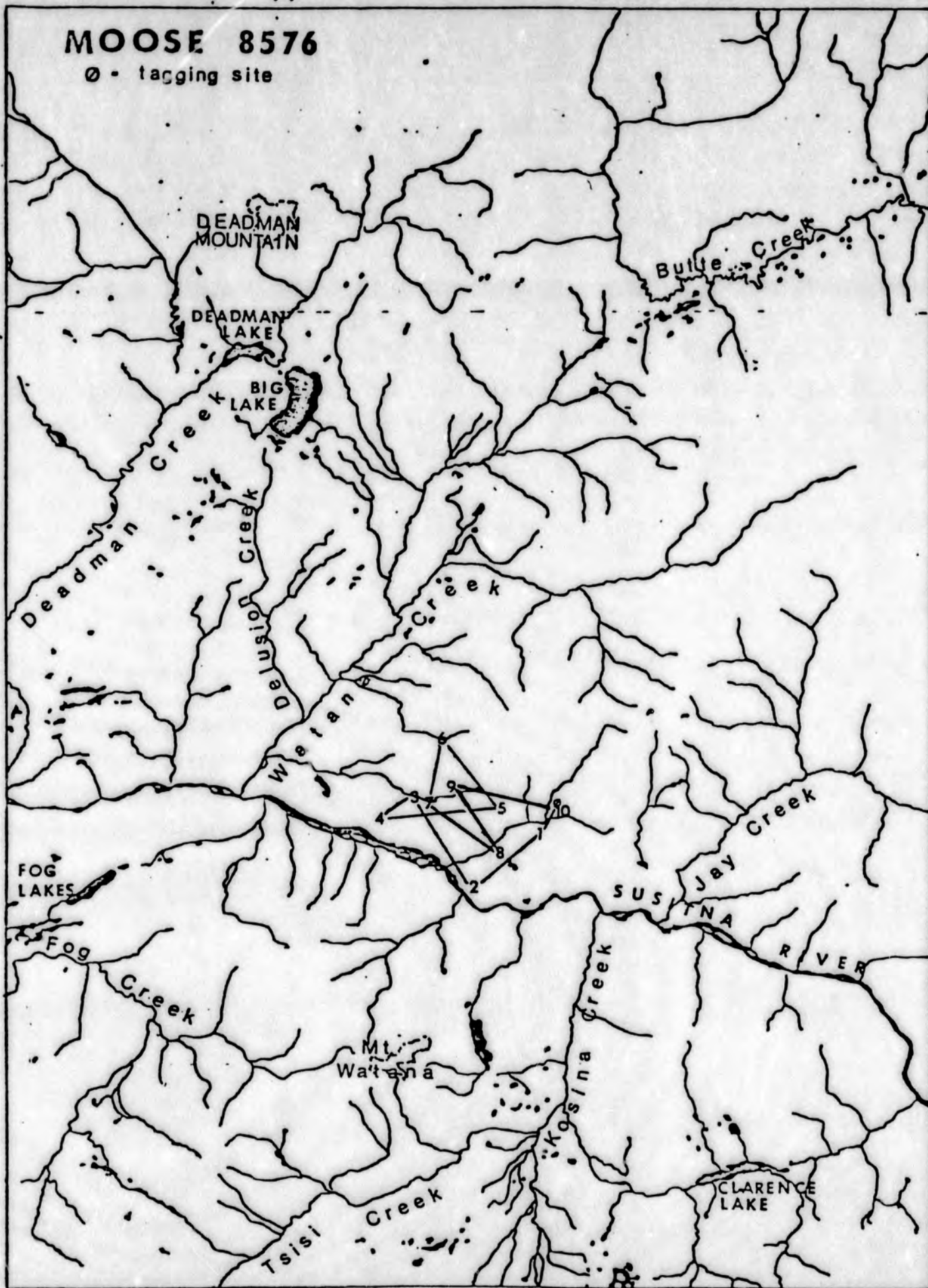
<u>Number</u>	<u>Collar Color</u>	<u>Collar Number</u>	<u>Date</u>	<u>Remarks</u>
8573	Orange	5	19 March 1977	Pregnant

Observations

1	6 April 1977	
2 (10:15 AM)	22 April 1977	With 1 cow, sparse short spruce, condition 7
3	26 May 1977	With 1 cow, dense tall spruce
4	31 May 1977	Not visually observed
Ø	1 June 1977	Not visually observed, dense tall spruce
5	3 June 1977	Alone, medium medium spruce
6	8 June 1977	Alone, medium medium spruce
Ø	16 June 1977	Alone, medium medium spruce
7	28 June 1977	Not visually observed, alder
8	5 July 1977	Alone, medium medium spruce
9	5 August 1977	With 2 cows and white #75
10	5 October 1977	Alone, medium medium spruce
11	30 November 1977	With 1 cow, willow

MOOSE 8576

Ø - tagging site



<u>Number</u>	<u>Color</u>	<u>Collar Number</u>	<u>Collar Date</u>	<u>Remarks</u>
8576	Orange	6	19 March 1977	With 1 bull, pregnancy status unknown

Observations

1 (3:50 PM)	6 April 1977	Alone, in spruce (SE-KB)
2	22 April 1977	With 2 cows, medium tall spruce, near radio 8588
3	26 May 1977	Alone, medium short spruce
4	3 June 1977	Alone, sparse medium spruce
5	8 June 1977	Alone, medium medium spruce
6	16 June 1977	Alone, medium medium spruce
7	28 June 1977	Alone, medium medium spruce
8	5 July 1977	Alone, medium medium spruce with some alder
9 (11:00 AM)	5 August 1977	Within 1/2 mile Blue #10, sparse medium spruce
10	5 October 1977	With 1 large bull and 3 cows, medium medium spruce, not visually observed.
11	30 November 1977	Alone, open medium spruce