PRELIMINARY ENVIRONMENTAL ASSESSMENT OF HYDROELECTRIC DEVELOPMENT ON THE SUSITNA RIVER

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Fisheries and Habitat Investigations of the Susitna River--A Preliminary Study of Potential Impacts of the Devils Canyon and Watana Hydroelectric Projects

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SUMMARY

Biological and water quality and quantity investigations were conducted from May 1, 1977 through March 7, 1978 to obtain baseline data on indigenous fish populations and the existing aquatic habitat of the Susitna River drainage. These investigations conclude a four year series of environmental baseline inventories. They were designed to generate sufficient biological information to enable the Alaska Department of Fish and Game (ADF&G) to prepare a comprehensive biological study plan in the event a final environmental impact study is initiated to determine the feasibility of constructing the proposed Watana and Devils Canyon hydroelectric dams on the Susitna River.

The relative abundance, distribution and migrational timing of adult salmon (Oncorhynchus sp.) were determined within the Susitna River drainage through tag and recovery programs during 1977. The salmon escapement from June 29 through August 14 was estimated to be approximately 237,000 sockeye (O. nerka), 50,000 coho (O. kisutch), and 105,000 chum salmon (O. keta) (Friese, in prep.). An escapement estimate in excess of 100,000 fish was determined for chinook salmon (O. tshawytscha) through aerial surveys (Kubik, 1977; Watsjold, 1977). Population estimates of pink salmon utilizing the drainage in the area of the Susitna and Chulitna river confluence were determined as a part of this study.

Documentation of the outmigration of salmon fry from tributary rearing areas into the mainstem Susitna River was accomplished by intensive investigation of two clearwater tributaries. The objective of these studies was to determine utilization of the mainstem river for rearing during winter months. A total of 25,176 chinook salmon fry were marked

in Montana Creek between July 19 and August 4. A gradual downstream movement of fry was noted from the latter part of August to February. A drastic reduction in population density was found in February and was attributed to low flows which prevailed at the time. Chinook fry were documented overwintering in the Susitna River. No distinct movement of fry was observed in Rabideux Creek.

The relative abundance, distribution, age, length, and weight characteristics, and feeding habits of juvenile salmonids were monitored in sloughs and tributaries of the Susitna River from Portage Creek downstream to the Chulitna River confluence from July 1 through October 5, 1977. The predominant rearing species were chinook and coho salmon. Water quality and quantity determinations were made in conjunction with all juvenile salmon surveys.

The Susitna River was floated from its intersection with the Denali Highway to Devils Canyon during the first two weeks of July to inventory fish species present and survey the aquatic habitat in the areas to be inundated. Arctic grayling (*Thymallus arcticus*) were abundant in all of the clearwater tributaries within the proposed impoundment area. The headwaters of these tributaries and upland lakes were also surveyed by separate crews. It is apparent that the Watana reservoir, which is projected to have substantial seasonal fluctuations, will alter the fisheries habitat.

Measurements of hydrological and limnological parameters associated with the Susitna River and selected tributaries and sloughs were obtained between the Denali Highway and Montana Creek. A cooperative agreement between the United States Geological Survey (USGS) and the ADF&G was initiated to determine discharge, sediment loads, and standard water quality analysis of the mainstem Susitna River. This data, along with the water quality and quantity data collected in conjunction with the fisheries studies, will be extremely valuable for future comparisons.

Long term ecological changes to the drainage may be significant due to dam construction. The level and flow patterns of the Susitna River will be altered and will affect the fisheries resources. Extensive research is necessary both upstream and downstream of the proposed dams to adequately assess the potential effects of these impacts on fisheries resources.

The effects of impoundments and construction activities which alter natural flow regimes, water chemistry, mass transport of materials, and quantity of wetted habitat areas are of primary concern. These changes may disrupt the trophic structure and habitat composition and reduce or eliminate terrestrial and aquatic populations. These populations and vegetation in and around the free-flowing rivers have evolved to their current levels due to natural flow variations. Some species may be present only because this particular hydrologic regime exists.

BACKGROUND

Background knowledge of the Susitna River basin is limited. The proposed hydroelectric development necessitates gaining a thorough knowledge of its natural characteristics and populations prior to final dam design approval and construction authorization to enable protection of the aquatic and terrestrial populations from unnecessary losses.

The Susitna River basin has long been recognized as an area of high recreational and aesthetic appeal. It is also important habitat to a wide variety of fish species, both resident and anadromous. Five species of Pacific salmon (chinook, coho, chum, pink, and sockeye) utilize the

Susitna River drainage for spawning and rearing. The majority of the chinook, coho, chum, and pink salmon production in the Cook Inlet area occurs within this drainage. Grayling, rainbow trout (Salmo gairdneri), Dolly Varden (Salvelinus malma), burbot (Lota lota), lake trout (Salvelinus namaycush), whitefish (Coregonus sp.), and sculpins (Cottus sp.) are some of the more common and important resident fish species.

Baseline environmental fisheries studies have been conducted by ADF&G intermittently since 1974. The projects were financed with federal funding averaging $29,000 per year for the first three years. An allocation of $100,000 was received for this study. The National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) contracted ADF&G to conduct a one-year assessment of salmon populations utilizing the Susitna River in the vicinity of the proposed Devils Canyon dam site during 1974. The objectives of these studies were to determine the adult salmon distribution, relative abundance and migrational timing and to determine juvenile rearing areas (Barrett, 1974). Additional funding was received in 1975, 1976, and 1977 from USFWS to continue and expand these studies and to monitor the physical and chemical parameters associated with the mainstem Susitna (USFWS, 1976 and Riis, 1977). Additional baseline studies will not be initiated during 1978 due to lack of funding.

The proposed hydroelectric project is discussed in Barrett (1974), Friese (1975), USFWS (1976), and Riis (1977). The purpose of this data report is to present the findings of the studies conducted from May 1977 through March 1978 and to make recommendations for future investigations and a final environmental impact statement.

DESCRIPTION OF AREA

The Susitna River is approximately 275 miles long from its source in the Alaska Mountain Range to its point of discharge into Cook Inlet

(Figure 1). The major tributaries of the Susitna originate in glaciers and carry a heavy load of glacial silt during ice free months. There are also many smaller tributaries which are perennially silt free. The study area included the majority of the Susitna River between the Denali Highway and Cook Inlet. The entire drainage from Devils Canyon downstream was monitored for chinook salmon escapement. Studies of other anadromous species were more restricted to the mainstem Susitna and adjacent areas between Devils Canyon and Susitna Station.

Two clearwater tributaries, Rabideux and Montana creeks, were selected for intensive juvenile salmon studies. These streams are located downstream of the proposed dam site near the Parks Highway Bridge. A total of 26 clearwater sloughs and eight tributaries were surveyed between the Chulitna River confluence and Devils Canyon area. These areas are described in USFWS (1976). Surveys of the Talkeetna River were conducted, but results are not included within this report. Resident fish were inventoried in the impoundment area upstream of Devils Canyon.

Water quality and quantity sampling stations were monitored in the Susitna River and tributaries. Twenty-six of these sites were clearwater sloughs adjunct to the Susitna River. Three sites were in the mainstem Susitna River and the ten remaining locations were clearwater creeks and rivers flowing into the Susitna River. Site selection was based on proximity to the Devils Canyon dam area and previous Susitna River studies documenting fish usage (Barrett, 1974; USFWS, 1976).

PROCEDURES

A field camp was established at Gold Creek for studies downstream of Devils Canyon due to its central location to the sample sites and the

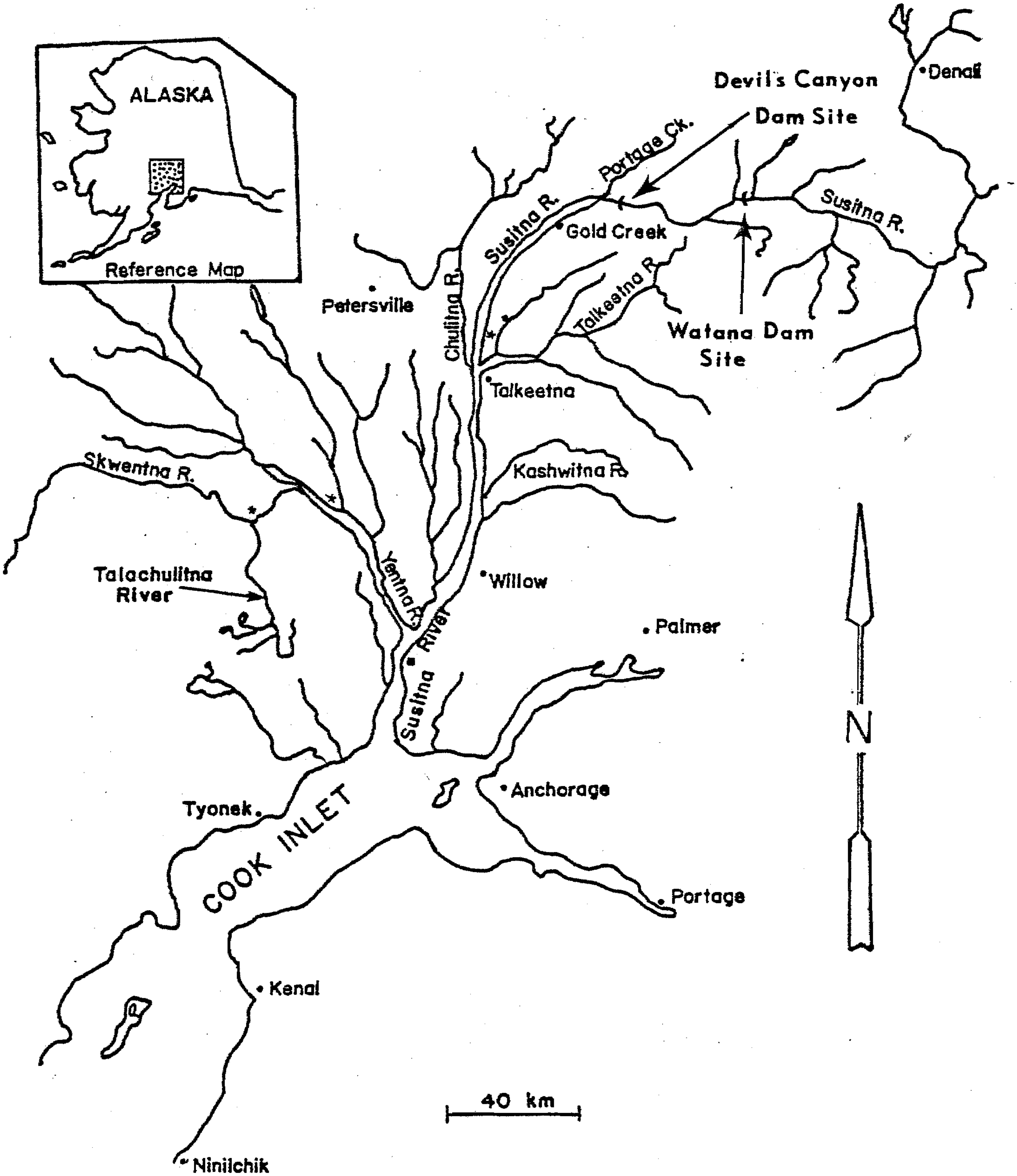

Figure 1. The Susitna River drainage, Devils Canyon Project, 1977.

logistical advantages offered by the Alaska Railroad. Travel on the Susitna River to the sites was accomplished by riverboats equipped with jet outboard motors. Access to sloughs and tributaries downstream from Gold Creek was accomplished with a Zodiac raft. A field camp was also established along the Susitna River five miles upstream from Talkeetna to install and operate fishwheels. Fishwheels were deployed commencing July 5 and were operated through August 27. Methods of operation are discussed by Friese (1975). A field station was located in the vicinity of Talkeetna to conduct Rabideux and Montana creek studies. Avon rubber rafts supported with helicopter and fixed wing aircraft were used for the impoundment area studies.

FISHERIES

Adults

Adult salmon escapement was generally determined by tag and recovery population estimates utilizing fishwheels and ground escapement surveys. Methods are discussed in Friese (1975). The Peterson population estimate used to determine salmon abundance is presented in Table 1. Chinook salmon counts were conducted with a Bell-47 helicopter and fixed wing aircraft. Variable mesh gillnets were used to determine species composition in the impoundment area lakes. Electroshockers and angling were also employed to collect adult fish for this study. Sloughs and tributaries in the upper study area were surveyed on the ground according to methods described in Friese (1975).

Juvenile salmon migration

Intensive fry trapping was undertaken in Rabideux Creek on June 16. The creek was sectioned into three study areas: upper, middle, and lower. Coho salmon yearlings were anesthetized with MS-222 and fin clipped from June 16 through August 31. The following fin clip codes were used: upper caudal lobe for upper sub-area, one-half dorsal for mid sub-area, and lower caudal lobe for lower sub-area. After marking, the salmon were allowed to recover and were released at the location of capture. Recovery of these marked coho salmon was continued until mid-November when extreme cold weather and icing conditions prevented further intensive work.

Montana Creek was also sectioned into three study sub-areas: upper, middle, and lower. The upper area was approximately eight stream miles above its mouth, the middle about three stream miles, and the lower was from the Parks Highway downstream to its junction with the Susitna River. The upper and middle sections were seined from July 19 through August 4. All chinook salmon fry captured were marked with an upper caudal fin clip for the upper area and a lower caudal fin clip for the middle area. Minnow traps baited with salmon roe were utilized from the latter part of August until the end of February to monitor fry movements and population densities throughout the system.

Juvenile studies

Twenty-eight clearwater sloughs and nine tributary streams have previously been identified as observed or potential rearing sites for juvenile salmon in the upper Susitna River between Talkeetna and Devils Canyon (Figure 2) (Barrett, 1974; Friese, 1975). Juvenile salmon were collected from these locations during two different sampling periods during this study. Each slough and tributary were also surveyed biweekly for relative abundance of rearing fish and water quality data. Methods are discussed in Friese (1975). Fry samples for analysis of physical characteristics and feeding habits were collected with dip net, minnow traps, or seine and preserved in a 10 percent formalin solution (Brown, 1971).

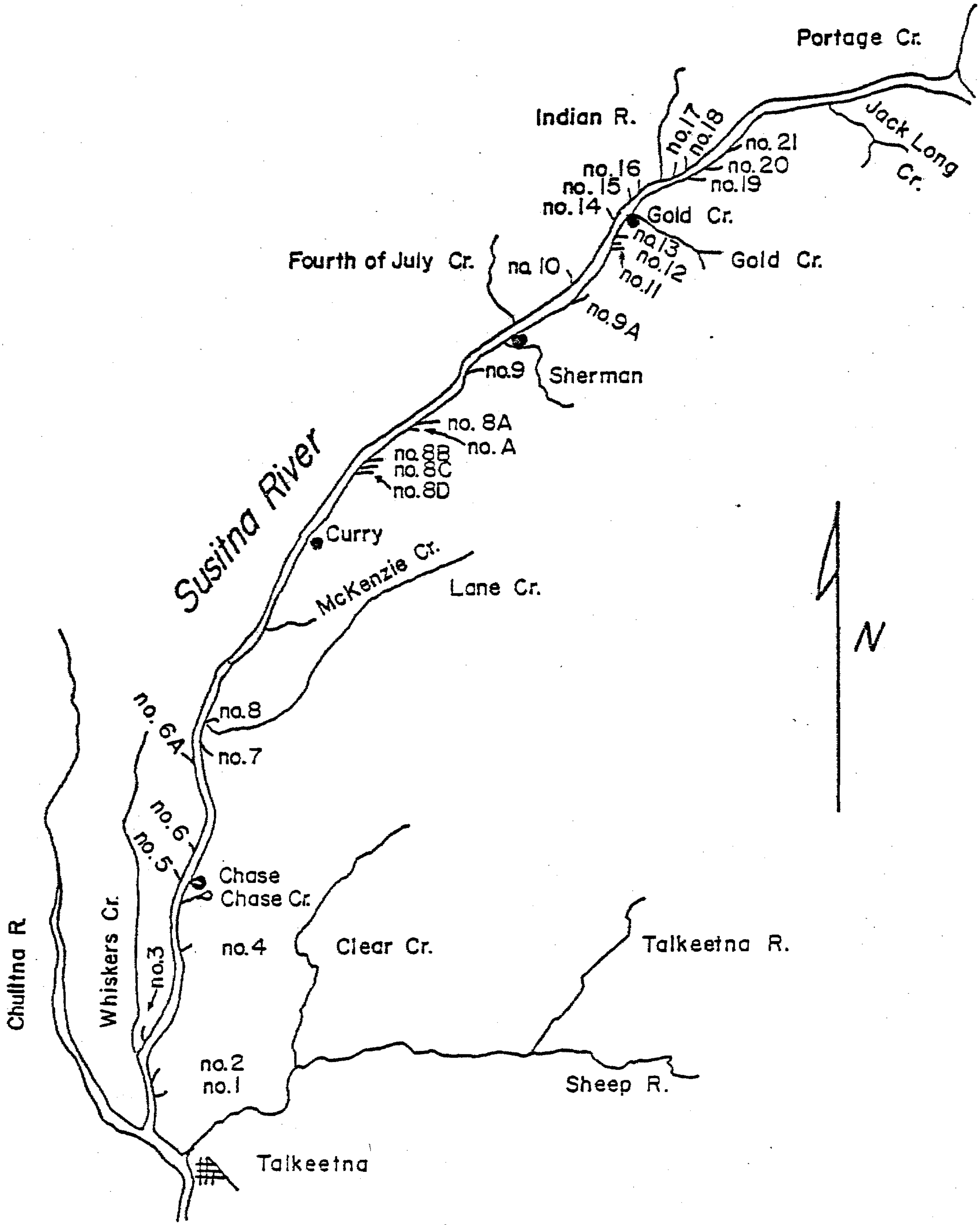

Figure 2. Upper Susitna River study area, Devils Canyon Project, 1977.

Summer samples were netted by minnow seine between July 11 and August 5. Juvenile salmon were collected by a combination of minnow seine and minnow traps from September 20 to 24. Fork lengths and scale smears were taken in the field for each individual fish. Specimens, together with incidental catches of other resident fish species, were preserved in 10 percent formalin. Species identification, verified by pyloric caecae counts, and weight determinations were made in the Anchorage laboratory. The gut was dissected from each fish and contents from both hind- and foregut removed. All gut contents from one sampling location were pooled by species for each sampling day to facilitate investigation. Individual stomachs were not examined separately. Insects were identified to order and larval and pupal forms of Diptera to family. Other organisms present were identified to the most convenient taxon, usually order. The major keys used were Pennack (1953), Usinger (1968), Ward and Whipple (1959), and Jacques (1947). Volume percentages were estimated according to four gross categories: Crustacea, immature Insecta, adult Insecta, and other organisms. These estimates reflect the interpretations of the investigator, but it is felt that they gave a close approximation of actual volumes.

WATER QUANTITY

Discharge data were collected by ADF&G personnel at many of the slough and tributary sites. Flows were measured with Price AA Gurley current meters. Leupold stage gauges were installed in the sloughs and permanent bench marks were established on the river banks adjacent to the gauges for future location reference (Riis, 1977).

Mainstem Susitna River flow was continually monitored by USGS at their Gold Creek site and three times during the summer at Portage Creek and at the Parks Highway Bridge.

Water flows in Rabideux Creek were measured by recording the height of the water passing through culverts at the Parks Highway, approximately one-half mile above its confluence with the Susitna River. Recordings were converted into cubic feet per second. The River Forecast Center of the National Weather Service monitored water stage and computed flow in Montana and Willow Creeks.

WATER QUALITY

Dissolved oxygen, temperature, pH, and specific conductance were measured biweekly and on a random basis in clearwater sloughs and tributaries with a Yellow Springs Instrument Model 57 oxygen and temperature meter, Cole Parmer Digi sense pH meter, and Labline Lectro mho meter, respectively. Alkalinity and hardness were determined with a Hach chemical kit (model DR-EL/2 and model AL36B) using methods outlined by the manufacturers.

Temperature data was continually recorded with Ryan thermographs, Model D-30, at one site on the Susitna River and at three sites in both Rabideux and Montana creeks. Analysis of water samples from the mainstem Susitna were analyzed by the USGS laboratory.

Benthic invertebrates were collected with artificial substrates (McCoy, 1974) and Surber samplers for future analysis.

FINDINGS AND DISCUSSION

FISHERIES

Adults

Adult salmon abundance above the Chulitna River confluence was determined by tag and subsequent recovery programs during 1974, 1975, and 1977 (Table 1). The relative magnitude of pink salmon moving past

Table 1 . Relative magnitude of pink, chum, and sockeye salmon moving past the fishwheel sites as determined by Peterson population estimates, Devils Canyon Project, 1974, 1975, and 1977.[1/]

	Species		
	Pink	Chum	Sockeye
1974			
M	160	568	39
R	23	74	13
C	755	3,164	336
N	5,040	23,970	939
Confidence Interval	3,836-8,359	20,081-30,746	709-1,764
1975			
M	943	674	370
R	46	8	22
C	291	139	103
N	6,129	10,549	1,760
Confidence Interval	4,977-11,895	7,122-35,293	1,355-2,865
1977[2/]			
M	429	46	31
R	64	3	1
C	6,644	2,332	661
N	43,857	---	---
Confidence Interval	36,375-57,439	---	---

1/ Calculated by the following formulas:

$$N = \frac{M\ (C+1)}{R+1}$$

95% confidence interval around N $R/C = R/C \pm t \sqrt{\frac{\frac{R}{C}\left(1-\frac{R}{C}\right)}{C}\ \frac{(N-C)}{N}}$

where:

N = Population size during time of marking
M = Number of fish marked
C = Total of fish observed for presence of mark during sample census.
R = Total number of marked (recaptured) fish found during sample census.

2/ Population estimates were not determined for chum and sockeye salmon since number of tag recoveries were too low to place confidence limits on estimates.

the fishwheel sites above Talkeetna during 1977 was approximately 44,000 fish. Tag recoveries of other salmon species were too low to determine abundance. Abundance of all salmon species within sloughs and tributaries, with the exception of chinook salmon, was determined by ground escapement surveys. Peak survey counts by species from Portage Creek downstream to the Chulitna River confluence was 1,330 chum, 3,429 pink, and 301 sockeye salmon (Table 2). These estimates are considered minimum escapements, since counts were only conducted within index areas (USFWS, 1976). Migrational timing of coho salmon was too late to determine peak abundance.

The chinook salmon escapement within the drainage was about 100,000 fish (Table 3). The 1977 escapement appears to have a high reproduction potential (Kubik, 1977 and Watsjold, 1977). Historic escapement and harvest data indicate a minimum escapement level of at least 60,000 chinook salmon would be required yearly to restore stocks to historic levels.

Numerous tag recoveries downstream of the tagging project were obtained from the sport fish harvest during 1977 (Figure 3). This "drop-out" phenomenon was also observed during 1974 and 1975. The total magnitude of tagged fish moving downstream was not determined since reporting of tag recoveries was on a voluntary basis. This should, however, be thoroughly evaluated during future studies. If the Chulitna, Susitna, and Talkeetna river confluence area serves as a milling area for fish destined to spawning areas downstream, the project impact area would be greatly expanded and numbers of fish affected increased significantly.

Age, length, and sex composition characteristics were determined from fishwheel catch samples for all species except pink salmon. Results are presented in Appendix I, Tables 1 and 2. Data is comparable with

Table 2. Peak chum, pink and sockeye salmon ground escapement survey counts within the upper Susitna River, Devils Canyon Project, 1977.

		CHUM SALMON		
		Density		
Area	Date	Live	Dead	Total
Slough 8A	9/22/77	34	17	51
Slough 9	8/19/77	34	2	36
Slough 10	9/9/77	0	2	2
Slough 11	9/22/77	79	37	116
Slough 16	8/28/77	0	4	4
Slough 20	8/16/77	27	1	28
Slough 21	9/20/77	187	117	304
Lane Creek	8/19/77	0	2	2
Fourth of July Creek	8/11/77	11	0	11
Indian River	8/18/77	514	262	776
TOTAL		886	444	1,330

		PINK SALMON		
		Density		
Area	Date	Live	Dead	Total
Slough 16	8/28/77	0	13	13
Lane Creek	8/11/77	1,190	3	1,193
Fourth of July Creek	8/11/77	611	1	612
Indian River	8/18/77	1,031	580	1,611
TOTAL		2,832	597	3,429

		SOCKEYE SALMON		
		Density		
Area	Date	Live	Dead	Total
Slough 8A	9/9/77	64	6	70
Slough 8B	9/9/77	2	0	2
Slough 9	9/9/77	6	0	6
Slough 11	9/8/77	181	33	214
Slough 19	9/7/77	7	1	8
Indian River	8/18/77	1	0	1
TOTAL		261	40	301

Table 3. Peak chinook salmon counts within the Susitna River drainage, 1977.

Streams (West Side)	Count	Streams (East Side)	Count
Deshka River	39,642	Willow Creek	1,065
Alexander Creek	13,385	Montana Creek	1,443
Talachulitna River	1,856	Moose Creek	153
Lake Creek	7,391	Prairie Creek	5,790
Martin Creek	1,060	Chunilna Creek	769
Cache Creek	100	Kashwitna River (North Fork)	336
Bear Creek	298	Little Willow Creek	598
Red Creek	1,511	Sheep Creek	630
Peters Creek	3,042	Indian River	393
Donkey Creek	159	Portage Creek	374
Fish Creek (Quits)	131	Chulitna River (East Fork)	168
Fish Creek (Kroto S.)	132	Chulitna River (Middle Fork)	1,782
Unnamed-Kichatna River	120	Chulitna River (Mainstem)	229
Clearwater Creek	47	Goose Creek	133
Quartz Creek	8	Honolulu Creek	36
Canyon Creek	135	Byers Creek	69
Dickason Creek	4	Troublesome Creek	95
Unnamed-Hayes River	2	Bunco Creek	136
Rabideux Creek	99		
		Total Count	14,199
Total Count	69,122	Estimated Total Count	17,028
Estimated Total Count	93,411		

Total Count	83,321
Estimated Total Count	109,439

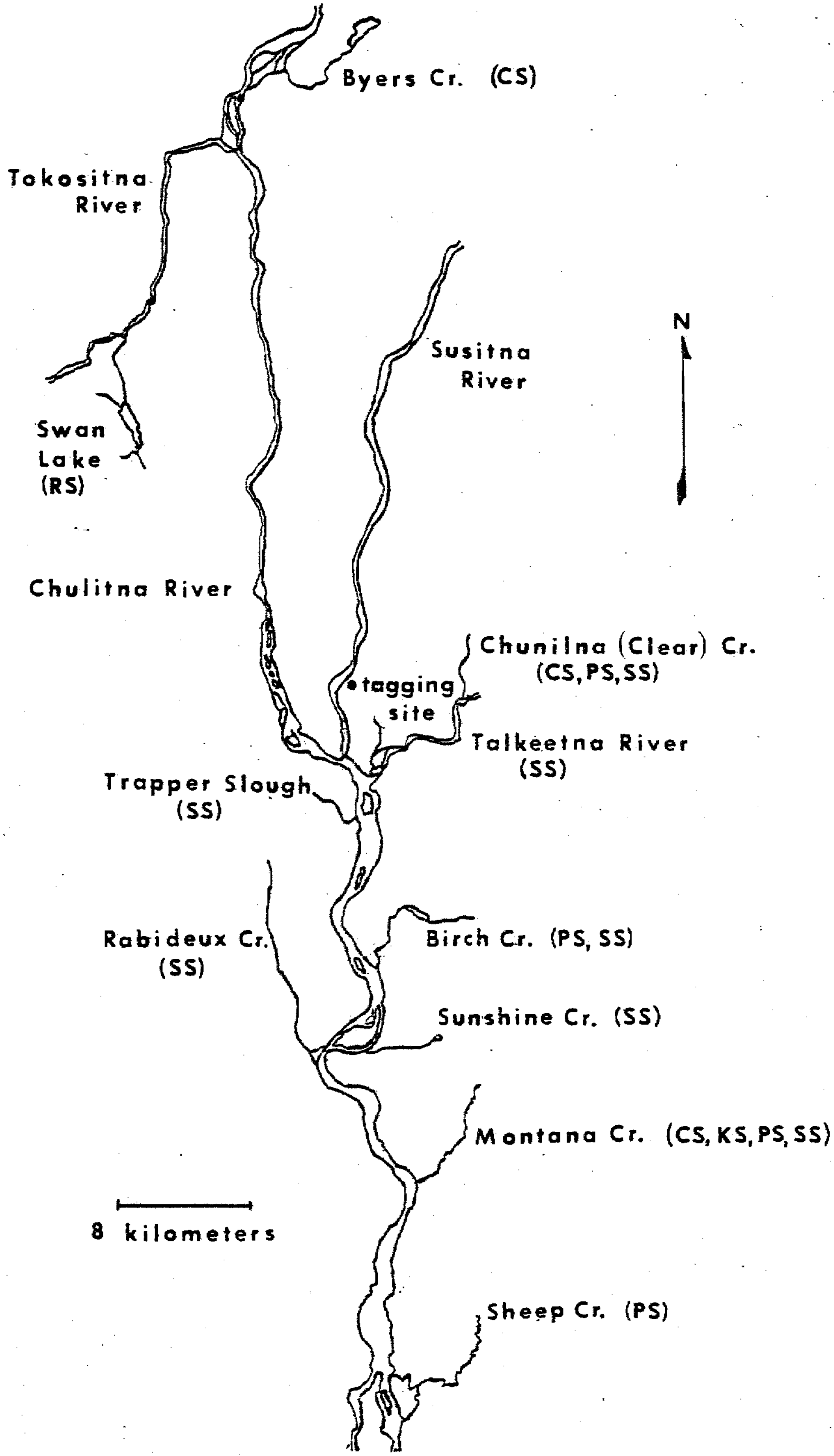

Figure 3. Locations of adult salmon tag recoveries occurring downstream of the Susitna River fishwheel sites, Devils Canyon Project, 1977 (RS-sockeye salmon; PS-pink salmon; CS-chum salmon; SS-coho salmon; KS-chinook salmon).

escapement samples obtained from other areas within the drainage (Friese, in prep.). Carcass data collected in the Deshka River and Alexander Creek revealed a high percentage of five- and six-year-old chinook salmon females (Kubik, 1977).

Juvenile salmon migration

Intensive studies of juvenile chinook and coho salmon were conducted in Rabideux and Montana creeks to define the life histories of these species as related to the variable conditions of the drainage. The authors believe that the overwintering period during the first year of life is probably the most critical time for survival of these two species.

Rabideux and Montana creeks were selected for this study due to: accessibility, their opposite physical characteristics, and the difference in the ratio of rearing species. Willow Creek and Indian River were also sampled periodically for comparative purposes.

Rabideux Creek was selected to obtain representative data on coho salmon fry densities and yearling movements. A total of 1,041 yearling cohos were marked. Of these, 274 were marked in the upper sub-area, 753 in the middle sub-area, and 14 in the lower sub-area. Catches of rearing coho and chinook salmon captures and recaptures are presented in Table 4. A total of 159 marked fish were recaptured in the original area of marking and 32 in dispersed areas. An increase in catch per hour of coho salmon fry occurred following August 1 because increased growth made them more susceptible to capture in the 1/4" mesh minnow traps. Fourteen marked yearlings moved downstream, five upstream, and thirteen migrated to small lateral tributaries. No distinct pattern was exhibited, which could be attributed to the fact that environmental conditions are more stable throughout the year in this tributary during this particular year.

Table 4. Rabideaux Creek salmon fry trapping, Devils Canyon Project, 1977.

Date	Coho Smolt	Coho Yearling	Marked Coho Yearling	Coho Fry	Chinook Fry	No. Traps	Trap Hours	Coho Yearling Per Hour	Coho Fry Per Hour	Chinook Fry Per Hour
				UPPER SECTION						
6/16-6/30	33	218	5u.1/	60	728	67	1608	.14	.04	.45
7/10-7/15	0	56	12u.	136	650	70	1680	.04	.08	.39
9/16-9/30	0	36	1u.	27	48	14	336	.11	.08	.14
11/1-11/15	0	274	7m.2u.	117	0	35	805	.35	.15	0
				MIDDLE SECTION						
6/16-6/30	80	361	12m.	109	1120	200	4800	.08	.02	.23
7/1-7/15	0	229	26m.	243	1284	135	3240	.08	.08	.40
8/1-8/15	0	38	17m.1u1/ 1.	602	249	104	2496	.02	.24	.04
8/16-8/31	0	125 2/	64m.2u.	3764	1479	207	4968	.04	.76	.30
10/1-10/15	0	116	7m.	960	1253	59	1416	.09	.68	.88
10/16-10/31	0	58	6m.	510	133	5	105	.61	4.86	1.27
11/1-11/15	0	57	4m.	1952	399	23	522	.12	3.74	.76
				LOWER SECTION						
6/16-6/30	0	2	0	2	45	29	696	tr.	tr.	.06
7/1-7/15	0	2	0	2	15	29	696	tr.	tr.	.02
8/1-8/15	0	6	1 1.	95	50	50	1200	tr.	.08	.04
9/1-9/15	0	31	1 1.	180	797	20	480	.07	.38	1.66
9/16-9/30	0	44	2u.1 1.	221	468	47	1128	.04	.20	.41
10/1-10/15	0	125	1u.	668	3832	207	4944	.03	.14	.78
10/16-10/31	0	98	3m.	198	821	44	964	.10	.21	.85
11/1-11/15	0	142	4m.	621	1449	93	2078	.07	.30	.70
				LATERAL TRIBUTARIES						
10/1-10/15	0	270	2u.4m.	393	76	31	744	.37	.53	.10
10/16-10/31	0	231	4m.	794	117	55	1212	.19	.66	.10
11/1-11/15	0	181	4m.	588	72	22	506	.37	1.16	.14

1/ u - Upper Section marked coho; m.-Middle Section marked coho; 1.-Lower Section marked coho.
2/ 8/31 marking of coho yearlings was terminated.

Other species inhabiting the system were chinook salmon, round whitefish (Prosopium cylindraceum), longnose sucker (Catostomus catostomus), arctic grayling, pink salmon, Dolly Varden, rainbow trout, threespine stickleback (Gasterosteus aculeatus), burbot, slimy sculpin (Cottus cognatus), and the western brook lamprey (Lampetra planeri).

Montana Creek was selected to obtain data on juvenile chinook salmon abundance and migration. A total of 25,176 fry were marked from July 19 through August 14. The distribution of marking was 16,039 in the upper area and 9,137 in the middle area. Species composition of other fish was similar to Rabideux Creek. Table 5 illustrates the findings of trapping in biweekly periods until the first of December. After this time, trapping was conducted one to three days per month.

The chinook salmon catch per hour indicated a gradual population density decline until February when a drastic reduction was recorded (Table 5). The gradual reduction is attributed to fry slowly moving downstream to the Susitna River throughout the season. This is also evidenced by marked fry being recovered below their area of release while no evidence of upstream recoveries was recorded.

Willow Creek was also sampled with minnow traps periodically between August 23 and March 2. This data clearly shows a decline in population density between December and February (Table 6).

The drastic reduction in population density found in February is attributed to the extremely low water conditions encountered at that time. The reduced flow was believed to have eliminated required rearing habitat and forced the juvenile salmonids into the mainstem Susitna River. Traps were set in the Susitna River and one of its sloughs to test this theory. Chinook salmon fry were recovered from the Susitna

Table 5. Montana Creek salmon fry trapping, Devils Canyon Project, 1977.

Date	Chinook Fry Unmarked	Chinook Fry Upper Mark	Chinook Fry Lower Mark	Coho Fry	Coho Yearling	Number Traps	Total Trap Hours	Chinook Per Trap	Chinook Per Hour
UPPER SECTION									
8/16-8/31	178	56	--	--	--	13	312	18.0	.75
9/1-9/15	336	6	--	1	5	5	115	68.4	2.97
9/16-9/30	461	2	--	11	--	14	294	33.1	1.57
10/1-10/15	4188	7	--	--	14	110	2540	38.1	1.65
10/16-10/31	2987	16	--	6	5	74	1560	40.6	1.93
11/1-11/15	1467	3	--	2	8	37	888	39.7	1.66
11/16-11/30	410	1	--	--	2	17	402	24.2	1.02
12/22	136	--	--	2	--	5	128	27.2	1.06
1/27	185	--	--	4	--	5	126	37.0	1.47
2/23-24	126	--	--	1	--	22	440	5.7	0.29
MIDDLE SECTION									
8/16-8/31	1206	6	13	--	--	15	360	81.7	3.40
9/1-9/15	1445	6	8	19	1	17	328	85.8	4.45
9/16-9/30	--	--	--	--	--	--	--	--	--
10/1-10/15	1982	4	4	--	10	39	936	51.0	2.13
10/16-10/31	3218	5	10	24	13	65	1490	49.7	2.17
11/1-11/15	1601	3	5	22	3	52	1208	30.9	1.33
11/16-11/30	507	3	1	3	3	17	390	30.1	1.31
12/22	187	--	--	--	3	5	120	37.4	1.56
1/27	40	--	--	1	--	7	130	5.7	0.31
2/23-24	32	--	--	--	1	20	406	1.6	0.08
LOWER SECTION									
8/16-8/31	1627	6	9	--	--	24	576	68.4	2.85
9/1-9/15	2077	--	2	56	--	30	142	69.3	14.64
9/16-9/30	891	1	3	7	39	28	423	32.0	2.12
10/1-10/15	5002	4	1	100	162	141	3292	35.5	1.52
10/16-10/31	2221	6	1	75	21	54	1236	41.3	1.80
11/1-11/15	647	1	--	3	--	40	936	16.2	0.69
11/16-11/30	456	--	--	1	3	10	228	45.6	2.00
12/21-23	174	1	--	--	4	12	288	14.6	0.61
1/27	116	--	--	3	--	5	108	23.2	1.07
2/23-24	108	--	--	--	1	18	372	6.0	0.29

Table 6. Willow Creek chinook salmon fry trapping, Devils Canyon Project, 1977.

	Catch/Trap Hour				
	1977			1978	
Index Area	8/23	10/26	12/1	1/18	3/2
#1	2.8	2.6	1.3	1.5	1.29
#2	3.8	3.2	3.3	1.3	0.28
#3	4.2	4.1	4.8	1.3	0.67

River at a rate of 0.45 per hour. In the slough they were recovered at a rate of 0.12 per hour. These catch rates document that chinook salmon juveniles utilize the mainstem river for rearing during the winter period.

Juvenile studies

Juvenile salmonids were present in all sloughs and clearwater tributaries identified within this study, with the exception of Lane Creek. The absence of juveniles in the latter location does not preclude their presence, since survey conditions of this creek were generally poor for juveniles. Pink salmon were the only species observed spawning within this creek and emergent fry would not be expected to be present when surveys were conducted, since this species migrate toward sea after their emergence from the gravel in late May and early June.

The major species utilizing these areas for rearing during summer months were chinook and coho salmon, although sockeye salmon were also collected. Misidentification of salmon fry samples collected in previous studies, particularly between chinook and coho salmon, was noted during 1977. Samples from previous years were reexamined and correct identification was made. Data indicates chinook salmon were the most abundant rearing species collected during 1974 through 1976.

Estimated fry abundance varied throughout the season. Lowest numbers occurred during late September surveys. This data is concurrent with studies conducted in Willow and Montana creeks (see p.25). Attempts were not generally made to establish migration from the upper sloughs and tributaries to the mainstem river. A limited experiment was, however, conducted in Indian River to determine if migrations observed in Montana and Willow creeks also occurred. A total of 579 chinook salmon fry were trapped during a two hour period on August 18. Large numbers of chinook salmon fry were also observed near the confluence area during late August and September. On August 31 the first chinook salmon fry was trapped in the mainstem Susitna River immediately downstream of Indian River. Logistical problems prevented follow-up studies until March 7. Ten traps were fished on this date for 24 hours in areas where high densities of fry had been observed during the summer. Only four chinook salmon were captured. Data is limited, but it does corroborate findings in Montana Creek. Montana Creek and Indian River have comparable gradients, velocities, pool to riffle ratios, and are representative of most of the clearwater tributaries to the Susitna River. It would be reasonable to speculate that life history information of salmon fry from one of these tributaries would be representative of the other.

In addition to the apparent intrasystem migration of juvenile chinook salmon from the lateral tributaries to the Susitna River in the fall, it appears some young-of-the-year chinooks move out of the parent stream in the spring. The majority of the salmon fry observed in sloughs during 1977 were chinook salmon. Adult chinook salmon were not observed spawning in these sloughs during 1976. Observations, therefore, indicate the fry dropped out of spawning areas sometime in the spring into the Susitna River and then moved into the sloughs to rear for the summer.

Definition of the intrasystem migrations for the various life history phases of each species will be important considerations in assessing the potential impacts of this project. It can be assumed that individuals of a species will tend to select areas within a drainage that have the most favorable combinations of hydraulic conditions which support life history requirements. They will also utilize less favorable conditions, with the probability-of-use decreasing with diminishing favorability of one or several hydraulic conditions (Bovee, 1978). Observations demonstrate that individuals elected to leave an area before conditions became lethal. The movement of rearing salmon fry out of the sloughs in the fall has been documented and is an example of areas where conditions could become lethal.

Data indicates that in early summer salmon rearing conditions are poor in the mainstem Susitna River because of high discharge and sediment loads. The clearwater sloughs and tributary areas are utilized by fry at this time. As the season progresses, discharge and sediment loads of the mainstem Susitna begin to decrease. By fall and winter, the silt load appears to be low enough to transform the mainstem Susitna River into suitable fry rearing habitat to replace slough areas, which are dewatered when mainstem discharge and stage decreases, and tributaries that often freeze in the winter.

Samples for age, length and weight analysis were obtained from each slough during late July and early August and late September. Analysis will not be discussed, but is presented in Appendix I Tables 3, 4, and 5.

Aquatic insects and juvenile salmon gut contents

Knowledge of the aquatic insect fauna and its ecology is necessary to assess the potential impacts of the Devils Canyon and Watana dams upon the salmon population downstream. Alterations of currently existing populations would probably have a corrollary effect upon rearing fish.

Gut contents of juvenile salmon from sloughs and tributaries between Portage Creek and the Chulitna and Susitna River confluence were examined to determine feeding habits of rearing fish during 1977. Studies were considered minimal and further investigations will be required.

Immature members of the Orders Diptera, Plecoptera, Ephemeroptera, Trichoptera, Coleoptera, Hemiptera, and adult forms of Hemiptera and Coleoptera were found in the summer and fall diets of juvenile salmon (Appendix I Table 6). Adult terrestrial insects were estimated to be the largest percentage of the gut contents by volume. Although most of these adult forms were terrestrial, the majority of their life histories were spent in the aquatic environment.

Percent composition of gut contents varied between species of fish examined (Table 7). Feeding habits of chinook and coho salmon were, however, similar during the summer sampling period. Adult Insecta were of primary importance for the latter two species during summer. Sockeye salmon fry fed primarily on Diptera larvae during summer months. Cladocera (Bosminidae) were also found to be important food organisms for sockeye salmon in three sloughs (Appendix I Table 6).

Adult Insecta remained the major food items identified in the fall stomach content samples. Adult Diptera and Hymenoptera comprised approximately 80 percent of the food items in sockeye salmon during the fall as compared to about 18 percent during summer. The importance of immature Insecta and Crustacea apparently decreased appreciably. Change in percent composition of food items per fish was not significant for chinook and coho salmon fry.

Aquatic insects probably play a more important role in the juvenile salmon diet during winter months than in the summer and fall. Many groups of insects (Plecoptera, Ephemeroptera, Trichoptera, and Diptera)

Table 7. Mean percent composition of gut contents per fish of chinook, sockeye, and coho salmon juveniles in sloughs and clearwater tributaries of the Susitna River, Devils Canyon Project, 1977.

			Mean Percent Per Fish							
Species	Sample Size		Crustacea		Immature Insecta		Adult Insecta		Other	
	Summer	Fall	Summer	Fall	Summer	Fall	Summer	Fall	Summer	Fall
Chinook	219	158	4	trace	24	26	71	62	1	12
Sockeye	35	18	27	2	54	17	18	80	1	1
Coho	17	45	9	trace	17	9	68	69	6	22

are very active during the winter even at water temperatures of 0°C (Hynes, 1970). Conversely, during these cold months terrestrial insects are nonexistent and plankton is either greatly reduced or nil. This would suggest that aquatic insects would probably be a greater proportion of the juvenile salmon diets than in the summer. Additional studies are required to analyze this.

Research and literature in the area of environmental factors affecting aquatic insects is sparse and often times conflicting. There is, apparently, a high degree of variability as to substrate type preference, temperature requirements, and general modes of existence even within the Order level. Evaluating species diversity would probably be the most useful means of monitoring on-going environmental changes in the invertebrate fauna of the river (McCoy, 1974). It would not, however, provide a means to predict whether or how a change will occur. Environmental factors which would probably result in the greatest alterations in the aquatic fauna include: water temperature, flow, substrate types, water clarity, and chemical water quality.

Research in the area of water temperature effects on aquatic fauna are conflicting, but apparently the "environmental clues" for the hatching of eggs, the change from a larval to pupal state, etc., are a combination of threshhold temperatures and changing day length (Hynes, 1970). Disruptions in the seasonal pattern of temperature are attributed to have caused extensive alterations in the aquatic insect fauna of the Saskatchewan River (Lehmkuhl, 1972). Hypolimnial water discharge from a dam in the river reduced both diversity and absolute numbers of insects downstream. River temperatures became higher in winter and lower in summer, differing from the norm in such a way that Ephemeroptera eggs failed to develop into nymphs. Similar temperature effects were thought to have adversely affected other aquatic insect groups at this site, even at a distance of 70 miles downstream. Alteration of natural flow could affect both the respiration of organisms and substrate types.

Most arthropods in still water self-ventilate their gills or respiratory structures. Many immature aquatic insects have lost this function and rely on running water or current to artificially "fan" their gills. A decrease in flow could therefore have an adverse effect upon respiration. The nature of the flow is intimately related to substrate type. A fast current area will generally be clean swept and have a rocky or gravel substrate. The sediment load will drop in slow moving waters and the bottom will become increasingly silty. Each different substrate type supports a completely different benthic fauna. All these current related factors can perhaps best be summarized by Hynes' observation that areas subjected to wide fluctuations in current "are often without much fauna." Neither those organisms adapted to a slow moving area nor those to one of swift water can thrive.

Numerous investigators have established the importance of substrate types upon the nature of the benthic fauna. Each species of aquatic insect seems adapted to a certain substrate type or at least greatly prefers one type to another. Obviously, changes in substrate type will result in altered benthic fauna. This was evidenced when a small beaver dam across a stream in Ontario altered the upstream bottom habitat from swift flowing and stoney to slow moving and silty stones. The total number of aquatic insects were reduced, "especially of Ephemeroptera, Plecoptera, and Trichoptera," while the proportion of Diptera Chironomid larvae was increased (Hynes, 1970). There can be great variations in substrate preference within each order or even family. Some trends are, however, discernable. In general, rocky or stoney substrates with a swift flow of water will contain both a greater species diversity and a higher biomass than silty substrates with slower moving water. These riffle areas are the most productive regions in running water.

The possible introduction of turbid glacial water by the proposed dam into the clear winter water of the upper Susitna seems to indicate substrate type would be altered to one of increasing silt. This would probably change the aquatic insect fauna and quite possibly reduce its abundance.

Chemical water quality influences upon aquatic insects would be minimal in comparison to the above factors. Lehmkuhl (1972) and Spence and Hynes (1971) discovered no appreciable differences in chemical water quality upstream and downstream from dam impoundments and thus concluded there were no effects from these factors upon benthic invertebrates.

The importance of drift to the relationship between aquatic insects and the diet of juvenile salmon is another factor to consider. Many benthic invertebrates, displaced by crowded conditions and as a means of finding more favorable substrate habitats, leave the substrate and are carried downstream by the water's flow. These are cumulatively called "drift". Investigators have repeatedly found that most of the food items of salmonid fish in flowing water situations consist of drift. Hynes (1970) reports that brown trout feed mostly on drifting organisms. Becker's (1973) food habits study of juvenile chinook salmon on the Columbia River concluded prey items were either drift organisms or adult insects floating on the water's surface. Loftus and Lenon (1977) also believed drift to be an important food source to chinook and chum smolt on the Salcha River in interior Alaska. A comparison between the gut contents of a limited number of longnose suckers (bottom feeders) collected in our study with that of the juvenile salmon reveals that drift aquatic insects together with floating adult insects were apparently the major food items. The numbers and kinds of organisms in the drift appear to differ substantially when compared to fauna collected strictly on the bottom. As might be expected, heavier organisms such as Trichoptera larvae and their cases, snails, etc., are relatively rare in drift, while Ephemeroptera, Diptera Chironomid larvae, and Plecoptera form a higher percentage than they do on the substrate. Various environmental factors can alter the amount of drift. Investigators have reported varying drift because of ice scouring, water temperature, and daylight changes (Hynes, 1970). The role of drift organisms in both the food habits of rearing salmonid fishes and in the overall ecology of aquatic insects is thus probably of some importance in the Susitna River and should be investigated further.

If a hypolimnial discharge hydroelectric dam is constructed at Devils Canyon, it appears almost certain the downstream benthic fauna will be altered. This will most probably occur because of: 1) changed water temperatures resulting from the hypolimnial discharge which may disrupt the life cycles of certain species; 2) substrate types altered by increased winter turbidity of downstream river water, which will in turn alter the aquatic insects living on the substrate, and 3) discharge flow variations because of varying power demands, which will create areas of the river bottom to which neither swift current associated species nor slow current forms are perfectly adapted for. Which species or group of insects will be most affected, whether they will be major food items of rearing juvenile salmon or whether the salmon will switch their food preference to the newly abundant forms, and whether the biomass of benthic fauna will decrease, will probably be difficult, if not impossible, to predict. We can only hope to broadly outline what changes may occur.

Impoundment area fisheries investigations

Alterations will definitely occur to the fish habitat in the areas to be inundated. The fisheries investigations in the impoundment area during the first two weeks of July revealed that Arctic grayling were abundant in all of the major clearwater tributaries (Table 8). Extreme lake level fluctuations of the Watana reservoir will destroy habitat and affect the high quality fishery which presently exists.

No anadromous species were captured upstream of Devils Canyon during the first two weeks of July. More extensive sampling, however, is necessary throughout the summer to determine if Devils Canyon is a velocity barrier to salmon during different natural flow regimes over a three to five year period.

Lakes in the impoundment area which could be impacted by construction of road or transmission corridors and increased access were also surveyed for species composition (Table 9). Fifteen of the eighteen lakes sampled supported desirable game fish populations.

Construction of the Devils Canyon dam would inundate 7,550 acres and have a surface elevation of 1,450 feet and extend for 28 miles upstream (U.S. Army Corps of Engineers, 1977). Construction of the Watana dam would result in inundation of 43,000 acres with a surface elevation of 2,200 feet extending for 54 miles upstream along the Susitna River. For downstream discharge to remain relatively constant, at least

Table 8. Limnological data from selected tributaries to the Susitna River, Devils Canyon Project, 1977.

Stream	Est. Flow (cfs)	Estimated Velocity (fps)	Percent Pools	Bottom Type	Temp.	pH	Conductivity	Fish Observed*
Oshetna	600	3	15	Rubble Boulder	13	8	75	GR
Goose	100	2	40	Rubble Boulder	15	-	-	GR
Jay	75	2	40	Gravel Boulder	8	8.4	160	GR, SK, WF, SC
Kosina	100	2	30	Gravel Boulder	14	8	65	GR
Watana	300	1.5	20	Gravel Rubble	12	7.8	110	GR
Deadman	900	3	10	Boulder	14	-	-	GR
Tsusena	600	2	10	Gravel Boulder	6	7.8	50	GR
Fog	200	1.5	30	Sand	9	7.9	75	GR

* GR - Grayling
SK - Suckers
SC - Sculpin
WF - Whitefish

Table 9. Susitna River impoundment area lake surveys, Devils Canyon Project, 1977.

Lake	Location	Surface Elevation	Surface Acres	Maximum Depth (Ft)	Fish Species Present*
Clarence	T30N, R9E, S19, 20	2,900	299	35	LT, GR, WF
Fog 1	T31N, R5E, S9	2,230	147	72	DV, SC
2	T31N, R5E, S8	2,230	237	50	DV, SC
3	T31N, R5E, S15	2,110	339	81	DV, SC
4	T31N, R5E, S13	2,300	358	9	DV, SC
5	T31N, R6E, S7	2,300	269	6	-
George	T6N, R7W, S20, 29	2,400	80	18	GR, LNS
Louise	T32N, R6E, S7	2,362	155	155	LT, BB, WF, GR
Connor	T6N, R7W, S28	2,450	18	13	GR
Tsusena Butte	T33N, R5E, S21	2,493	190	110	GR, LT, WF
Pistol	T32N, R6E, S7	2,350	205	-	-
Big	T32S, R3, 4W, S25, 18, 19, 30	3,070	1,080	80	LT, WF
Deadman	T22S, R4W, S13, 14	3,064	380	70	LT, GR, WF
Watana	T30N, R7W, S36	3,000	300	30	LT, WF, GR
Square	T30N, R3E, S35	1,935	230	34	-
Little Moose Horn	T30N, R3E, S36	1,850	120	33	GR, LT, LNS
Stephan	T30N, R3E, S2,10,16	1,862	840	95	LT, RT, RS SS, GR, WF, LNS

* Species: GR - Grayling; RT - Rainbow Trout; DV - Dolly Varden; LT - Lake Trout; WF - White Fish; SC - Sculpin; SS - Coho Salmon; BB - Burbon; RS - Sockeye Salmon; LNS - Long Nosed Sucker

one of these reservoirs will have to fluctuate considerably. The Watana reservoir is projected to have the most extreme fluctuations. The majority of the clearwater tributaries to be inundated are found within this section of river and, of the two impoundments, greater impacts will probably occur here since loss of portions of these tributaries is inevitable if the two dams are built. If salmon utilize the area above the Devils Canyon dam site, however, both the Devils Canyon and Watana dams and impoundments could adversely impact migration. Reservoir fluctuations could have a variety of effects on the tributaries. The mouths of these tributaries and stretches of water upstream provide some of the most productive fishery habitat in this area. Some tributaries have steep gradients upstream of the mouth area which act as migration barriers and do not appear to support fish species.

In tributaries where the full pool would extend up to the base of steep tributary gradients or waterfalls, critical lotic habitat would be lost. Periods of lowered pool levels could have a suction effect and result in the erosion and formation of channels with steep gradients which may block intersystem fish migrations and eliminate suitable fishery habitat. Preliminary data on fish species present demonstrates that additional information is required to evaluate the full effects of inundation and regulation in these areas.

WATER QUANTITY

Between May 17 and June 14, 1977 the unregulated flow of the Susitna River increased from 13,600 cubic feet per second (cfs) to a peak discharge of 52,600 cfs (Figure 4; Appendix II, Table 1). By July 20, the flow decreased to 22,400 cfs and fluctuated around 20,000 cfs until August 25. On September 6 the flow dropped to 9,520 cfs and then increased to

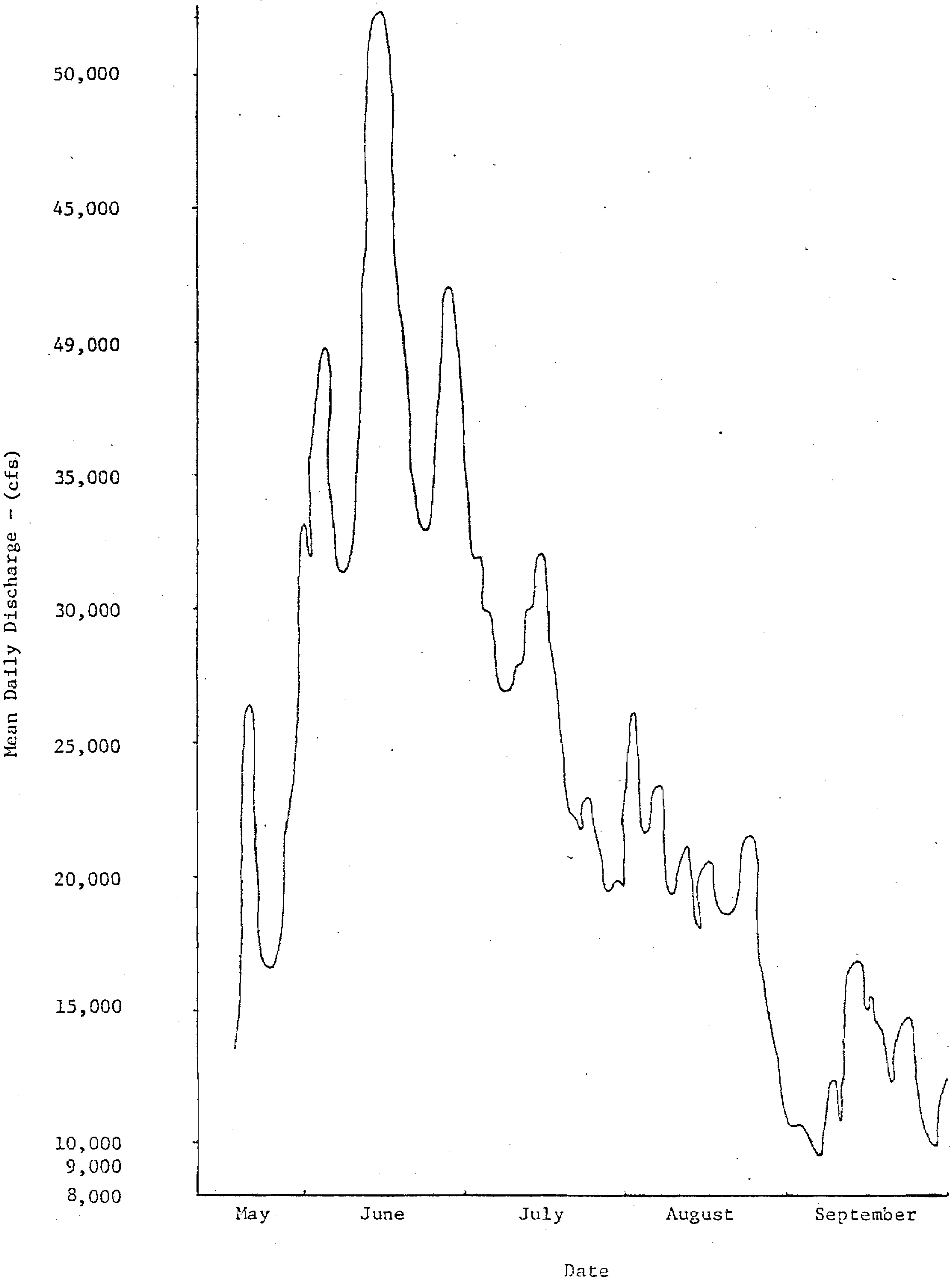

Figure 4. Susitna River discharge at Gold Creek, Devils Canyon Project, 1977.

16,900 cfs one week later. The flow decreased to 9,840 cfs on September 27 which again was followed by increased flow until the last reading of 12,500 cfs was made on September 30.

Fluctuations in flow during August and September were attributed to heavy rain. Stage fluctuations within the majority of clearwater sloughs of the Susitna River, related directly to mainstem discharge variations (Appendix II, Table 2). Downstream flow is projected to be maintained at a constant rate of approximately 7,000 to 8,000 cfs at Gold Creek after completion of the dams. Slough surveys were terminated near the end of September when the flow was approximately 15,000 cfs. It was not possible to observe the sloughs during this study when the mainstem flow was 8,000 cfs due to freezing conditions. Observations during the 1976 study, however, concluded that 75 percent of the rearing sloughs studied were undesirable habitat when the flow in the mainstem was 7,000 cfs (Riis, 1977).

Habitat requirements for passage, spawning, egg incubation, fry, juvenile, and adult phases of the salmon species studied are quite specific. The USFWS Cooperative Instream Flow Service Group has developed criteria which demonstrate the narrow tolerances of certain salmonid species to hydraulic parameters of velocity, depth, substrate and temperature (Bovee, 1978). The seasonally wide fluctuations of water velocity, depth, temperature, substrate, and sediment of the mainstem Susitna, its sloughs and tributaries determine to some extent the intrasystem migrations of fish seeking more desirable environments. Thus, any alterations to the existing aquatic ecosystem which restrict or reduce the availability of required habitat, will also reduce fish production.

Low flows were encountered in Rabideux Creek from mid-June through the end of August (Table 10). The lowest flow recorded was 24.3 cfs on August 23. The highest flow was 440.7 cfs on September 29 and was apparently due to the heavy rains encountered at that time.

WATER QUALITY

Ryan thermographs were installed in the upper sub-areas of Rabideux and Montana creeks. Water temperatures in Rabideux Creek ranged up to five degrees celsius (°C) higher than Montana Creek during corresponding time periods. The high recorded in Rabideux Creek was 18.8°C on both July 11 and 12; the low of 1.7°C occurred on October 22 and 23 at which time the thermograph was removed (Appendix II, Table 3). In Montana Creek, a high of 15.0°C was recorded on July 28 and the low of 0.0°C was recorded from November 3 through 6 at which time recording was terminated (Appendix II, Table 4).

A thermograph was also installed in the Susitna River at the Parks Highway bridge. When installed on June 27 the temperature was 10.5°C and the highest water temperature of 14°C was reached on July 12 followed by temperatures fluctuating between 13.5°C and 10°C when a steady decline began on August 25 and continued to the lowest reading of 2°C on October 2 (Table 11).

Temperatures at all other sampling sites were measured with a combined dissolved oxygen and temperature meter and/or a pocket thermometer. Data is presented in Appendix II, Table 2.

Water chemistry of Rabideux and Montana creeks was measured throughout the season. Determinations of dissolved oxygen, pH, hardness, and total alkalinity are presented in Appendix II, Tables 5 and 6.

In Rabideux Creek, dissolved oxygen ranged from a low of 6 ppm in the upper sub-area to a high of 11 ppm recorded in all areas. Hydrogen

Table 10. Water flows of Montana, Rabideux, and Willow creeks from May through November, Devils Canyon Project, 1977.[1/]

MONTANA CREEK

Date	Flow (cfs)
5/1	935
5/21	2,000
6/5	4,800
6/20	1,764
7/1	935
7/21	935
8/6	233
8/22	153
9/1	103
9/29	1,349
10/15	394
11/9	490

RABIDEUX CREEK

Date	Flow (cfs)
4/13	325.4
5/25	128.7
6/7	116.7
6/17	50.2
6/30	33.2
7/13	36.7
7/26	31.4
8/23	24.3
8/31	29.2
9/21	242.9
9/29	440.7

WILLOW CREEK

Date	Flow (cfs)
5/1	443
5/30	1,590
6/15	3,320
6/29	1,900
7/15	951
7/30	525
8/15	409
8/30	322
9/16	1,590
9/29	2,070
10/15	525
10/30	348
11/8	676

1/ Montana and Willow creeks data is provisional and was obtained from the National Weather Service.

Table 11. Thermograph set in Susitna River downstream of Parks Highway Bridge, daily maximum and minimum water temperature, Devils Canyon Project, 1978.

Date	Temp. °C Min.	Max.	Date	Temp. °C Min.	Max.	Date	Temp. °C Min.	Max.
6/27	10.5	10.5	7/30	12.5	12.5	9/12	7.5	8.0
6/28	10.5	10.5	7/31	11.0	12.5	9/13	7.5	7.5
6/29	10	10.5	8/1	10.0	10.5	9/14	7.5	7.5
6/30	10	10	8/2	10.0	10.0	9/15	6.0	7.5
7/1	10.5	10.5	8/3	10.0	11.0	9/16	6.0	6.5
7/2	10.5	10.5	8/4	11.0	11.0	9/17	6.5	6.5
7/3	10	10.5	8/5	11.0	11.0	9/18	6.5	6.5
7/4	9.5	10	8/6	10.5	11.0	9/19	6.0	6.5
7/5	9.5	10	8/7	11.0	11.0	9/20	5.5	6.5
7/6	10	11	8/8	10.0	10.5	9/21	5.5	5.5
7/7	12	12.5	8/9	10.0	11.5	9/22	5.5	6.0
7/8	12	13	8/10	11.0	11.5	9/23	5.5	6.0
7/9	12	13	8/11	10.5	11.0	9/24	5.0	5.5
7/10	12.5	13.5	8/12	10.5	11.0	9/25	4.5	5.0
7/11	13	13.5	8/13	10.5	11.0	9/26	4.5	5.0
7/12	13.5	14	8/14	10.5	11.0	9/27	5.0	5.0
7/13	13	13.5	8/15	10.5	11.0	9/28	5.0	5.0
7/14	11	13	8/16	11.0	11.0	9/29	4.5	5.0
7/15	10.5	11	8/17	11.0	11.0	9/30	3.0	4.5
7/16	10.5	11.5	8/18	10.0	10.5	10/1	2.5	3.0
7/17	11.3	12	8/19	10.5	12.0	10/2	2.0	2.5
7/18	12	12	8/20	11.0	12.0	10/3	2.0	2.0
7/19	11.5	11.5	8/21	10.5	12.0	10/4	2.0	3.0
7/20	11.5	11.5	8/22	11.0	11.5	10/5	2.5	3.0
7/21	11	11	8/23	11.0	12.0	10/6	2.0	2.5
7/22	11	11.5	8/24	10.5	11.5	10/7	2.5	2.5
7/23	11	11.5	8/25	9.5	10.5	10/8	2.5	3.0
7/24	11	11.5	8/26	9.0	--	10/9	3.0	3.5
7/25	11.5	11.5	--	--	--	10/10	3.5	3.5
7/26	11.5	11.5	--	--	--	10/11	3.5	4.0
7/27	10.5	12.0	9/9	8.0	--	10/12	--	3.5
7/28	11.0	12.5	9/10	7.5	8.0	--	--	--
7/29	12.0	13.0	9/11	7.5	8.0	--	--	--

ion (pH) concentrations were found to be relatively stable ranging from a low of 6.5 to a high of 7.7. Both hardness and total alkalinity were found to range between 17 mg/1 to 68 mg/1. The higher readings occurred during the warmer summer months.

Montana Creek exhibited less fluctuation in chemical water characteristics than Rabideux Creek. The dissolved oxygen ranged from 9 to 12 ppm, pH from 6.8 to 7.7, and hardness and total alkalinity from 17 to 34 mg/1.

Water samples were collected jointly by ADF&G and USGS from three sites on the Susitna and the USGS laboratory carried out the complete standard chemical analysis. This data is presented in Appendix II, Table 7 and considerably expands the data base which will be used for future comparisons.

Field determinations of dissolved oxygen, pH, hardness, total alkalinity and specific conductance were collected in clearwater sloughs and tributaries and are tabulated in Appendix II, Table 2. The findings were within acceptable limits for fish life and were in the range of expected results for natural waters in southcentral Alaska.

CONCLUSION

Baseline inventory studies, to date, emphasize the need to initiate a comprehensive study to properly assess the potential environmental impacts to the aquatic ecosystem of the Susitna drainage by the proposed Watana and Devils Canyon hydroelectric project prior to final design approval and construction authorization.

The Susitna River is a product of its tributaries. All aquatic habitat and populations (within the power transmission corridor site, construction road routes, and above and below the proposed dam sites) which would be directly or indirectly affected during construction and after completion of the project must be carefully evaluated. It is imperative to thoroughly investigate the interrelationships between the aquatic biology and the water quantity and quality of the existing free flowing Susitna River system. Recreational, social, economic, and aesthetic considerations should also be included.

With this information the Alaska Department of Fish and Game will be able to provide the input for preventing unnecessary losses of the fisheries and related resources held in high esteem by the people of Alaska and the Nation as a whole.

RECOMMENDATIONS

Continued collection of biological data and completion of resource assessment in the area affected by the proposed hydroelectric project is essential to understanding the potential impacts of the proposed action. Appendix III is a summary of ADF&G's recommendations for essential aquatic studies.

Direct studies of aquatic and terrestrial species can delineate a population and indicate their distribution throughout the year and define why species are there to a certain extent. Seasonal life history studies must be accompanied by habitat studies if we are to determine the full significance of habitat alteration to the population.

The studies identified for the pre-authorization environmental assessment are necessary to predict the impacts of hydroelectric development on the ecosystem. The objectives of the biological investigations are based upon the assumption that the Devils Canyon and Watana two dam plan will be selected. It must be realized that as the plan evolves and new information becomes available, the program must be flexible enough to permit adjustment in study direction. If other basin development schemes are proposed, study time and costs will have to be reevaluated. Capital requirements for each year were based upon FY-78 dollars. Inflation will therefore necessitate annual supplemental allocations which represent revised cost estimates. The proposals are closely integrated and demonstrate the need for continuity. The design, timing, manpower requirements, and funding levels of the individual projects have been coordinated.

A team of resource specialists representing various scientific disciplines will be required to carry out field investigations in habitat assessment. Adequate time will be required to organize study personnel and procure equipment prior to the first field season. An untimely delay could prevent the initiation of the field studies one year.

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APPENDIX I

Tables in the following appendix include data on adult and juvenile salmonids and stomach content analysis.

Appendix I

Table 1 . Percent age composition of chinook, sockeye, coho, and chum salmon escapement samples, Devils Canyon Project, 1974, 1975, and 1977.

Year of Return	Age Class					Brood Year					Sample Size
CHINOOK:											
1977	1.1	1.2	1.3	1.4	1.5	1970	1971	1972	1973	1974	
Percent	9.5	9.5	52.4	28.6	0.0	0.0	28.6	52.4	9.5	9.5	100.0
Number	2	2	11	6	0	0	6	11	2	2	21
1975	1.1	1.2	1.3	1.4	1.5	1968	1969	1970	1971	1972	
Percent	9.3	4.6	34.9	44.2	7.0	7.0	44.2	34.9	4.6	9.3	100.0
Number	4	2	15	19	3	3	19	15	2	4	43
SOCKEYE:											
1977	1.1	1.2	1.3	2.1	2.2		1972	1973	1974		
Percent	3.3	16.7	76.7	3.3	0.0		76.7	20.0	3.3		100.0
Number	1	5	23	1	0		23	6	1		30
1975	1.1	1.2	1.3	2.1	2.2		1970	1971	1972		
Percent	6.3	41.8	37.9	0.0	14.0		51.9	41.8	6.3		100.0
Number	5	33	30	0	11		41	30	5		79
1974	1.1	1.2	1.3	2.1	2.2		1969	1970	1971		
Percent	27.9	46.5	4.7	11.6	9.3		14.0	58.1	27.9		100.0
Number	12	20	2	5	4		6	25	12		43
COHO:											
1977		1.1	1.2	2.0	2.1			1973	1974		
Percent		14.3	0.0	0.0	85.7			85.7	14.3		100.0
Number		1	0	0	6			6	1		7
1975		1.1	1.2	2.0	2.1			1971	1972		
Percent		11.8	5.9	0.0	82.3			88.2	11.8		100.0
Number		2	1	0	14			15	2		17
1974		1.1	1.2	2.0	2.1			1970	1971		
Percent		15.9	0.0	0.9	83.2			84.1	15.9		100.0
Number		18	0	1	94			95	18		113
CHUM:											
1977		0.2	0.3	0.4			1972	1973	1974		
Percent		4.8	88.1	7.1			7.1	88.1	4.8		100.0
Number		2	37	3			2	37	2		42
1975		0.2	0.3	0.4			1970	1971	1972		
Percent		16.4	82.0	1.6			1.6	82.0	16.4		100.0
Number		21	105	2			2	105	21		128
1974		0.2	0.3	0.4			1969	1970	1971		
Percent		48.1	33.4	18.5			18.5	33.4	48.1		100.0
Number		229	159	88			88	159	229		476

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Table 2 . Age, length, and sex characteristics of chum, chinook, sockeye, and coho salmon escapement samples, Devils Canyon Project, 1974, 1975, and 1977.

Year of Return	Age Class	Mean Length (mm)	Standard Deviation (s.)	Range of Lengths	Number Males	Number Females	n
CHUM:							
1974	0.2	545.0	32.05	410-650	155	74	229
	0.3	614.8	33.61	510-695	88	71	159
	0.4	627.6	30.71	520-695	47	41	88
1975	0.2	552.7	13.58	530-578	11	10	21
	0.3	587.6	20.62	532-628	55	50	105
	0.4	620.5	2.50	618-623	0	2	2
1977	0.2	568.5	3.50	565-572	0	2	2
	0.3	618.3	29.05	545-667	28	9	37
	0.4	656.7	9.43	650-670	2	1	3
CHINOOK:							
1975	1.1	389.3	31.69	341-421	4	0	4
	1.2	483.5	6.50	477-490	1	1	2
	1.3	710.6	84.25	569-812	12	3	15
	1.4	856.2	62.63	778-990	7	12	19
	1.5	937.0	45.08	897-1000	0	3	3
1977	1.1	371.5	28.50	343-400	2	0	2
	1.2	580.0	5.00	575-580	2	0	2
	1.3	816.3	59.10	725-920	8	3	11
	1.4	994.8	52.02	950-1103	4	2	6
SOCKEYE:							
1974	1.1	395.5	69.14	315-485	12	0	12
	1.2	527.8	48.99	417-595	10	10	20
	1.3	572.5	12.50	560-585	0	2	2
	2.1	376.6	56.94	318-485	5	0	5
	2.2	536.3	20.12	515-565	3	1	4
1975	1.1	352.4	37.15	313-423	5	0	5
	1.2	471.8	42.36	398-548	15	18	33
	1.3	576.1	26.65	514-638	12	18	30
	2.1	—	—	—	0	0	0
	2.2	532.3	39.54	460-576	4	7	11
1977	1.1	347.0	—	347	1	0	1
	1.2	451.8	27.09	433-505	4	1	5
	1.3	596.4	30.24	509-639	11	12	23
	2.1	371.0	—	371	1	0	1
	2.2	—	—	—	0	0	0
COHO:							
1974	1.1	487.9	42.92	410-575	11	7	18
	2.0	375.0	—	375	1	0	1
	2.1	527.7	48.00	376-605	49	45	94
1975	1.1	495.5	4.50	491-500	1	1	2
	1.2	540.0	—	540	1	0	1
	2.1	531.1	38.53	454-608	5	9	14
1977	1.1	337.0	—	337	1	0	1
	2.1	473.0	54.54	400-549	5	1	6

Appendix I
Table 3. Analyses of age, length, weight and condition factors of juvenile sockeye salmon samples from Susitna River sloughs and clearwater tributaries, Devils Canyon Project, 1977.

			Length (mm)			Weight (g)			Condition Factor				
Location	Age Class	Date	Mean	Standard Deviation	Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	Range	Percent1/ Composition	n
Slough 1	0.0	8/5	48.0	1.0	47-49	1.5	0.2	1.3-1.8	1.391	0.139	1.252-1.530	100	2
Slough 3	0.0	9/24	53.0	-	-	1.7	-	-	1.142	-	-	100	1
Slough 5	0.0	7/27	44.0	-	-	1.7	-	-	1.996	-	-	100	1
Slough 6	0.0	7/27	34.3	2.9	31-38	0.4	0.0	0.4	1.029	0.250	0.729-1.342	100	3
Slough 8	0.0	7/27	42.7	1.7	40-45	0.7	0.1	0.5-0.9	0.945	0.095	0.781-1.006	100	4
	0.0	9/23	44.5	5.5	39-50	1.1	0.4	0.6-1.5	1.105	0.094	1.011-1.200	100	2
Slough 8B	0.0	9/23	48.9	5.3	44-60	1.3	0.4	0.9-2.4	1.091	0.064	0.986-1.207	100	12
Slough 11	0.0	9/21	51.5	0.5	51-52	1.7	0.1	1.6-1.7	1.207	0.001	1.206-1.209	100	2
Slough 12	0.0	8/2	36.9	4.6	29-45	0.7	0.3	0.3-1.2	1.300	0.277	0.932-1.399	100	10
Slough 17	0.0	7/26	44.0	-	-	0.5	-	-	0.988	-	-	100	1

Appendix I
Table 3. Analyses of age, length, weight and condition factors of juvenile sockeye salmon samples from Susitna River sloughs and clearwater tributaries, Devils Canyon Project, 1977. (continued)

			Length (mm)			Weight (g)			Condition Factor				
Location	Age Class	Date	Mean	Standard Deviation	Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	Range	Percent 1/ Composition	n
Slough 19	0.0	7/26	32.4	7.9	25-51	0.4	0.5	0.1-1.9	0.803	0.335	0.370-1.432	100	12
	0.0	8/2	53.5	1.5	52-55	1.5	0.1	1.4-1.7	1.009	0.013	0.996-1.022	100	2
	0.0	9/21	50.0	-	-	1.5	-	-	1.200	-	-	100	1

1/ Percent composition of each age class within sampling period.

Appendix I
Table 4. Analyses of age, length, weight and condition factors of juvenile coho salmon samples from Susitna River sloughs and clearwater tributaries, Devils Canyon Project, 1977.

			Length (mm)			Weight (g)			Condition Factor				
Location	Age Class	Date	Mean	Standard Deviation	Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	Range	Percent 1/ Composition	n
Slough 1	0.0	9/24	54.6	3.9	49-61	2.0	0.5	1.3-2.9	1.199	0.084	1.022-1.315	93	13
	1.0	9/24	80.0	-	-	6.0	-	-	1.172	-	-	7	1
Slough 4	0.0	9/24	62.7	3.3	59-67	2.9	0.4	2.5-3.6	1.196	0.017	1.175-1.217	23	3
	1.0	9/24	75.4	8.3	68-99	5.9	3.3	3.7-15.8	1.268	0.126	1.152-1.628	77	10
Slough 5	0.0	9/23	77.0	-	-	6.2	-	-	1.358	-	-	25	1
	1.0	9/23	105.3	8.9	93-114	14.9	3.0	10.7-17.5	1.267	0.104	1.120-1.351	75	3
Slough 6	0.0	7/27	57.0	-	-	1.9	-	-	1.026	-	-	100	1
Slough 6A	0.0	7/27	49.5	1.5	48-51	1.5	0.0	1.5	1.243	0.113	1.113-1.356	100	2
Slough or 8A	0.0	9/23	63.0	-	-	3.0	-	-	1.216	-	-	100	1
Slough 8C	0.0	9/23	47.0	-	-	1.2	-	-	1.156	-	-	100	1
Slough 10	0.0	7/27	57.0	-	-	2.1	-	-	1.134	-	-	100	1

Appendix I
Table 4. Analyses of age, length, weight and condition factors of juvenile coho salmon samples from Susitna River sloughs and clearwater tributaries, Devils Canyon Project, 1977. (continued)

			Length (mm)			Weight (g)			Condition Factor				
Location	Age Class	Date	Mean	Standard Deviation	Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	Range	Percent1/ Composition	n
Slough 13	0.0	9/22	59.0	-	-	2.2	-	-	1.071	-	-	100	1
Slough 16	0.0	9/21	63.0	2.0	61-65	3.2	0.3	2.9-3.5	1.276	0.002	1.274-1.278	100	2
Slough 19	0.0	9/21	71.0	2.0	69-73	4.7	0.7	4.0-5.3	1.290	0.072	1.218-1.362	100	2
Slough 21	0.0	9/20	56.0	-	-	1.5	-	-	0.854	-	-	100	1
Chase Creek	0.0	8/6	43.0	2.0	41-45	0.9	0.1	0.8-1.1	1.184	0.023	1.161-1.207	100	2
Whiskers Creek	0.0	8/5	43.0	5.0	38-48	0.9	0.3	0.6-1.2	1.089	0.004	1.085-1.093	100	2
	0.0	9/24	50.7	4.3	46-57	1.7	0.4	1.1-2.2	1.243	0.837	1.130-1.356	100	6

1/ Percent composition of each age class within sampling period.

Appendix I

Table 5. Analyses of age, length, weight and condition factors of juvenile chinook salmon samples from Susitna River sloughs and clearwater tributaries, Devils Canyon Project, 1977.

			Length (mm)			Weight (g)			Condition Factor				
Location	Age Class	Date	Mean	Standard Deviation	Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	Range	Percent1/ Composition	n
Slough 1	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Slough 2	0.0	8/5	49.1	4.5	42-55	1.5	0.4	0.7-1.7	1.152	0.127	0.945-1.282	100	6
Slough 3	0.0	8/5	51.0	7.1	45-68	1.7	0.7	1.1-3.4	1.233	0.074	1.081-1.348	100	10
	0.0	9/24	62.8	4.3	58-69	2.8	0.7	1.8-3.9	1.107	0.118	0.916-1.230	100	6
Slough 4	0.0	9/24	59.0	-	-	2.4	-	-	1.169	-	-	100	1
Slough 5	0.0	7/27	55.3	3.7	51-60	1.7	0.3	1.2-2.0	1.011	0.135	0.904-1,202	100	3
Slough 6	0.0	7/27	48.3	6.6	42-63	1.3	0.6	0.7-2.7	1.049	0.108	0.904-1.026	100	7
Slough 6A	0.0	7/27	50.7	1.7	49-54	1.2	0.1	1.0-1.5	0.935	0.065	0.850-1.067	88	7
	1.0	7/27	76.0	-	-	4.3	-	-	0.980	-	-	12	1
Slough 8	0.0	7/27	46.2	3.9	43-53	0.9	0.2	0.7-1.3	0.854	0.029	0.814-0.880	100	5
	0.0	9/23	52.0	5.7	45-60	1.7	0.6	1.0-2.7	1.183	0.102	1.027-1.317	100	10

Appendix I
Table 5. Analyses of age, length, weight and condition factors of juvenile chinook salmon samples from Susitna River sloughs and clearwater tributaries, Devils Canyon Project, 1977. (continued)

Location	Age Class	Date	Length (mm)			Weight (g)			Condition Factor			Percent1/ Composition	n
			Mean	Standard Deviation	Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	Range		
Slough 8A	0.0	8/3	54.5	1.5	53-56	2.1	0.1	1.9-2.2	1.264	0.011	1.253-1.276	100	2
	0.0	9/23	64.0	2.0	62-66	3.3	0.3	3.05-3.70	1.283	0.003	1.280-1.287	100	2
Slough 8B	0.0	8/4	49.2	5.4	44-59	1.3	0.5	0.8-2.4	1.008	0.088	0.924-1.169	100	5
	0.0	9/23	61.0	4.2	55-64	3.0	0.8	1.9-3.8	1.284	0.127	1.142-1.450	100	3
Slough 8C	0.0	8/4	47.6	2.2	44-51	1.1	0.1	0.8-1.4	1.026	0.053	0.939-1.085	100	5
	0.0	9/23	52.7	4.0	47-57	1.8	0.3	1.2-2.3	1.181	0.059	1.080-1.242	100	6
Slough 8D	0.0	9/23	56.0	-	-	2.1	-	-	1.196	-	-	100	1
Slough 9	0.0	7/12	49.8	4.9	44-59	1.5	0.5	0.9-2.5	1.185	0.082	1.056-1.336	100	10
	0.0	7/27	50.8	3.1	46-57	1.0	0.3	0.5-1.7	0.725	0.199	0.427-1.020	100	11
	0.0	9/22	56.3	6.3	46-64	2.1	0.7	1.1-3.1	1.154	0.400	1.080-1.209	100	10
Slough 10	0.0	7/27	48.5	3.4	44-51	1.0	0.3	0.5-1.6	0.862	0.128	0.587-1.055	100	9

Appendix I
Table 5. Analyses of age, length, weight and condition factors of juvenile chinook salmon samples from Susitna River sloughs and clearwater tributaries, Devils Canyon Project, 1977. (continued)

			Length (mm)			Weight (g)			Condition Factor				
Location	Age Class	Date	Mean	Standard Deviation	Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	Range	Percent1/ Composition	n
Slough 11	0.0	9/21	60.3	3.5	54-69	2.5	0.5	1.3-4.0	1.166	0.104	0.972-1.366	100	40
Slough 13	0.0	9/22	56.0	3.5	53-62	2.1	0.5	1.9-3.0	1.221	0.052	1.142-1.276	100	4
Slough 14	0.0	9/22	60.7	4.1	54-68	2.8	0.5	2.0-3.8	1.233	0.040	1.165-1.296	90	9
	1.0	9/22	74.0	-	-	5.1	-	-	1.259	-	-	10	1
Slough 15	0.0	7/26	48.5	2.1	45-52	1.2	0.1	1.0-1.6	1.048	0.080	0.924-1.175	100	10
	0.0	9/21	60.8	6.3	48-74	2.9	0.9	1.8-4.8	1.260	0.137	0.926-1.628	100	19
Slough 16	0.0	7/26	51.7	3.1	46-58	1.5	0.3	1.0-2.3	1.092	0.080	0.962-1.242	100	20
	0.0	9/21	54.8	4.4	47-63	2.1	0.5	1.4-2.8	1.268	0.102	1.075-1.461	93	13
	1.0	9/21	73.0	-	-	4.6	-	-	1.182	-	-	7	1
Slough 17	0.0	7/11	47.9	1.0	46-50	1.3	0.1	1.2-1.4	1.208	0.069	1.085-1.266	100	10
	0.0	7/26	46.1	2.6	40-50	0.9	0.1	0.7-1.1	0.916	0.239	0.719-1.563	100	9

Appendix I
Table 5. Analyses of age, length, weight and condition factors of juvenile chinook salmon samples from Susitna River sloughs and clearwater tributaries, Devils Canyon Project, 1977. (continued)

			Length (mm)			Weight (g)			Condition Factor				
Location	Age Class	Date	Mean	Standard Deviation	Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	Range	Percent1/ Composition	n
Slough 18	0.0	7/26	50.0	3.5	46-52	1.3	0.3	1.0-2.2	1.079	0.065	0.963-1.175	100	10
	0.0	9/21	61.7	4.5	58-69	3.1	1.0	2.3-4.6	1.286	0.126	1.179-1.463	100	3
Slough 19	0.0	8/2	60.5	3.5	57-64	2.1	0.2	1.9-2.4	0.970	0.055	0.915-1.026	100	2
	0.0	9/21	60.3	3.7	52-65	2.7	0.4	1.7-3.2	1.206	0.084	1.111-1.412	100	8
Slough 20	0.0	7/25	54.2	4.4	46-64	1.7	0.5	0.8-2.8	1.048	0.128	0.822-1.207	100	20
	0.0	9/20	60.7	3.9	51-68	2.7	0.5	1.5-3.2	1.211	0.063	1.080-1.343	100	19
Slough 21	0.0	7/13	45.0	1.6	43-47	1.2	0.2	1.0-1.5	1.340	0.078	1.258-1.445	100	3
	0.0	9/20	58.9	2.5	57-63	2.3	0.3	1.9-3.0	1.139	0.075	1.019-1.296	100	14
Chase Creek	0.0	8/6	48.7	4.1	42-54	1.3	0.3	0.8-2.2	1.174	0.069	1.080-1.266	100	6
Fourth of July Creek	0.0	8/3	49.7	4.3	40-57	1.3	0.3	0.7-1.8	1.009	0.076	0.873-1.138	100	13
	0.0	9/22	63.0	3.0	59-68	3.2	0.3	2.9-3.6	1.297	0.061	1.240-1.412	100	6

Appendix I

Table 5. Analyses of age, length, weight and condition factors of juvenile chinook salmon samples from Susitna River sloughs and clearwater tributaries, Devils Canyon Project, 1977. (continued)

			Length (mm)			Weight (g)			Condition Factor				
Location	Age Class	Date	Mean	Standard Deviation	Range	Mean	Standard Deviation	Range	Mean	Standard Deviation	Range	Percent1/ Composition	n
McKenzie Creek	0.0	7/27	47.6	4.8	39-59	1.1	0.4	0.7-2.1	1.012	0.085	0.822-1.142	100	24
Whiskers Creek	0.0	8/5	45.0	4.0	41-49	1.1	0.3	0.8-1.4	1.175	0.014	1.161-1.190	100	2
	0.0	9/24	53.0	3.7	49-59	1.9	0.3	1.5-2.5	1.246	0.033	1.209-1.282	100	4

1/ Percent composition of each age class within sampling period.

Appendix I Table 6. Stomach content analysis of juvenile chinook, coho, and sockeye salmon collected in sloughs and clearwater tributaries of the Susitna River during summer and fall, Devils Canyon Project, 1977.

Location	Date	Number Specimens	Estimated Percent of Combined Gut Contents				Predominate Organisms
			Crustacea	Immature Insecta	Adult Insecta	Other	
Chinook-Summer							
Susitna #1	8/5	7	0	10	90	0	Adult Diptera and Hymenoptera
Susitna #2	8/5	6	<5	20	75	0	Adult Diptera; Diptera Chironomid larvae
Susitna #3	8/5	10	<5	80	>14	<1	Diptera Chironomid larvae and pupae
Susitna #5	7/27	4	<1	10	>89	0	Adult Diptera
Susitna #6	7/27	7	50	<5	>45	0	Ostracoda and Calanoid Copepoda; Adult Diptera
Susitna #6A	7/27	8	0	4	>95	<1	Adult Diptera
Slough #8	7/27	5	0	0	100	0	Adult Diptera
Slough #8A	8/3	2	0	0	0	0	Guts empty
Susitna #8B	8/4	5	0	5	75	20	Adult Diptera; unidentified capsules (plant seeds?)
Susitna #8C	8/4	5	0	<5	>94	<1	Adult Diptera and Hymenoptera

Appendix I Table 6. Stomach content analysis of juvenile chinook, coho, and sockeye salmon collected in sloughs and clearwater tributaries of the Susitna River during summer and fall, Devils Canyon Project, 1977, (continued).

Location	Date	Number Specimens	Estimated Percent of Combined Gut Contents: Crustacea	Immature Insecta	Adult Insecta	Other	Predominate Organisms
Susitna #9	7/14	10	0	<1	>80	19	Adult Diptera and Hymenoptera; unidentified structures (plant seeds?)
Susitna #9A	7/27	11	0	5	95	0	Adult Diptera
Susitna #10	7/27	8	20	10	70	0	Unidentified adult insect fragments; Cladocera Bosminidae
Susitna #15	7/26	10	<1	10	>89	0	Adult Diptera
Susitna #16	7/26	20	0	70	30	0	Diptera Chironomid larvae; Adult Diptera
Susitna #17	7/14	10	0	10	90	0	Adult Diptera
Susitna #17	7/26	9	0	40	60	0	Adult Diptera and Homoptera; Diptera Chironomid larvae
Susitna #18	7/26	10	20	20	60	0	Adult Homoptera and Hymenoptera; Ostracoda
Susitna #19	8/2	2	0	50	50	0	Diptera Chironomid larvae and pupae; Adult Diptera
Susitna #20	7/25	20	0	<5	>95	0	Adult Diptera and Coleoptera

Appendix I Table 6. Stomach content analysis of juvenile chinook, coho, and sockeye salmon collected in sloughs and clearwater tributaries of the Susitna River during summer and fall, Devils Canyon Project, 1977, (continued).

Location	Date	Number Specimens	Estimated Percent of Combined Gut Contents: Crustacea	Immature Insecta	Adult Insecta	Other	Predominate Organisms
Susitna #21	7/13	3	0	10	90	0	Adult Diptera
Whiskers Creek	8/5	2	10	<5	>85	0	Adult Diptera
Chase Creek	8/6	11	1	4	95	0	Adult Homoptera and Hymenoptera
McKenzie Creek	7/27	21	0	40	60	0	Adult Diptera; Diptera Chironomid larvae and pupae
Fourth of July Creek	8/3	13	0	40	60	0	Adult Diptera; adult Chironomid larvae and pupae
Chinook-Fall							
Susitna #3	9/24	6	0	20	80	0	Adult Hemiptera and unidentified adult Insecta; Diptera Chironomid larvae
Susitna #4	9/24	1	0	10	>85	<5	Unidentified adult insect fragments
Slough #A	9/23	2	0	5	35	60	Oligochaeta (?); Unidentified adult insect fragments
Susitna #8	9/23	10	0	>45	50	<5	Adult Diptera and Hymenoptera; Diptera Chironomid pupae and larvae; Trichoptera pupae; Diptera Tepulidae larvae

Appendix I Table 6. Stomach content analysis of juvenile chinook, coho, and sockeye salmon collected in sloughs and clearwater tributaries of the Susitna River during summer and fall, Devils Canyon Project, 1977, (continued).

Location	Date	Number Specimens	Estimated Percent of Combined Gut Contents: Crustacea	Immature Insecta	Adult Insecta	Other	Predominate Organisms
Susitna #8B	9/23	3	0	10	90	0	Adult Diptera, Hymenoptera and Lepidoptera
Susitna #8C	9/23	6	0	30	40	30	Adult Homoptera and unidentified adult insect fragment; Oligochaeta (?); Diptera Chironomid larvae and pupae
Susitna #8D	9/23	1	0	30	70	0	Adult insect fragments; Diptera Chironomid larvae
Susitna #9	9/22	10	0	<5	>95	0	Adult Diptera, Hymenoptera, Homoptera and Lepidoptera
Susitna #11	9/21	20	0	70	20	10	Trichoptera and Diptera Chironomid pupae; adult Hemiptera and unidentified adult fragments
Susitna #13	9/22	4	0	30	70	0	Adult Diptera and unidentified adult fragments; Diptera Chironomid larvae and pupae
Susitna #14	9/22	10	0	9	90	1	Adult Diptera, Hymenoptera, Plecoptera
Susitna #15	9/21	19	0	10	30	60	Oligochaeta (?); Adult Diptera and Hemiptera
Susitna #16	9/21	14	0	10	85	5	Adult Diptera and Hemiptera
Susitna #19	9/21	8	1	14	85	0	Diptera Chironomid pupae

Appendix I Table 6. Stomach content analysis of juvenile chinook, coho, and sockeye salmon collected in sloughs and clearwater tributaries of the Susitna River during summer and fall, Devils Canyon Project, 1977, (continued).

Location	Date	Number Specimens	Estimated Percent of Combined Gut Contents: Crustacea	Immature Insecta	Adult Insecta	Other	Predominate Organisms
Susitna #20	9/20	19	0	30	65	5	Adult Hemiptera Diptera and Hymenoptera fragments; Diptera Chironomid larvae
Susitna #21	9/20	14	0	<5	>95	0	Adult Diptera
Whiskers Creek	9/24	4	0	>95	<5	0	Trichoptera pupae
Fourth of July Creek	9/22	7	0	15	75	10	Adult Diptera, Hemoptera, and Hymenoptera
Coho-Summer							
Susitna #1	8/5	5	10	10	80	0	Adult Lepidoptera and unidentified adult insect fragments
Susitna #6	7/27	1	70	0	30	0	Calanoid Copepoda; Adult insect fragments
Susitna #6A	7/27	2	0	80	20	0	Diptera Chironomid larvae, unidentified adult insect fragments
Susitna #10	7/27	2	0	20	80	0	Unidentified adult insect fragments; Diptera Chironomid pupae
Whiskers Creek	8/5	2	10	10	80	0	Adult Coleoptera fragments
Chase Creek	8/6	2	<5	0	>45	50	Sand grains; adult Hymenoptera and Diptera

Appendix I Table 6. Stomach content analysis of juvenile chinook, coho, and sockeye salmon collected in sloughs and clearwater tributaries of the Susitna River during summer and fall, Devils Canyon Project, 1977, (continued).

Location	Date	Number Specimens	Estimated Percent of Combined Gut Contents: Crustacea	Immature Insecta	Adult Insecta	Other	Predominate Organisms
McKenzie Creek	7/27	3	0	10	90	0	Adult Diptera
Coho-Fall							
Susitna #1	9/24	14	<1	1	>98	0	Adult Hemiptera, Homoptera, Coleoptera, Lepidoptera and fragments
Susitna #4	9/24	13	0	<5	>35	60	3 salmonid juveniles; adult Coleoptera, Hemiptera, Homoptera, Hymenoptera, Diptera
Susitna #5	9/23	4	0	1	89	10	Adult Diptera, Coleoptera, Hemiptera, and Homoptera
Slough #A	9/23	1	0	70	30	0	Diptera Chironomid larvae; Ephemeroptera Plecoptera nymphs; adult Diptera
Susitna #8C	9/23	1	0	40	60	0	Unidentified adult Insecta; Diptera Chironomid larvae
Susitna #13	9/22	1	<1	10	>84	5	Adult Diptera and Homoptera
Susitna #16	9/21	2	0	20	0	80	Algae; Diptera Chironomid larvae
Susitna #19	9/21	2	0	20	80	0	Adult Coleoptera and Diptera; Diptera Chironomid pupae
Susitna #21	9/20	1	0	10	90	0	Adult Diptera

Appendix I Table 6. Stomach content analysis of juvenile chinook, coho, and sockeye salmon collected in sloughs and clearwater tributaries of the Susitna River during summer and fall, Devils Canyon Project, 1977, (continued).

Location	Date	Number Specimens	Estimated Percent of Combined Gut Contents: Crustacea	Immature Insecta	Adult Insecta	Other	Predominate Organisms
Whiskers Creek	9/24	6	0	20	80	0	Adult Homoptera, Coleoptera, Hemiptera, Hymenoptera; Trechoptera pupae
Sockeye-Summer							
Susitna #1	8/5	2	50	20	20	10	Calanoid and Cyclopoid Copepoda; Diptera adults and Chironomid larvae
Susitna #5	7/27	1	90	10	0	0	Cladocera Bosminidae
Susitna #6	7/27	3	50	50	0	0	Ostracoda; Diptera Chironomid larvae
Susitna #8	7/27	4	0	10	90	0	Adult Diptera, Homoptera, Hymenoptera
Susitna #12	7/29	10	0	90	10	0	Diptera Chironomid larvae
Susitna #17	7/26	1	20	80	0	0	Diptera Chironomid larvae
Susitna #19	7/14	3	20	40	40	0	Adult Diptera; Diptera Chironomid larvae; Cladocera Bosmididae
Susitna #19	7/26	11	50	50	0	0	Cladocera Bosminidae; Diptera Chironomid larvae

Appendix I Table 6. Stomach content analysis of juvenile chinook, coho, and sockeye salmon collected in sloughs and clearwater tributaries of the Susitna River during summer and fall, Devils Canyon Project, 1977, (continued).

Location	Date	Number Specimens	Estimated Percent of Combined Gut Contents: Crustacea	Immature Insecta	Adult Insecta	Other	Predominate Organisms
Sockeye-Fall							
Susitna #3	9/24	1	5	10	85	0	Unidentified adult insect fragments; Diptera Chironomid larvae
Susitna #8	9/23	2	1	9	90	0	Adult Diptera
Susitna #8B	9/23	12	<1	3	>95	<1	Adult Hymenoptera, Diptera, and Lepidoptera
Susitna #11	9/21	2	5	95	0	0	Diptera Chironomid pupae and larvae
Susitna #19	9/21	1	10	50	40	0	Diptera Chironomid larvae; unidentified adult insect fragments

APPENDIX II

Tables in the following appendix include data on water quality and quantity within the mainstem Susitna River and its clearwater sloughs and tributaries collected by ADF&G and USGS water quality data collected at established gaging stations.

Appendix II
Table 1. Susitna River discharge at Gold Creek (USGS provisional data) 1977.

	May		June		July		August		September	
Day	Gauge Height	Discharge	Gauge Height	Discharge	Gauge Height	Discharge	Gauge Height	Discharge	Gauge Height	Discharge
1			11.49	30,900		35,000	10.60	24,200	8.00	10,600
2			12.19	36,700		32,000	10.89	26,200	8.03	10,700
3			12.44	39,000		32,000	10.49	23,400	8.02	10,700
4			12.52	39,700		30,000	10.17	21,500	7.97	10,500
5			12.34	38,100		30,000	10.20	21,700	7.81	9,840
6			11.77	33,200		28,000	10.49	23,400	7.72	9,520
7			11.54	31,300		27,000	10.48	23,400	7.82	9,880
8			11.56	31,500		27,000	10.12	21,200	8.20	11,400
9			11.61	31,900		27,000	9.80	19,300	8.48	12,500
10			11.93	34,400		28,000	9.90	19,900	8.05	10,800
11			12.39	38,500		28,000	9.98	20,400	8.81	14,000
12			13.02	44,200		30,000	10.12	21,200	9.34	16,700
13			13.67	51,400		30,000	9.74	18,900	9.38	16,900
14			13.78	52,600		32,000	9.58	18,000	9.37	16,800
15			13.78	52,600		32,000	9.94	20,100	9.01	15,000
16			13.58	50,400		30,000	10.01	20,600	9.13	15,600
17	8.72	13,600	13.07	44,800		28,000	9.78	19,200	8.90	14,500
18	9.06	15,300	12.82	42,400		26,000	9.69	18,600	8.87	14,400
19	10.37	22,700	12.67	41,000		24,000	9.66	18,500	8.59	13,000
20	10.92	26,400	12.22	37,000	10.31	22,400	9.67	18,500	8.41	12,200
21	10.19	21,600	11.93	34,400	10.28	22,200	9.76	19,100	8.84	14,200
22	9.56	17,900	11.75	33,000	10.22	21,800	9.93	20,100	8.93	14,600
23	9.33	16,600		33,000	10.41	23,000	10.18	21,600	8.95	14,800
24	9.38	16,900		34,000	10.39	22,800	10.16	21,500	8.60	13,000
25	9.36	16,800		36,000	10.14	21,300	9.72	18,800	8.21	11,400
26	9.61	18,200		38,000	10.00	20,500	9.19	16,000	7.95	10,400
27	10.22	21,800		40,000	9.84	19,500	8.88	14,400	7.81	9,840
28	10.54	23,800		42,000	9.87	19,700	8.68	13,400	8.10	11,000
29	11.18	28,400		40,000	9.90	19,900	8.41	12,200	8.31	11,800
30	11.76	33,100		38,000	9.85	19,600	8.09	11,000	8.48	12,500
31	11.34	29,700			10.11	21,200	7.85	10,000		

Appendix II Table 2. Water quality data and juvenile salmon surveys in sloughs and clearwater tributaries of the Susitna River between the Chulitna River and Portage Creek, Devils Canyon Project, 1977.

Date	Time	Weather Conditions	Water Conditions	Temperature °C Air	Temperature °C Water	D.O. (PPM)	pH	Specific Conductance (uMHOS/CM)	Gage Height (M)	Number of Fry Observed
Slough #1 (26N 05W 11DAD)										
7/18	1250	Sunny	Silty	22.0	15.0	8.1	5.9	—	.90	—
7/30	1425	Sunny	Silty	22.0	11.0	8.4	—	100	.38	—
8/5	1340	Sunny	Silty	23.5	13.0	9.7	6.5	100	.76	—
8/12	1535	Cloudy	Silty	16.0	11.5	8.4	6.6	290	.76	190
8/22	1620	Cloudy	Silty	17.5	14.0	8.9	—	100	.70	150
9/24	1530	Sunny	Clear	16.0	6.0	9.4	6.0	125	.31	14
Slough #2 (26N 05W 02CDD)										
7/18	1330	Sunny	—	22.0	11.5	8.7	6.2	—	.26	500
7/30	1450	Sunny	—	21.0	10.0	8.6	—	150	.16	4
8/5	1440	Sunny	—	20.0	9.0	8.4	6.5	190	.17	100
8/12	1615	Sunny	—	18.5	10.0	6.7	7.1	130	.18	60
8/22	1520	Cloudy	—	18.0	10.0	8.0	—	130	.16	125
9/10	1130	Rain	—	10.0	8.0	10.1	6.0	102	—	—
Slough #3 (27N 05W 35CCB)										
7/17	1800	Sunny	Silty	26.5	19.5	8.3	5.9	—	—	—
7/30	1600	Sunny	Clear	19.0	13.5	7.1	—	125	—	2
8/5	1745	Sunny	Clear	19.5	11.0	7.0	5.6	100	—	100
8/12	1800	Sunny	Clear	20.5	10.0	5.4	6.2	110	—	465
8/22	1800	Sunny	Clear	17.0	13.0	5.6	—	100	—	300
9/10	1100	Rain	Silty	10.2	6.8	6.6	5.5	72	—	—
9/24	1245	Sunny	Clear	10.0	5.3	8.2	5.5	85	—	350
Slough #4 (27N 05W 25CCC)										
7/17	1725	Sunny	Clear	22.0	17.0	7.5	6.5	—	.88	1,000+
8/14	1800	Rain	Clear	17.5	15.0	9.1	6.0	100	.82	500
9/10	0900	Rain	Silty	9.0	10.1	11.1	6.0	78	.61	—
9/24	1120	Sunny	Clear	7.0	6.2	10.9	5.0	85	.82	52
Slough #5 (27N 05W 01CCA)										
7/16	1050	—	Silty	23.0	17.0	4.3	7.3	—	.58	—
7/27	1800	Sunny	Rusty	22.0	18.5	5.4	6.3	120	—	5
8/6	1200	Rain	—	16.0	15.0	7.2	6.0	105	.26	10
8/13	0845	Rain	—	14.0	13.5	2.7	6.0	180	.13	—
8/21	1330	Rain	—	21.0	14.0	1.2	—	240	.11	—
8/29	1730	Partly Sunny	—	17.0	15.0	7.6	6.5	100	—	7
9/9	1915	Overcast	Algae	11.0	12.5	10.8	6.0	88	—	90
9/23	1720	Overcast	—	11.0	9.9	11.0	5.0	68	—	4
Slough #6 (27N 05W 01BAD)										
7/16	1115	—	—	23.5	14.0	9.2	7.0	—	.85	—
7/27	1715	Sunny	Rusty	24.0	22.0	6.2	6.7	100	.36	100
8/6	1230	Rain	Rusty	19.5	14.0	5.6	5.0	100	.57	5
8/13	0800	Rain	Rusty	13.5	12.0	4.8	6.0	110	.42	12
8/21	1315	Rain	Rusty	21.0	16.0	7.2	—	100	.39	42
8/29	1700	Partly Sunny	Rusty & Algae	18.5	17.2	9.8	6.0	130	.33	—
9/9	1850	Overcast	Rusty & Algae	11.0	12.5	10.8	6.0	88	—	—
9/23	1650	Overcast	—	11.0	8.3	10.4	6.0	38	.36	—

Appendix II Table 2. Water quality data and juvenile salmon surveys in sloughs and clearwater tributaries of the Susitna River between the Chulitna River and Portage Creek, Devils Canyon Project, 1977 (continued).

Date	Time	Weather Conditions	Water Conditions	Temperature °C Air	Temperature °C Water	D.O. (PPM)	pH	Specific Conductance (uMHOS/CM)	Gage Height (M)	Number of Fry Observed
Slough #7 (28N 05W 12DCA)										
7/13	1530	Sunny	Clear	20.0	14.0	8.4	8.1	—	—	—
8/4	1500	Sunny	Clear	16.0	12.0	11.2	—	100	—	—
8/11	2025	Sunny	Clear	16.0	17.0	9.4	6.0	130	—	12
8/19	1930	Sunny	Clear	17.5	16.0	8.1	—	100	—	10
8/29	1530	Partly Sunny	Clear	18.0	17.0	11.0	6.0	90	—	30
9/9	1815	Overcast	Clear	11.0	14.5	10.0	5.0	100	—	80
9/23	1550	Overcast	Clear	11.0	9.0	12.2	5.0	100	—	—
Slough #8 (28N 04W 07BCB and 07BCC)										
7/13	1500	Sunny	Clear	18.0	12.0	9.2	7.8	—	.36	3,500
7/27	1510	Sunny	Clear	23.0	13.5	9.1	7.3	70	.26	—
8/4	1435	Rain	—	16.0	9.5	9.2	—	65	—	—
8/11	1915	Sunny	Clear	16.0	9.0	10.4	6.2	90	.26	670
8/19	1850	Sunny	Clear	18.0	11.0	9.2	—	102	.25	400
8/29	1500	Sunny	Clear	18.5	11.5	10.3	6.0	70	.24	—
9/9	1800	Overcast	—	12.5	8.8	10.7	—	100	.21	1,200
9/23	1500	Overcast	—	12.0	7.8	9.8	5.0	100	.20	35
Slough #8A (30N 03W 20C, 29BBB and 30A)										
7/12	1730	Sunny	Clear	23.0	17.0	10.1	7.6	—	—	—
8/3	1730	Fair	Silty	19.0	16.0	8.4	6.8	140	—	1,500
8/11	1400	Sunny	Clear	17.5	17.0	7.1	6.5	175	—	—
8/19	1400	Sunny	Clear	17.0	14.0	8.0	—	45	—	2,000
8/29	0825	Partly Cloudy	Clear	5.0	10.0	10.3	5.8	118	—	90
9/9	1350	Partly Cloudy	Clear	12.5	12.5	10.1	6.0	145	—	135
9/22	1700	Overcast	—	9.0	7.1	10.3	5.6	75	—	—
Slough #8B (29N 04W 02CBA)										
7/13	1105	Sunny	Silty	17.0	11.0	8.1	7.9	—	—	1,000
8/4	1000	Sunny	Silty	14.0	8.5	9.2	6.5	100	—	—
8/11	1515	Sunny	Clear	19.5	13.0	8.4	6.7	170	—	560
8/19	1510	Sunny	Clear	17.0	12.0	7.7	—	200	—	650
8/29	0930	Partly Cloudy	Clear	10.0	7.2	11.2	5.8	110	—	350
9/9	1510	Partly Cloudy	Clear	14.0	9.9	8.8	6.0	135	—	—
9/23	1100	Sunny	Clear	6.5	5.0	10.8	5.6	68	—	25
Slough #8C (29N 04W 02CCC)										
7/13	1140	Sunny	Clear	21.5	9.5	7.2	7.8	—	—	500
8/4	1100	Sunny	Clear	16.0	7.5	7.5	6.0	80	—	30
8/11	1625	Sunny	Clear	16.5	11.0	7.2	6.9	70	—	34
8/19	1540	Sunny	Clear	16.0	11.0	6.8	—	130	—	850
8/29	1020	Partly Cloudy	Clear	11.0	6.9	9.0	5.5	60	—	—
9/9	1540	Partly Cloudy	Clear	14.0	8.8	7.5	5.5	60	—	—
9/23	1130	Sunny	Clear	10.0	7.0	10.8	5.6	45	—	7
Slough #8D (29N 04W 11BBA)										
7/13	1200	Sunny	Clear	23.0	11.0	11.0	7.2	—	—	—
8/4	1130	Sunny	Clear	17.0	8.0	9.2	5.0	50	—	4
8/11	1640	Sunny	Clear	18.0	14.0	8.0	6.9	90	—	—
8/19	1600	Sunny	Clear	15.0	13.0	8.6	—	130	—	40
8/29	1045	Partly Cloudy	Clear	13.2	8.0	10.8	5.8	58	—	50
9/9	1600	Partly Cloudy	Clear	13.0	9.9	9.8	5.5	72	—	750
9/23	1210	Sunny	Clear	12.2	6.5	10.3	5.6	55	—	1

Appendix II Table 2. Water quality data and juvenile salmon surveys in sloughs and clearwater tributaries of the Susitna River between the Chulitna River and Portage Creek, Devils Canyon Project, 1977 (continued).

Date	Time	Weather Conditions	Water Conditions	Temperature °C Air	Temperature °C Water	D.O. (PPM)	pH	Specific Conductance (uMHOS/CM)	Gage Height (M)	Number of Fry Observed
Slough A (30N 04W 25DBB)										
7/13	1020	Sunny	Clear	17.5	9.0	9.9	7.7	—	—	—
8/3	1830	Sunny	Clear	24.0	12.0	7.0	6.3	110	—	20
8/11	1415	Sunny	Clear	15.5	14.0	7.1	6.9	110	—	27
8/19	1415	Sunny	Clear	20.0	13.0	7.1	—	200	—	85
8/29	0900	Partly Cloudy	Clear	11.0	9.8	11.3	5.0	110	—	—
9/9	1400	Partly Cloudy	Clear	12.2	9.9	12.4	—	85	—	—
9/23	1010	Sunny	Clear	5.2	6.0	9.8	5.6	58	—	3
Slough #9 (30N 03W 16BD)										
7/12	1600	Clear	Silty	20.0	15.5	9.6	8.0	—	.39	—
7/27	0850	Cloudy	Clear	15.0	8.0	8.9	6.7	190	.38	40
8/3	1630	Clear	Silty	17.0	13.0	8.8	7.0	115	.39	—
8/11	1200	Clear	Clear	17.0	11.0	7.7	6.8	175	.38	140
8/19	1150	Clear	Clear	17.0	10.0	8.0	—	210	.38	700
8/29	1015	Rain	Clear	15.0	12.0	7.0	5.4	—	.38	600
9/9	1230	Overcast	Clear	11.0	8.0	9.9	6.0	135	.36	250
9/22	1500	Clear	Clear	10.5	7.8	10.8	5.6	100	.43	78
Slough #10 (31N 03W 36AAB)										
7/8	1115	Clear	Clear	22.0	7.0	11.0	6.8	—	.68	—
7/12	1445	Clear	Clear	22.0	11.5	9.1	7.8	—	.81	—
7/27	0850	Partly Cloudy	Clear	19.0	7.0	9.7	6.5	150	.71	1,000
8/3	1135	Clear	Clear	16.0	7.5	9.4	6.5	100	.88	1,000
8/19	0900	Clear	Clear	12.0	6.0	8.5	6.0	140	.65	1,200
8/26	1415	Rain	Clear	13.0	4.0	7.0	6.4	—	.52	2,500
9/9	1015	Overcast	Clear	9.0	5.1	9.6	6.0	145	.30	250
Slough #11 (31N 02W 30AAB, 20B, 20C)										
7/1	1500	Clear	Clear	23.0	10.0	—	—	—	1.38	—
7/12	1350	Clear	Clear	23.0	11.0	10.6	7.8	—	1.24	3,000
7/27	1745	Partly Cloudy	Clear	27.0	12.0	11.0	7.9	—	<1.00	8,000
8/2	2010	Clear	Silty	14.0	9.0	9.2	7.5	—	<1.00	—
8/3	1710	Mostly Sunny	Silty	28.0	12.0	11.0	7.3	180	<1.00	8,000
8/10	1600	Partly Cloudy	Silty	16.5	11.0	10.0	7.0	155	<1.00	8,000
8/17	1530	Clear	Silty	16.0	9.0	11.0	—	150	1.08	8,000
8/28	1820	Clear	Clear	13.0	8.5	9.8	5.0	170	.92	10,000
9/8	1900	Clear	Clear	10.5	5.2	10.8	5.5	190	.89	2,000
9/22	1215	Clear	Clear	8.5	6.2	11.5	5.6	105	1.00	87
Slough #12 (31N 02W 19DCD)										
7/1	1400	Mostly Cloudy	Silty	22.0	11.0	—	—	—	—	—
7/12	1330	Clear	Silty	23.0	—	9.1	8.2	—	.95	—
7/27	1545	Partly Cloudy	Silty	20.0	9.0	8.0	7.6	150	.85	30
8/2	1945	Clear	Silty	14.0	9.5	9.2	6.8	200	<1.00	—
8/3	1540	Mostly Sunny	Clear	20.0	11.0	9.0	7.5	200	.94	175
8/10	1540	Clear	Silty	17.5	13.0	8.9	7.4	170	.85	10
8/17	1600	Rain	Silty	15.0	10.0	10.0	—	175	.80	—
8/23	—	—	—	—	—	—	—	—	—	10
8/28	1750	Clear	—	15.0	10.0	10.0	6.0	158	—	10
9/8	1830	Rain	Silty	10.0	9.1	11.1	6.0	160	.51	9
9/22	1200	Clear	Clear	7.0	6.0	11.0	6.5	175	.64	0

Appendix II Table 2. Water quality data and juvenile salmon surveys in sloughs and clearwater tributaries of the Susitna River between the Chulitna River and Portage Creek, Devils Canyon Project, 1977 (continued).

Date	Time	Weather Conditions	Water Conditions	Temperature °C Air	Temperature °C Water	D.O. (PPM)	pH	Specific Conductance (uMHOS/CM)	Gage Height (M)	Number of Fry Observed
Slough #13 (31N 02W 19DAB)										
7/1	1340	Mostly Cloudy	Clear	24.0	7.0	—	—	—	—	—
7/12	1310	Clear	Clear	26.0	—	11.1	7.7	—	.26	—
7/28	1210	Clear	Clear	25.0	7.0	10.0	7.4	180	.25	75
8/2	1900	Clear	Clear	18.0	7.5	9.6	6.5	185	.27	400
8/3	1800	Partly Cloudy	Clear	25.0	7.0	9.0	7.5	180	.26	75
8/10	1500	Clear	Clear	20.0	9.0	8.8	6.9	205	.25	310
8/17	1630	Clear	Clear	15.0	7.0	11.0	—	170	.25	400
8/28	1725	Clear	Clear	15.0	7.0	9.5	6.0	160	.25	400
9/8	1800	Clear	Clear	10.0	7.0	11.7	6.0	130	.29	120
9/22	1130	Clear	Clear	8.5	5.0	11.4	6.0	105	.25	5
Slough #14 (31N 02W 19AAA)										
7/1	1300	Mostly Cloudy	Clear	26.0	15.0	—	—	—	.58	—
7/12	1240	Clear	Clear	26.0	—	7.1	7.4	—	.43	—
7/28	1305	Clear	Clear	26.0	15.0	9.0	6.9	85	.35	—
7/29	0950	Clear	Clear	—	—	—	—	—	—	500
8/2	1800	Clear	Clear	18.0	13.5	7.1	6.3	85	—	2,000
8/3	1900	Partly Cloudy	Clear	18.0	11.0	6.8	6.0	80	.42	—
8/10	1435	Clear	Clear	18.0	15.0	7.8	6.0	95	.35	100
8/19	0830	Clear	Clear	12.0	10.5	7.8	6.0	78	.28	120
8/26	1530	Rain	—	10.0	14.0	—	6.5	—	.23	500
8/28	1645	Clear	Clear	13.0	12.0	8.0	6.5	85	.65	100
9/8	1720	Overcast	Cloudy	12.0	8.9	10.8	8.5	60	1.15	20
9/22	1030	Clear	Clear	7.5	6.5	10.3	5.6	34	.50	10
Slough #15 (31N 02W 17CAC)										
7/1	1235	Mostly Cloudy	Clear	25.0	15.0	—	—	—	.88	—
7/12	1215	Clear	Silty	22.5	14.0	8.3	8.4	—	.66	—
7/26	1745	Cloudy	Silty	18.5	13.5	7.3	6.7	70	.53	1,500
8/2	1400	Mostly Cloudy	Silty	17.0	12.5	7.8	6.4	105	.93	2,000
8/10	1145	Cloudy	Silty	22.5	12.5	7.2	6.4	105	.55	—
8/16	2000	Clear	Silty	16.5	14.0	6.8	6.0	78	.53	1,000
8/28	1515	Clear	Clear	16.0	8.8	8.8	6.0	58	.80	155
9/8	1410	Overcast	Clear	7.0	10.6	11.2	5.5	30	—	20
9/21	1630	Rain	Clear	7.5	6.5	10.8	5.6	18	.29	19
10/5		Clear	Clear (Ice Cover)						.09	50
Slough #16 (31N 02W 17AAC)										
7/1	1210	Partly Cloudy	Clear	21.5	9.0	—	—	—	.68	—
7/11	1600	Clear	Clear	—	—	9.0	7.2	—	.26	—
7/26	1710	Mostly Cloudy	Clear	17.5	12.5	9.5	6.7	50	.17	9,000
8/2	1248	Cloudy	Silty	16.5	11.5	10.4	7.6	95	.72	—
8/3	1200	Partly Cloudy	Silty	21.0	11.5	—	—	—	.48	99
8/10	1100	Cloudy	Clear	21.0	11.0	10.8	6.6	80	.18	600
8/16	1925	Clear	Clear	16.0	11.5	8.7	6.0	75	.17	—
8/28	1500	Clear	Clear	17.0	10.0	9.5	6.0	75	—	—
9/8	1340	Overcast	Clear	10.5	7.2	11.6	6.0	50	.08	300
9/21	1500	Rain	Clear	8.0	5.5	10.2	5.6	10	—	18
10/5	—	Clear	Clear (Ice Cover)	—	—	—	—	—	.13	150

Appendix II Table 2. Water quality data and juvenile salmon surveys in sloughs and clearwater tributaries of the Susitna River between the Chulitna River and Portage Creek, Devils Canyon Project, 1977 (continued).

Date	Time	Weather Conditions	Water Conditions	Temperature °C Air	Temperature °C Water	D.O. (PPM)	pH	Specific Conductance (uMHOS/CM)	Gage Height (M)	Number of Fry Observed
Slough #17 (31N 02W 09DBD)										
6/14	0030	Clear	Silty	—	—	—	—	—	1.03	—
6/30	2345	Clear	Silty	9.0	6.0	9.0	6.9	140	.84	—
7/7	1740	Mostly Sunny	Silty	19.0	10.0	—	—	—	.71	—
7/11	1710	Clear	Silty	—	—	10.8	7.5	—	.94	50
7/26	1315	Clear	Clear	20.0	8.5	9.8	6.8	90	.84	900
8/2	1145	Clear	Silty	17.0	8.0	10.2	6.2	85	1.12	1
8/10	1000	Cloudy	Clear	20.0	7.0	8.4	6.0	95	.83	230
8/16	1830	Clear	Clear	16.0	9.5	9.9	6.3	100	.82	3
8/28	1100	Clear	Clear	17.0	6.5	8.5	5.5	58	.75	15
9/8	1200	Rain	Clear	8.0	4.5	10.8	6.5	50	.17	10
9/21	1400	Rain	Clear	7.5	4.5	10.8	5.9	70	.37	—
10/5	—	Clear	Clear (Ice Cover)	—	—	—	—	—	.12	6
Slough #18 (31N 02W 10CBC)										
7/7	1725	Mostly Sunny	Clear	19.0	15.0	9.7	7.2	—	.51	—
7/11	1720	Clear	Clear	20.0	13.5	9.1	7.5	—	.65	—
7/26	1245	Clear	Clear	25.0	12.0	7.8	7.3	140	.63	1,000
8/2	1125	Clear	Clear	15.0	8.5	8.2	6.7	145	.98	125
8/10	0945	Cloudy	Clear	20.5	9.0	7.0	6.4	115	.63	60
8/16	1835	Clear	Clear	15.0	12.0	8.4	—	125	.60	100
8/28	1015	Clear	Clear	13.0	7.0	5.4	5.5	80	—	—
9/8	1230	Rain	Clear	9.5	8.2	9.7	5.5	88	.48	12
9/21	1330	Rain	Clear	7.5	6.0	10.4	6.0	100	.52	3
10/5	—	Clear	Clear (Ice Cover)	—	—	—	—	—	.47	50
Slough #19 (31N 02W 10DBD)										
6/30	2235	Mostly Sunny	Clear	—	—	10.0	7.2	125	.74	—
7/7	1700	—	Clear	20.0	12.0	—	—	—	.43	—
7/11	1745	Clear	Clear	15.0	18.5	11.4	6.7	—	.54	—
7/26	1210	Mostly Cloudy	Clear	20.0	8.5	9.5	7.7	150	.54	2,000
8/2	1000	Partly Sunny	Clear	11.5	7.5	10.8	6.6	130	.78	2,000
8/10	0845	Cloudy	Clear	17.0	9.0	8.6	6.4	140	.53	200
8/16	1750	Cloudy	Clear	18.5	10.0	8.3	6.8	130	.53	800
8/27	2010	Cloudy	Clear	12.0	8.5	9.0	6.9	100	.19	100
9/7	1935	Rain	Clear	9.0	7.0	8.9	6.5	100	.17	—
9/21	1100	Rain	Clear	6.5	5.0	10.8	5.5	100	.17	11
10/5	—	Clear	Clear (Ice Cover)	—	—	—	—	—	.11	500
Slough #20 (31N 02W 11BBD)										
6/30	2130	Mostly Sunny	Silty	14.0	9.0	10.0	7.8	70	.33	—
7/7	1630	—	Silty	24.0	12.0	—	—	—	.39	—
7/11	1817	Clear	Clear	19.0	12.0	10.4	7.5	—	.37	—
7/25	2045	Mostly Cloudy	Silty	13.0	10.0	10.0	7.9	75	.34	56
8/1	1855	Mostly Sunny	Silty	15.5	11.5	10.4	7.0	125	.56	—
8/9	1945	Cloudy	Clear	16.5	12.5	9.6	6.7	140	.31	700
8/16	1725	Partly Cloudy	Silty	18.0	13.0	9.6	7.2	180	—	700
8/27	1945	Mostly Sunny	Silty	12.5	11.5	10.3	6.0	90	—	1,000
9/7	1910	Rain	Clear	9.5	7.2	9.8	6.0	60	.38	—
9/20	1910	Rain	Clear	6.0	5.1	12.2	—	60	.77	19
10/5	—	Clear	Clear (Ice Cover)	—	—	—	—	—	.44	—

Appendix II Table 2. Water quality data and juvenile salmon surveys in sloughs and clearwater tributaries of the Susitna River between the Chulitna River and Portage Creek, Devils Canyon Project, 1977 (continued).

Date	Time	Weather Conditions	Water Conditions	Temperature °C Air	Temperature °C Water	D.O. (PPM)	pH	Specific Conductance (uMHOS/CM)	Gage Height (M)	Number of Fry Observed
<u>Slough #21</u> (32N 02W 36CCC)										
6/30	1940	Mostly Sunny	Silty	19.5	7.0	8.0	7.9	175	.52	—
7/7	1530	—	Silty	14.0	24.0	—	—	—	.25	—
7/11	2010	Clear	Clear	21.5	8.0	10.2	7.9	—	.30	—
7/25	1945	Clear	Clear	19.5	8.0	8.9	8.0	180	.28	—
8/1	1710	Mostly Cloudy	Silty	17.0	10.0	9.6	6.8	200	.43	33
8/9	1800	Mostly Cloudy	Silty	—	9.0	9.9	7.6	245	.26	385
8/16	1635	Clear	Silty	18.0	12.0	8.5	7.7	210	.29	600
8/27	1820	Partly Cloudy	Clear	17.0	7.5	10.2	6.7	170	—	180
9/7	1730	Rain	Clear	11.5	7.5	10.4	6.0	135	—	—
9/20	1800	Rain	Clear	7.0	3.9	11.6	5.6	145	—	15
10/5	—	Clear	Clear (Ice Cover)	—	—	—	—	—	.01	350
<u>Whisker's Creek</u> (26N 05W 03AAC)										
<u>Downstream Gage</u>										
7/17	1820	—	Silty	22.0	15.5	9.0	6.2	—	—	—
7/30	1530	—	Clear	21.5	17.0	8.9	—	95	.44	—
8/5	1525	—	Silty	17.0	13.0	10.8	6.0	100	.53	—
8/12	1655	—	Silty	17.0	14.0	9.8	7.0	80	.52	—
8/22	1700	—	Silty	17.5	16.0	9.0	—	70	.48	200
9/10	1000	Rain	Clear	9.5	9.1	10.8	5.5	30	.13	—
9/24	—	—	—	—	—	—	—	—	.25	—
<u>Upstream Gage</u>										
7/17	1825	—	Clear	25.0	15.5	9.3	5.3	—	—	—
7/30	1540	—	Clear	20.0	16.0	10.8	—	60	.76	1,000
8/5	1535	—	Clear	17.5	14.5	9.5	5.6	90	.78	—
8/12	1700	—	Clear	19.5	14.0	9.5	6.3	60	.78	500
8/22	1715	—	Clear	17.0	15.5	9.9	—	35	.76	200
9/10	—	Rain	Clear	—	—	—	—	—	.78	—
9/24	1320	—	Clear	8.0	7.0	11.2	5.5	38	.69	10
<u>McKenzie Creek</u> (29N 04W 32ABA)										
7/13	1350	Sunny	Clear	21.0	11.0	11.2	8.0	—	—	30,000
7/27	1405	Sunny	Clear	20.5	10.5	10.8	7.7	105	—	12,500
8/4	1310	Sunny	Clear	16.0	8.5	11.8	6.9	100	—	2,000
8/11	1800	Sunny	Clear	17.0	11.0	9.8	5.9	125	—	1,800
8/19	1800	Sunny	Clear	16.0	10.0	10.3	—	105	—	1,300
8/29	1200	Overcast	Clear	12.0	8.5	13.8	5.2	130	—	3,500
9/9	1650	Overcast	Clear	13.5	9.9	10.8	5.5	78	—	2,500
9/23	1340	Overcast	Clear	12.5	7.3	10.8	5.6	70	—	20
<u>Chase Creek</u> (27N 05W 12BCC)										
7/16	1130	Sunny	Clear	23.0	16.0	12.8	7.0	—	—	—
8/6	1330	Sunny	Clear	21.0	17.0	9.6	6.0	60	—	10,000
8/13	0905	Sunny	Clear	15.0	13.0	8.6	6.0	78	—	5,000
8/21	1400	Sunny	Clear	21.0	18.0	8.1	—	50	—	5,000
8/29	1800	Overcast	Clear	19.0	14.5	8.9	6.5	48	—	—
9/9	1935	Overcast	Clear	11.6	11.2	10.8	5.5	45	—	—
9/23	1800	Overcast	Clear	10.5	11.2	7.5	5.0	52	—	—

Appendix II Table 2. Water quality data and juvenile salmon surveys in sloughs and clearwater tributaries of the Susitna River between the Chulitna River and Portage Creek, Devils Canyon Project, 1977 (continued).

Date	Time	Weather Conditions	Water Conditions	Temperature °C Air	Temperature °C Water	D.O. (PPM)	pH	Specific Conductance (uMHOS/CM)	Gage Height (M)	Number of Fry Observed
Lane Creek (28N 05W 12DAA)										
7/13	1450	Sunny	Clear	18.0	11.0	9.6	7.7	—	—	—
7/27	1535	Sunny	Clear	24.5	12.0	10.9	8.0	60	—	—
8/4	1420	Sunny	Clear	17.0	11.0	10.4	5.4	60	—	—
8/11	2000	Sunny	Clear	17.0	11.0	10.0	6.2	90	—	—
8/19	1900	Sunny	Clear	18.0	12.0	9.0	—	90	—	—
8/29	1430	Overcast	Clear	24.0	10.5	10.7	6.0	62	—	—
9/9	1730	Overcast	Clear	13.0	9.0	11.4	—	99	—	—
9/23	1520	Overcast	Clear	14.0	6.2	10.6	5.0	75	—	—
Fourth of July Creek (30N 03W 03DAC)										
7/29	1140	Clear	Clear	23.0	15.0	9.0	7.3	30	—	—
8/3	1300	Clear	Clear	22.0	16.0	9.0	7.4	125	—	5,000
8/11	0945	Clear	Clear	14.0	13.0	9.5	7.1	50	—	—
8/19	1030	Clear	Clear	15.5	14.0	9.2	—	45	—	—
8/26	1230	Rain	Clear	12.0	12.0	6.6	8.0	—	—	18
8/28	2010	Partly Cloudy	Clear	12.5	11.0	9.8	5.5	24	—	—
9/9	1120	Cloudy	Turbid	10.0	9.1	11.6	5.5	46	—	—
9/22	1330	Clear	Turbid	9.0	7.0	11.7	5.6	31	—	7
Gold Creek (31N 02W 20BAD)										
6/14	2100	Rain	Turbid	11.0	4.0	12.0	7.8	60	—	—
7/21	1200	Partly Cloudy	Clear	23.0	10.0	10.0	7.8	160	—	—
8/17	1400	Rain	Clear	16.5	11.0	12.0	—	200	—	—
9/22	1030	Clear	Clear	—	—	—	—	—	—	28
Indian River (31N 02W 09CDA)										
7/29	1140	Clear	Clear	20.0	12.0	11.0	7.1	50	—	—
8/18	1530	Partly Cloudy	Clear	17.0	12.0	11.0	7.5	40	—	581
8/28	1430	Partly Cloudy	Clear	17.0	12.0	11.2	6.0	43	—	—
9/8	1300	Cloudy	Clear	10.0	7.8	10.0	5.9	40	—	—
Portage Creek (32N 01W 26CDB)										
7/7	1200	Clear	Clear	27.0	10.0	14.0	7.5	—	—	—
7/28	1645	Clear	Clear	23.0	13.0	10.0	7.8	80	—	—
8/25	1200	—	Clear	—	11.0	—	—	—	—	6

Appendix II

Table 3. Thermograph set in Rabideux Creek, upper sub-area; daily maximun and minimum water temperature, Devils Canyon Project, 1977.

	Temp. °C			Temp. °C			Temp. °C			Temp. °C			Temp. °C	
Date	Max.	Min.	Date	Max.	Min.	Date	Max.	Min.	Date	Max.	Min.	Date	Max.	Min.
5/25	8.2	8.2	6/27	14.7	14.3	7/30	16.0	15.6	9/1	11.0	10.9	10/5	4.0	3.0
26	10.0	8.2	28	14.3	14.2	31	15.6	15.3	2	10.9	10.9	6	3.9	3.5
27	10.0	9.8	29	15.5	14.2	8/1	15.2	14.8	3	10.8	10.7	7	4.0	3.5
28	11.7	10.0	30	15.2	14.1	2	14.8	14.7	4	10.7	10.0	8	4.0	3.9
29	10.8	9.2	7/1	15.6	14.1	3	16.0	14.8	5	10.0	10.0	9	4.1	4.0
30	10.1	9.2	2	14.8	13.7	4	15.8	15.4	6	10.0	10.0	10	4.5	4.1
31	11.7	10.1	3	14.4	13.0	5	15.4	14.6	7	10.0	10.0	11	5.5	4.5
6/1	12.6	11.3	4	13.1	13.0	6	15.3	14.6	8	10.0	10.0	12	5.7	5.5
2	14.1	12.6	5	13.2	13.0	7	15.2	15.0	9	10.0	10.0	13	5.7	3.7
3	14.8	13.0	6	13.9	13.0	8	15.1	14.9	10	10.0	10.0	14	4.0	3.9
4	13.3	10.8	7	15.3	13.2	9	16.0	15.1	11	10.0	10.0	15	4.0	3.9
5	10.8	10.4	8	16.3	13.2	10	15.9	15.0	12	10.0	10.0	16	4.0	3.9
6	10.7	10.4	9	17.2	14.2	11	15.0	14.0	13	9.9	9.9	17	4.0	3.8
7	11.0	10.8	10	17.9	14.5	12	14.0	13.7	14	9.9	9.9	18	3.8	3.2
8	12.3	10.0	11	18.8	15.1	13	14.8	13.8	15	9.9	8.8	19	3.2	2.5
9	12.8	12.3	12	18.8	15.0	14	14.7	14.7	16	8.8	8.3	20	2.5	2.2
10	13.6	12.8	13	16.0	15.0	15	14.7	14.7	17	8.3	8.3	21	2.2	1.8
11	13.6	13.6	14	15.5	15.0	16	14.7	14.7	18	8.3	8.3	22	1.8	1.7
12	13.6	13.6	15	15.0	14.0	17	14.7	14.5	19	8.3	8.3	23	1.8	1.7
13	13.6	13.6	16	17.0	14.0	18	14.5	14.4	20	8.3	7.7			
14	14.4	13.6	17	16.8	14.0	19	14.6	14.4	21	7.7	7.7			
15	14.7	14.5	18	16.5	14.0	20	15.5	14.4	22	7.7	7.5			
16	14.8	14.8	19	15.8	13.9	21	15.5	14.3	23	7.5	7.2			
17	14.8	14.5	20	14.8	13.9	22	15.5	14.5	24	7.2	6.7			
18	14.5	13.3	21	14.9	14.7	23	14.8	13.5	25	N/A	N/A			
19	13.3	13.2	22	15.2	13.7	24	14.0	13.9	26	N/A	N/A			
20	14.2	13.5	23	15.3	13.0	25	13.9	13.7	27	7.5	7.5			
21	14.2	14.0	24	16.0	13.0	26	13.7	13.0	28	7.5	7.2			
22	14.0	13.6	25	15.3	14.4	27	13.0	12.4	29	7.2	6.8			
23	13.3	13.0	26	15.3	14.4	28	12.4	11.5	30	6.8	5.5			
24	14.4	13.0	27	15.3	14.3	29	11.3	11.3	10/1	5.5	3.0			
25	13.9	13.8	28	16.4	14.3	30	11.3	11.0	2	3.0	2.4			
26	14.9	13.8	29	16.0	15.6	31	11.0	11.0	3	2.5	2.4			
									4	3.0	2.5			

Appendix II

Table 4. Thermograph set in Montana Creek, upper sub-area; daily maximum and minimum water temperature, Devils Canyon Project, 1977.

Date	Temp. °C Max.	Min.	Date	Temp. °C Max.	Min.	Date	Temp. °C Max.	Min.	Date	Temp. °C Max.	Min.	Date	Temp. °C Max.	Min.
5/25	3.0	2.8	6/27	10.1	9.5	8/17	13.2	12.5	9/19	6.0	5.5	11/1	0.2	0.1
26	5.1	3.2	28	10.1	9.3	18	13.2	12.0	20	5.8	5.5	2	0.1	0.1
27	5.2	2.9	29	10.5	10.0	19	13.8	12.3	21	6.5	5.6	3	0.1	0.0
28	6.5	4.7	30	10.3	10.1	20	13.7	12.6	22	6.8	5.0	4	0.0	0.0
29	3.9	3.0	7/ 1	11.1	9.8	21	13.6	12.6	23	5.6	4.7	5	0.0	0.0
30	4.9	3.0	2	11.1	10.5	22	13.3	12.7	9/24-10/24	N/A	N/A	6	0.0	0.0
31	5.8	4.0	3	10.5	10.0	23	13.7	13.0	10/ 5	3.4	3.0			
6/ 1	5.3	4.0	4	10.5	10.1	24	13.2	12.7	6	3.5	3.3			
2	5.8	4.0	5	10.0	10.0	25	12.7	11.3	7	4.0	3.6			
3	6.9	4.0	7/24	N/A	N/A	26	11.6	11.0	8	4.1	4.0			
4	4.5	4.1	25	14.0	12.3	27	12.0	10.5	9	4.4	4.2			
5	4.7	4.1	26	14.0	11.7	28	11.0	9.8	10	4.5	4.5			
6	5.1	4.5	27	14.8	12.7	29	10.6	9.9	11	4.5	3.2			
7	5.5	5.0	28	15.0	13.7	30	10.6	9.8	12	3.8	3.2			
8	7.0	5.1	29	13.8	12.7	31	10.2	9.8	13	3.9	3.4			
9	6.5	6.1	30	13.8	11.0	9/ 1	10.2	9.2	14	3.4	3.0			
10	7.8	6.1	31	12.8	11.3	2	10.2	9.8	15	3.0	2.3			
11	7.8	7.2	8/ 1	13.7	11.0	3	11.9	9.6	16	2.3	1.1			
12	7.0	6.7	2	14.0	12.8	4	10.1	9.4	17	1.1	0.8			
13	7.6	6.4	3	12.8	12.1	5	10.0	9.8	18	0.8	0.7			
14	8.3	7.2	4	12.2	11.1	6	9.8	8.4	19	0.8	0.8			
15	8.0	7.7	5	12.2	11.8	7	8.4	8.4	20	0.9	0.2			
16	7.7	7.5	6	11.0	10.5	8	8.7	8.4	21	0.5	0.1			
17	8.0	7.7	7	12.8	10.8	9	9.0	8.8	22	0.8	0.5			
18	7.8	7.0	8	13.2	12.5	10	8.9	8.9	23	0.6	0.5			
19	8.7	6.9	9	12.8	11.7	11	9.0	8.6	24	0.6	0.4			
20	9.8	8.3	10	12.5	11.5	12	8.6	7.7	25	0.6	0.5			
21	9.0	9.0	11	13.0	11.8	13	7.7	7.7	26	0.8	0.5			
22	9.0	8.8	12	13.5	12.7	14	7.9	7.5	27	0.9	0.7			
23	9.0	8.5	13	13.0	12.3	15	7.5	6.6	28	0.8	0.8			
24	10.9	8.7	14	12.7	12.2	16	7.2	6.3	29	0.9	0.8			
25	10.7	9.5	15	12.9	12.0	17	6.8	6.3	30	0.9	0.5			
26	11.0	9.5	16	13.7	12.1	18	6.8	5.7	31	0.5	0.3			

Appendix II Table 5.
Water chemistry data, Rabideux Creek, Devils Canyon Project, 1977.

Date	D.O. (mg/l)	pH	Hardness (mg/l)	Alkalinity (mg/l)
		Upper Sub Area		
5/25	11	6.6	17	17
6/7	12	7.3	34	17
6/16	8	7.0	34	34
6/30	7	7.3	51	51
7/13	6	6.5	51	51
7/26	8	7.0	51	51
8/8	7	7.0	51	51
8/23	6	6.8	51	51
9/15	8	6.8	34	17
9/27	10	6.8	34	17
10/12	9	6.8	34	17
10/27	11	7.2	34	17
		Middle Sub Area		
5/25	11	7.0	34	34
6/7	11	7.3	34	17
6/16	9	7.3	51	51
6/30	9	7.3	51	51
7/13	9	7.7	51	51
7/26	8	7.5	68	51
8/8	8	7.3	68	68
8/23	8	7.3	68	68
9/15	9	7.3	34	34
9/28	10	7.3	34	17
10/12	10	7.2	51	34
10/27	10	7.2	51	51
		Lower Sub Area		
5/25	11	7.2	17	17
6/8	10	7.5	34	34
6/30	9	7.3	51	51
7/13	10	7.7	51	68
7/26	9	7.7	51	68
8/8	10	7.3	68	68
8/23	9	7.3	68	68
9/15	9	7.3	34	34
9/29	9	7.3	34	34
10/12	11	7.2	34	34
10/27	11	7.2	34	34

Appendix II Table 6.
Water chemistry data, Montana Creek, Devils Canyon Project, 1977.

Date	D.O. (mg/l)	pH	Hardness (mg /l)	Alkalinity (mg/l)
		Upper Sub Area		
6/7	11	7.3	34	17
6/29	9	7.7	34	34
7/13	9	7.7	34	34
7/26	9	7.3	34	17
8/10	9	7.3	34	34
8/22	9	7.3	34	34
9/13	10	7.3	34	34
9/28	10	7.3	17	17
10/11	10	7.3	34	34
10/26	13	7.3	34	34
		Middle Sub Area		
6/7	12	7.3	34	17
6/29	9	7.3	34	34
7/13	8	6.8	34	34
8/10	9	7.3	34	34
8/22	9	7.3	34	34
9/13	10	7.3	34	34
10/11	9	7.3	34	34
10/28	10	7.4	34	34
11/11	10	7.3	34	34
		Lower Sub Area		
6/7	11	7.3	34	17
6/29	10	7.3	34	34
7/13	9	7.7	34	34
7/26	9	7.3	34	17
8/10	9	7.3	34	34
8/22	9	7.3	34	34
9/2	9	7.6	34	34
9/13	10	7.3	34	34
9/30	10	7.3	34	17
10/11	10	7.3	34	34
10/28	10	7.4	34	34

Appendix II Table 7.

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY PROCESS DATE 02/1(

624941149221500 - SUSITNA R AB PORTAGE C NR GOLD CREEK AK DISTRICT CODE 02

WATER QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

DATE	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)	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 (HG) (UG/L) (71900)	SUS-PENDED SEDI-MENT (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 .002 MM (70337)
20	1	100	<10	110	9500	1	50	51	6750	.07	2

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Appendix II Table 7.

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY PROCESS DATE 02/10/78

62494114922150 0 - SUSITNA R AB PORTAGE C NR GOLD CREEK AK 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-LINITY AS CACO3 (MG/L) (00410)	BICAR-BONATE (HCO3) (MG/L) (00440)	CAR-BONATE (CO3) (MG/L) (00445)
JUN 14...	1130	2	8.0	E50000	55	80	12.8	7.2	3.7	30	37	0

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)
.06	.06	.02	36	5	12	1.4	2.6	.2	13	1.2	4.9

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) (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)	TOTAL LEAD (PB) (UG/L) (01051)	TOTAL MAN-GANESE (MN) (UG/L) (01055)
5.0	.0	5.2	11	100	<10	30	200	15000	170	1200	280

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.SEQ.: 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		6	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	EST	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	(MG/L)	(MEQ/L)	ANIONS	(MG/L)	(MEQ/L
CALCIUM DISS	20	0.998	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	1.595		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 0
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-LINITY 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 (HG) (UG/L) (71900)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE MSL) (72000)	SUS-PENDED SEDI-MENT (MG/L) (80154)	SUS-PENDED SEDI-MENT 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 (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)
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 (SIO2) (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
DISTRICT CODE 02

WATER QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

DATE	DIS-SOLVED SOLIDS (TONS PER AC-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 CONSTI-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	8850
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	(MG/L)	(MEQ/L)	ANIONS	(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 PROCESS DATE 03/16/78
15292780 - SUSITNA R AT SUNSHINE AK 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-LINITY 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 — PROCESS DATE 0341

15292780 - SUSITNA R AT SUNSHINE AK — 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) (UG/L) (71900)	SUS-PENDED SEDI-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) (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. 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) (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)	TOTAL LEAD (PB) (UG/L) (01051)	TOTAL MAN-GANESE (MN) (UG/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 RECORD # 42801

SAMPLE LOCATION: SUSITNA R AT SUNSHINE AK
STATION ID: 15292780 LAT.LONG.SEQ.: 621035 1501018 00
DATE OF COLLECTION: BEGIN--771004 END-- TIME--0915
STATE CODE: 02 COUNTY CODE: 170 PROJECT IDENTIFICATION: 470208350
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
CADMIUM 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	(MG/L)	(MEQ/L)	ANIONS	(MG/L)	(MEQ/L)
CALCIUM DISS	17	0.849	BICARBONATE	52	0.853
MAGNESIUM DISS	3.0	0.247	CARBONATE	0	0.000
POTASSIUM DISS	1.2	0.031	CHLORIDE DISS	6.0	0.170
SODIUM DISS	4.4	0.192	FLUORIDE DISS	0.1	0.006
			SULFATE DISS	12	0.250
			NO2+NO3 AS N D	0.23	0.017
TOTAL		1.317	TOTAL		1.293

PERCENT DIFFERENCE = 0.92

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 of 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 of 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. Foregut 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} feet^3. 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 electrofishing, 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 dependent 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
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Alaska Department of Fish and Game
Division of Game

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March 1978

CONTENTS

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 km^2. 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

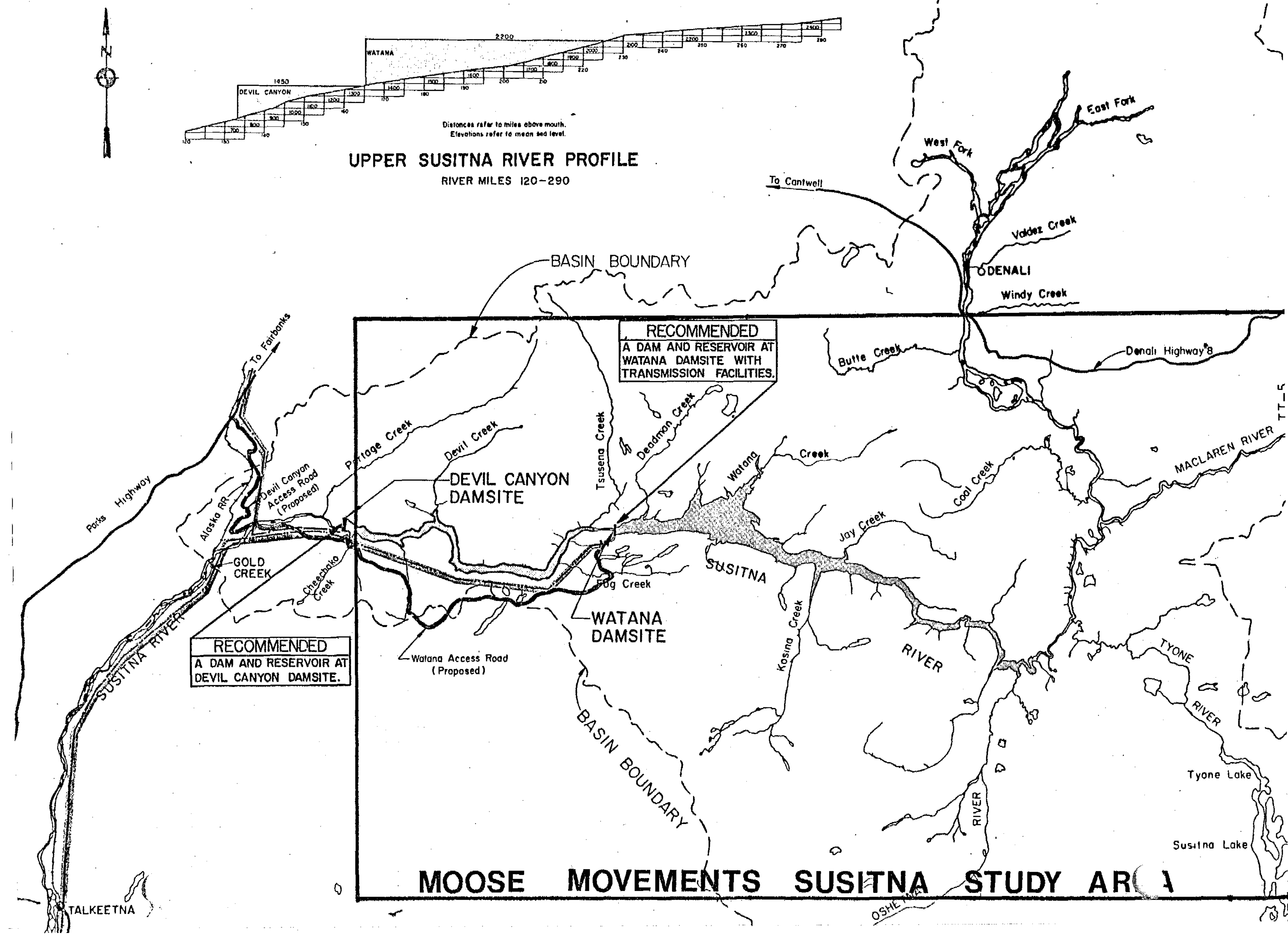
on movements both upstream and downstream are needed to adequately assess the impacts of the proposed construction (Appendix II).

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 subsistance 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					
3578	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 km^2 to 520 km^2 (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

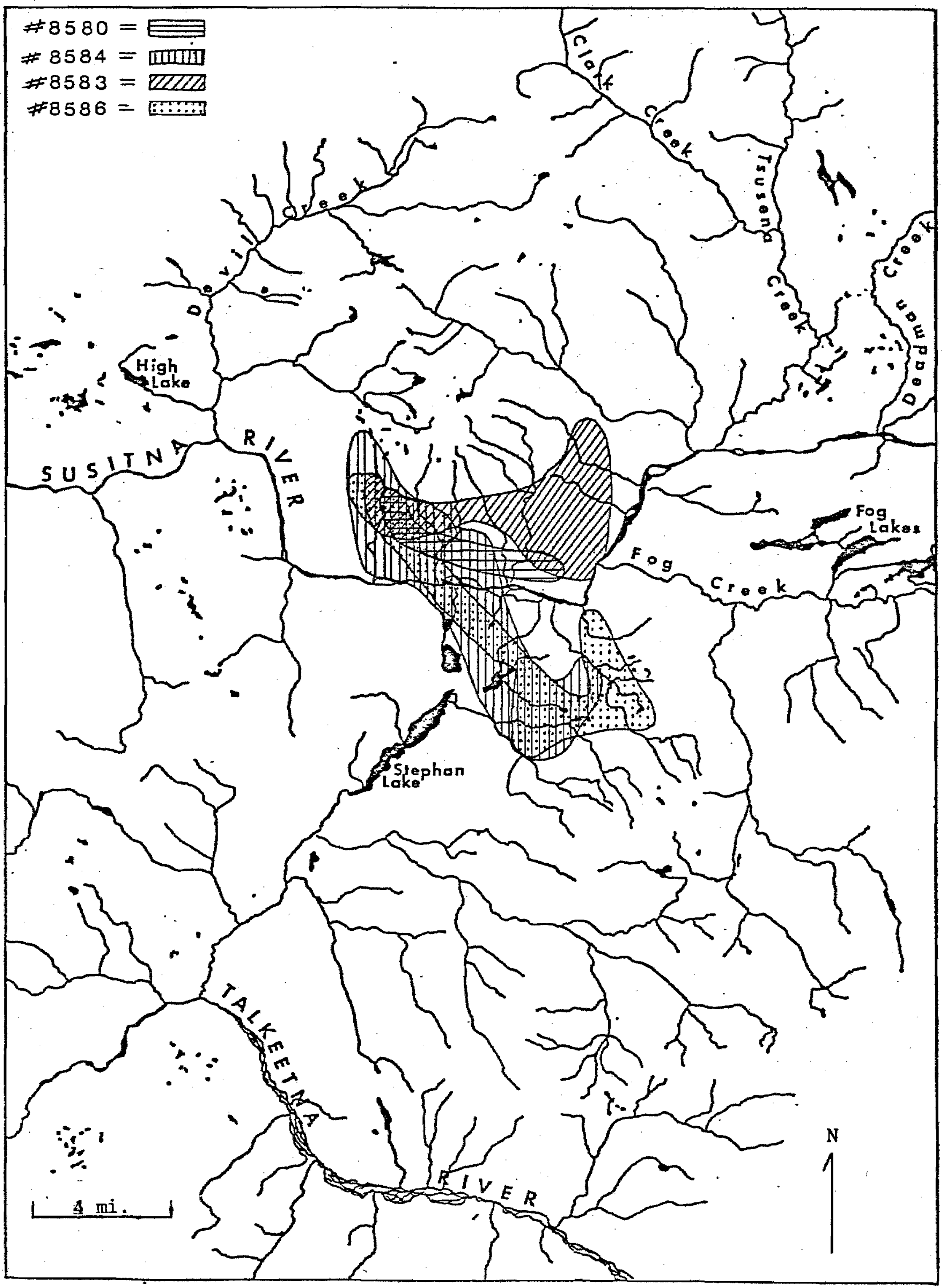
Table 2. Range size, number of locations and minimum number of river crossings of radio collared moose along the Susitna River. Devils Canyon Project, March 1978.

Collar Number	Number of Locations	Range Length km.	Range Width km.	Total Area km^2	Minimum number of river crossings
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	20	103.0	10.5	291.4	0
	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 km^2.

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.

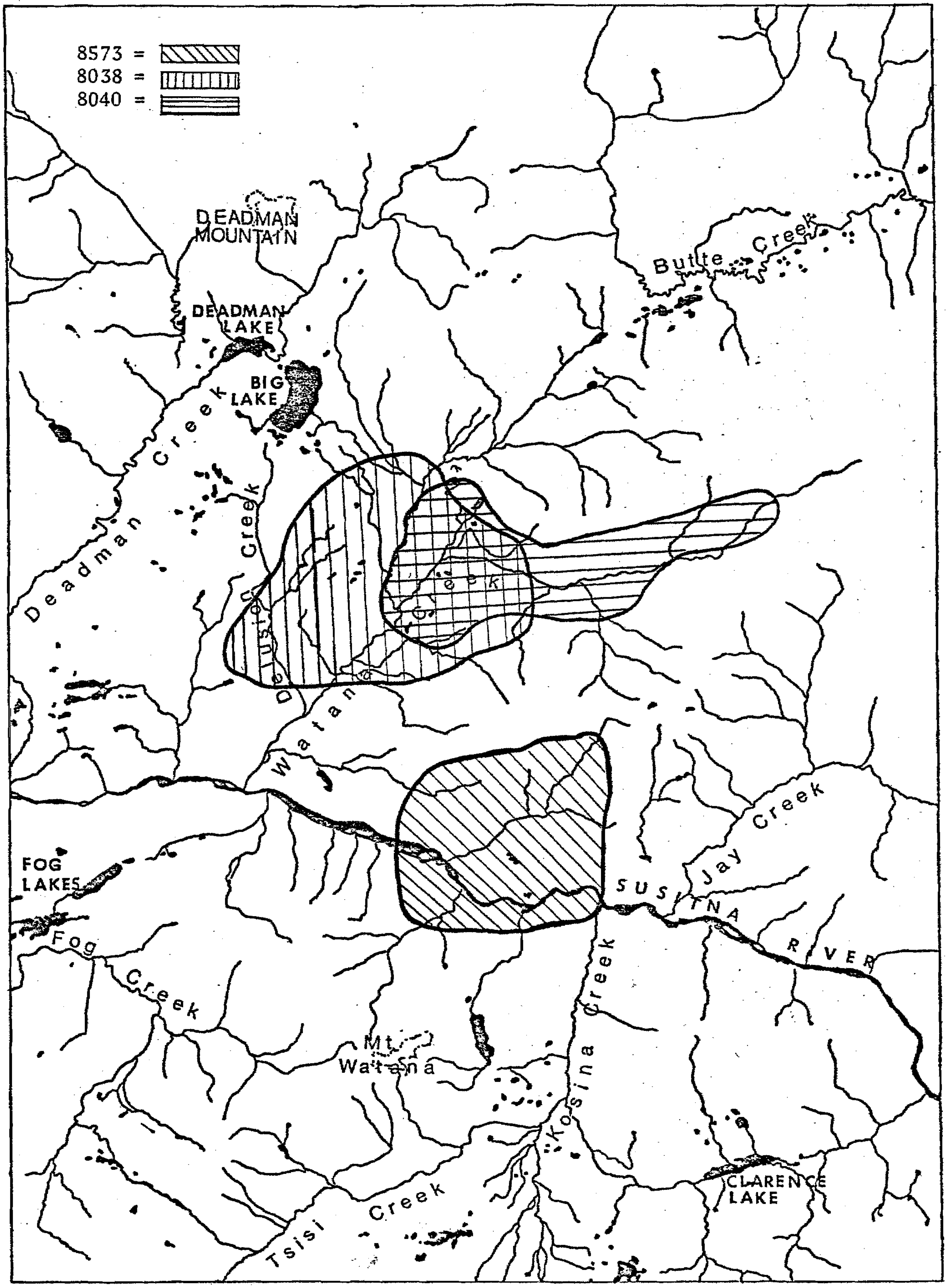
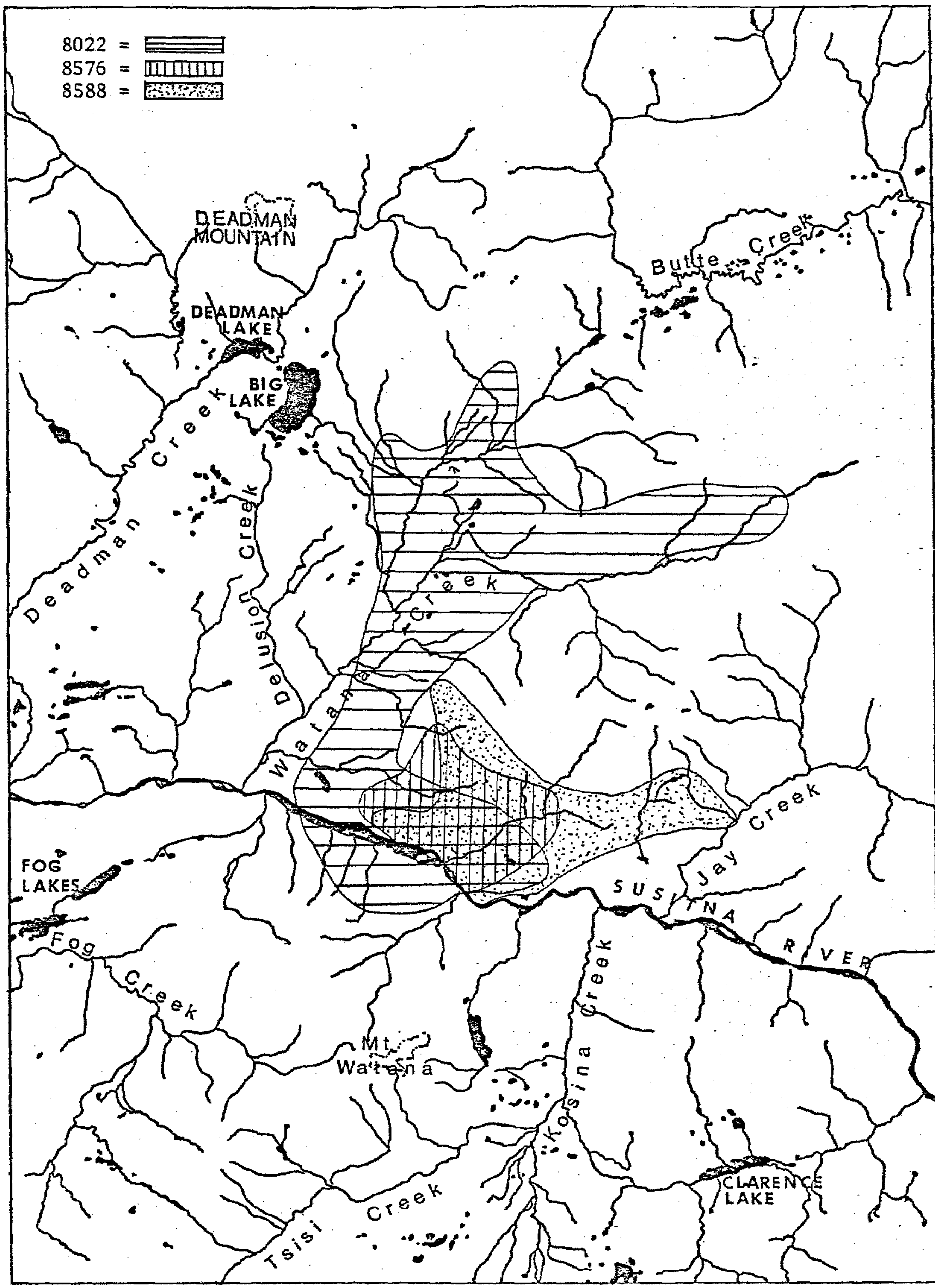


Figure 5. Location and General Range of Radio Collared Moose Numbers 8022, 8576 and 8588 Along Watana Creek. Devils Canyon Project, March 1978.



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 km^2. 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.

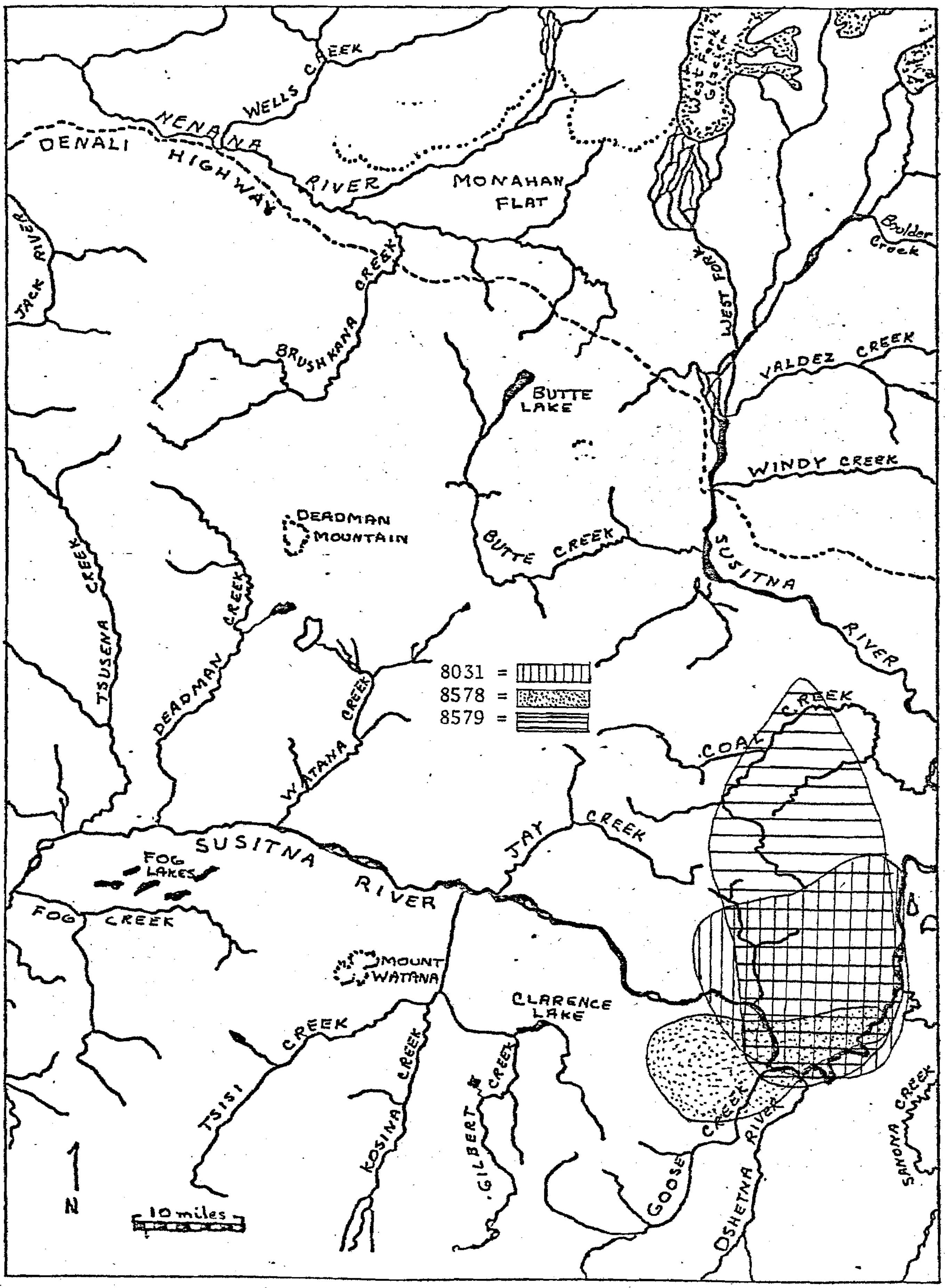
Susitna Bend Area

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 Oshetna River (Fig. 6). She never returned to the north side and spent the remaining summer months and fall in an area of approximately 7 km^2, 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.

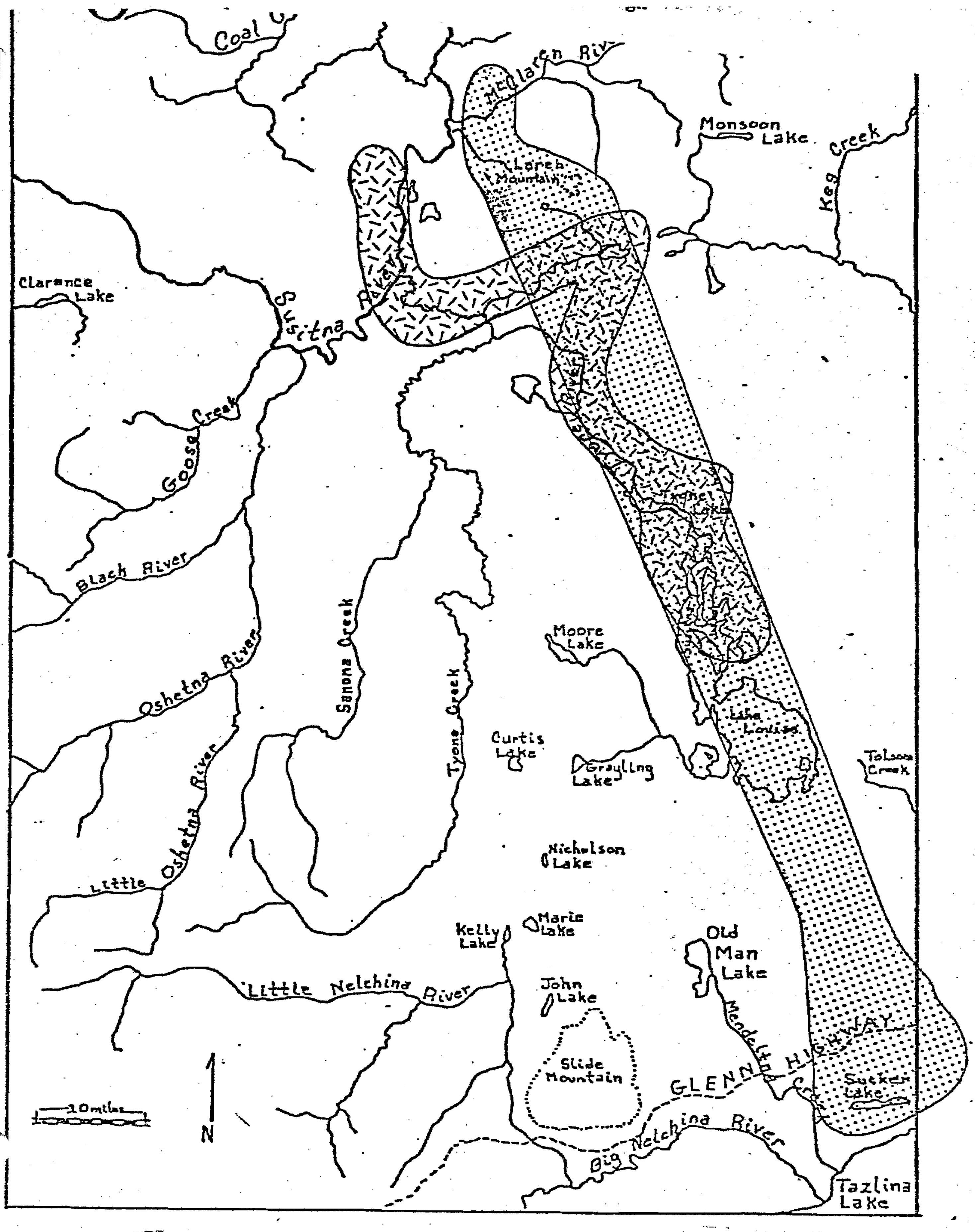


Number 8030 was collared very close to #s 8031, 8578 and 8579, but her movement patterns were totally dissimiler (Fig. 7). She moved south across the Susitna River and wintered along the drainage of the Tyone River. By 10 May she had moved 2 km to an island in Susitna Lake and was observed there with 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.



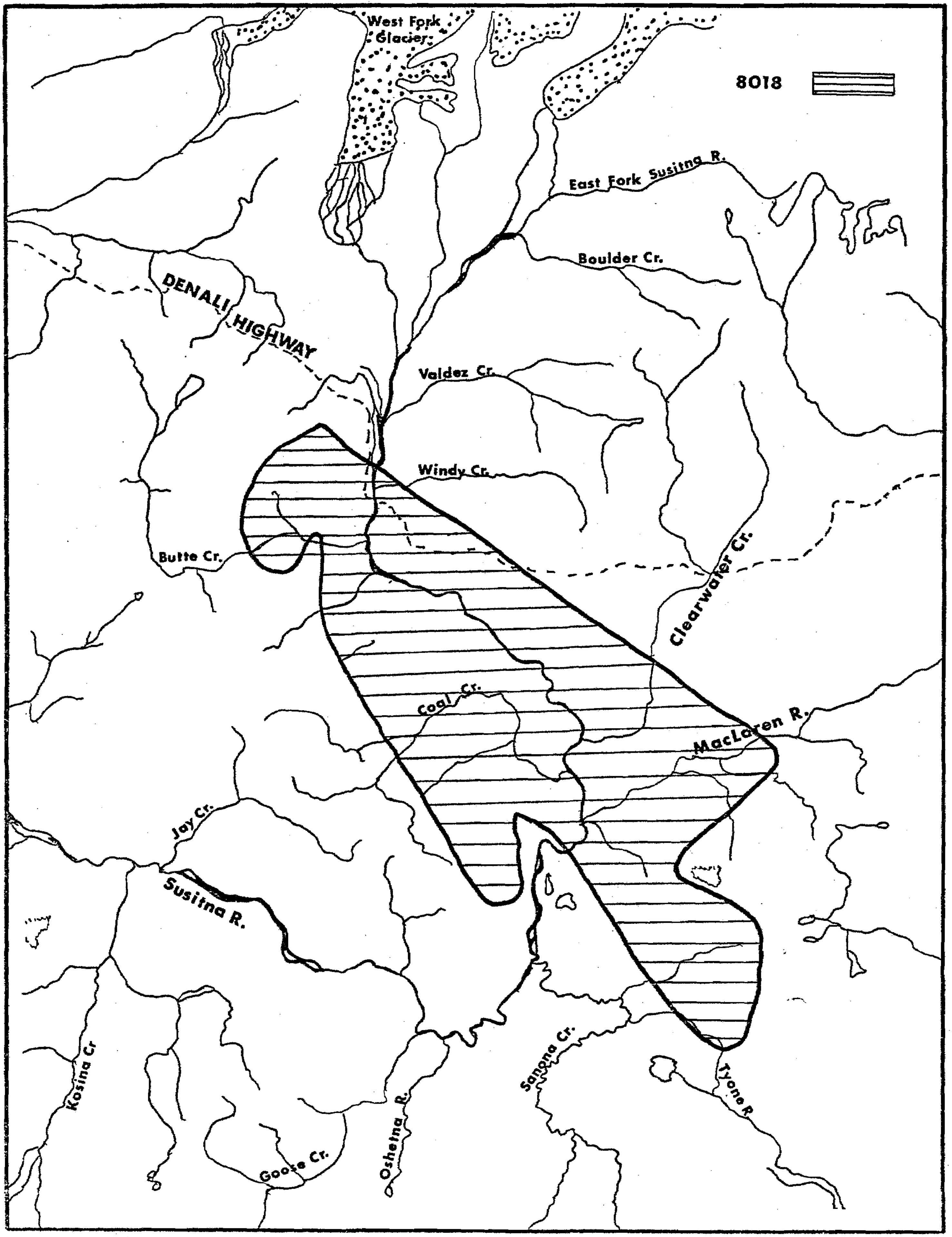
Female #8018 was collared in October along Butte Creek. She was accompanied by a calf and remained in the Butte Creek vicinity through January (Fig. 9). On 7 February she and her calf were observed across the Susitna, 43 km away on the north side of Kelley Lake. She wintered there with her calf and began 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.

Collar Number	Total Sightings	Open Spruce*	Medium Spruce	Dense Spruce	Spruce/ Hardwood**	Alpine Tundra	Alder	Willow	Riparian Willow	Open
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	3	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	
	172	43	51	26	7	7	16	11	10	1
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 km^2. 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 km^2. 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 km^2 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 km^2 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 km^2 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 prject. 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

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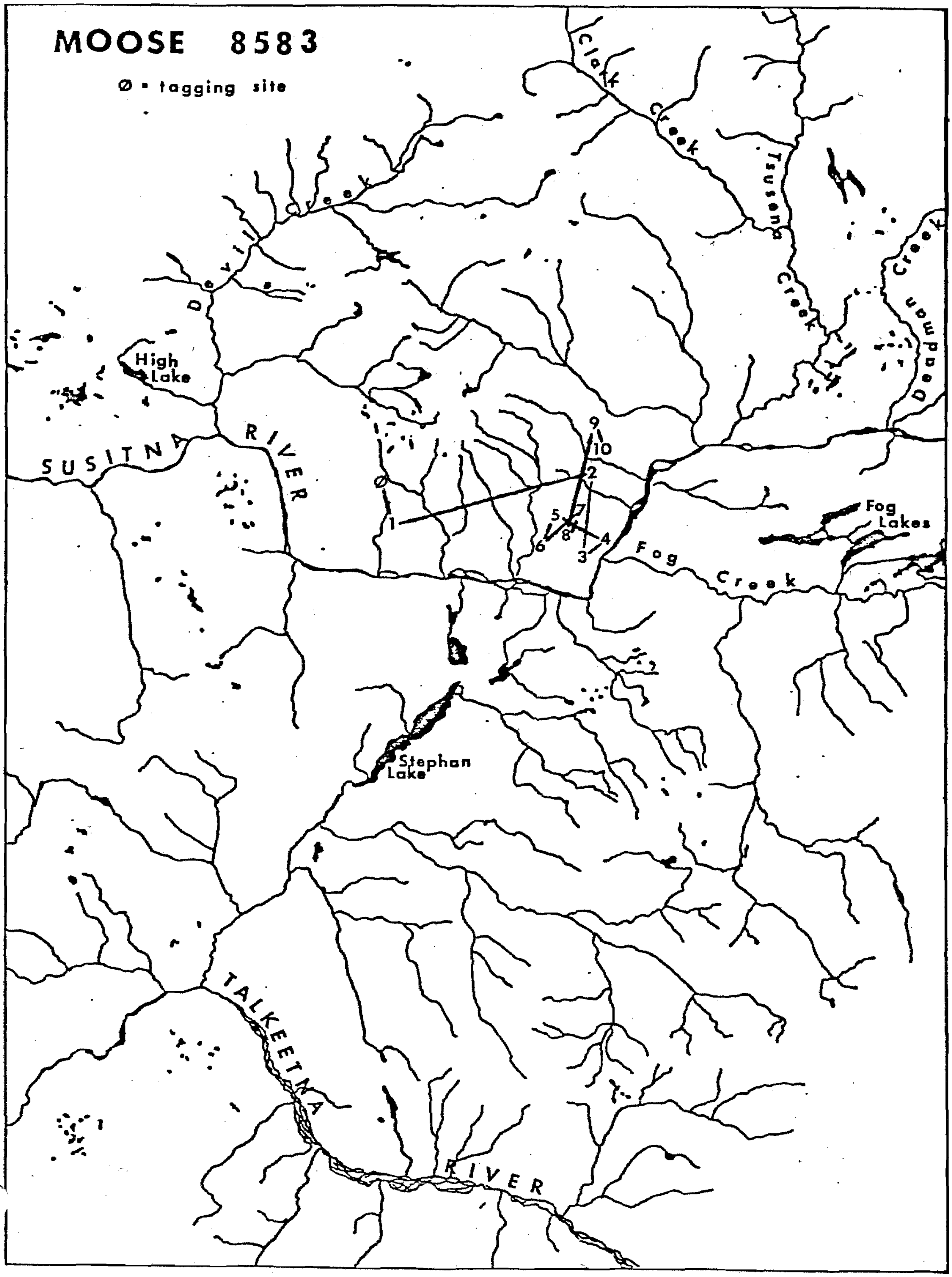
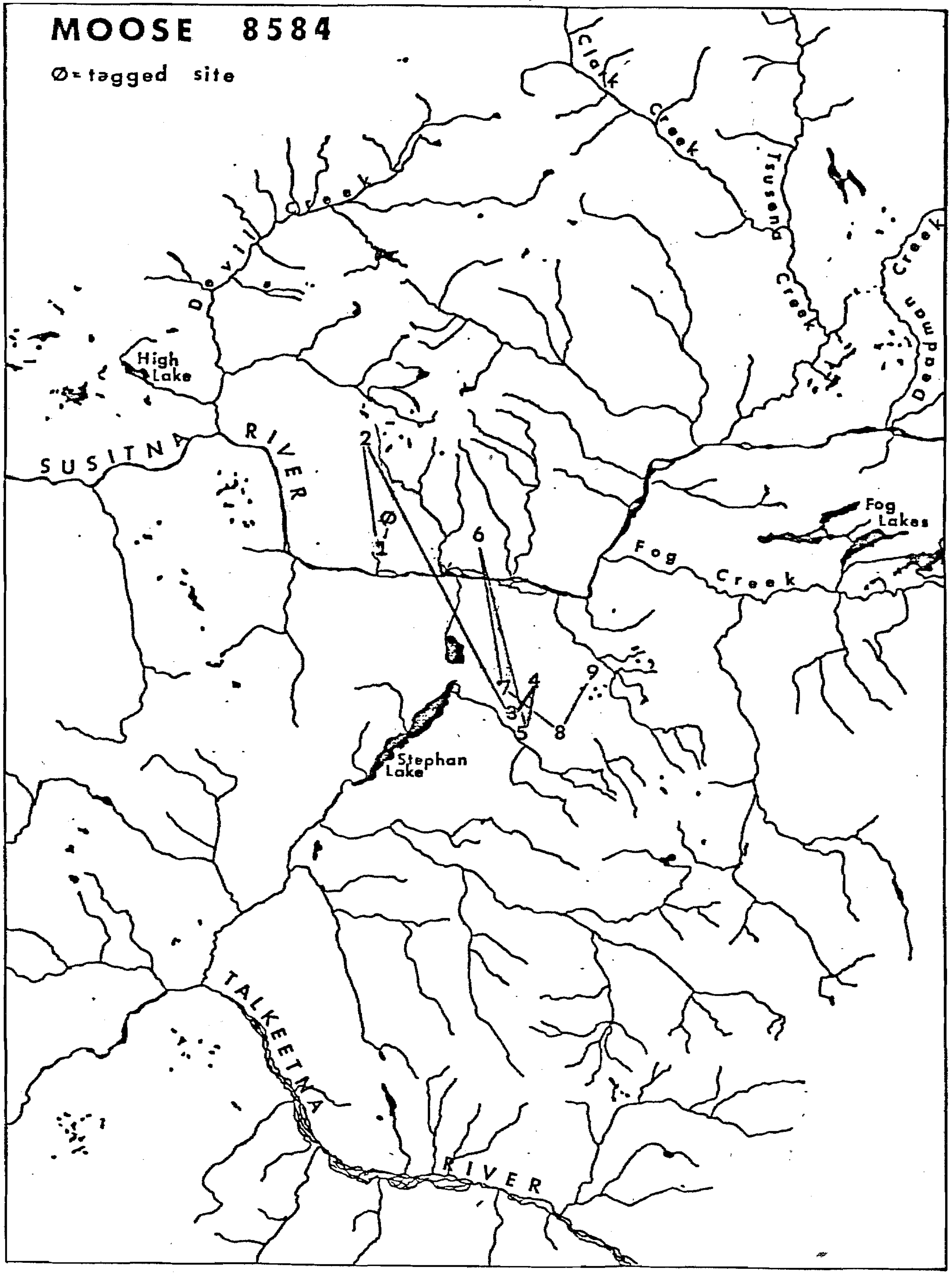
Appendix I. Individual Observations and Locations of each Radio Collared Moose Between October 1976 and November 1977. Devils Canyon Project, March 1978.



Number	Collar Color	Collar Number	Date	Remarks
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
Clark Creek
Tsusena Creek
Devil Creek
Deadman Creek
High Lake
SUSITNA RIVER
Fog Lakes
Fog Creek
Stephan Lake
TALKEETNA RIVER
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1
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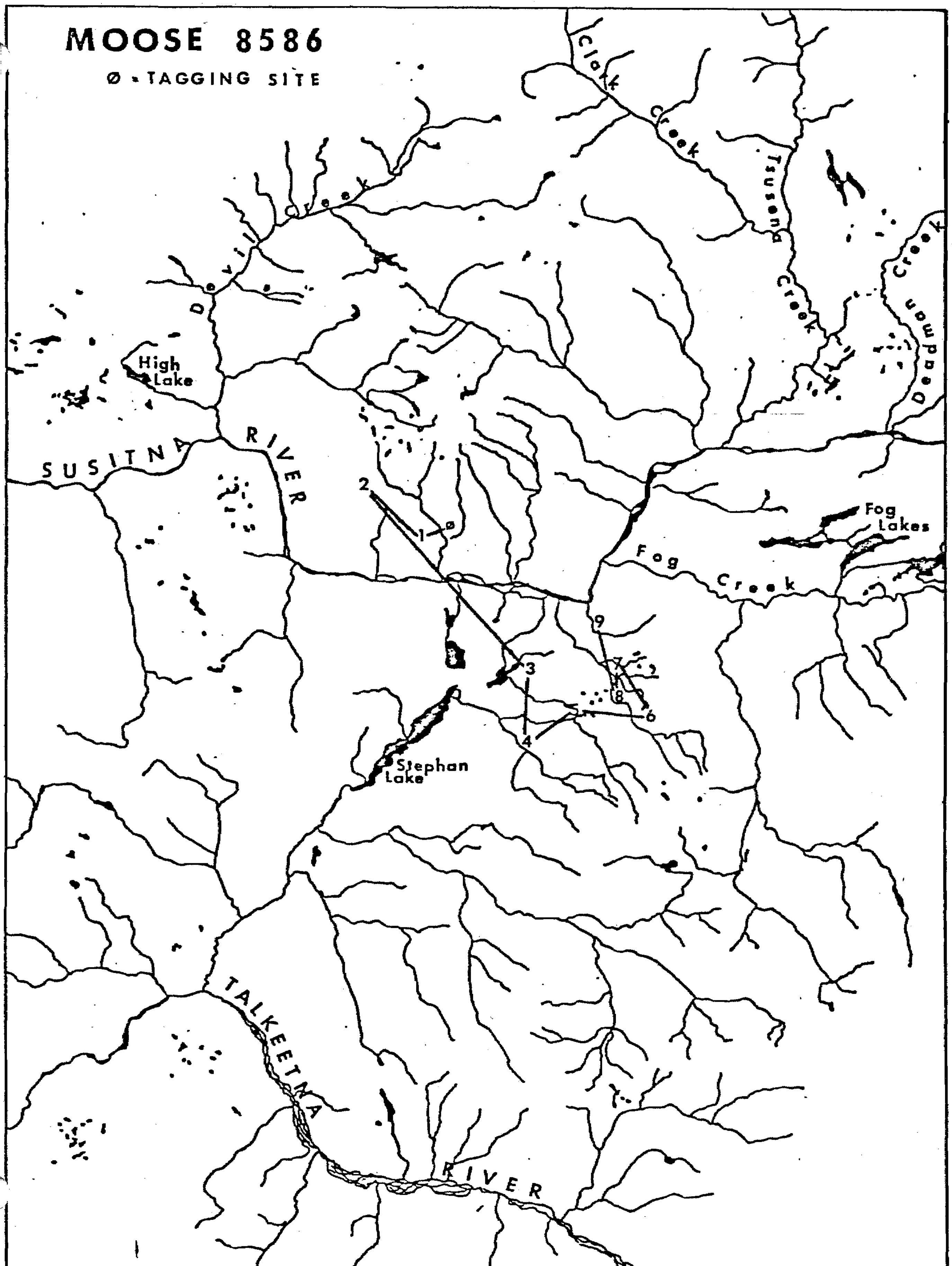
Number	Collar Color	Collar Number	Date	Remarks
8584	Orange	9	18 March 1977	Pregnant

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
Ø = TAGGING SITE
Clark Creek
Devil Creek
Tsusena Creek
Deadman Creek
High Lake
SUSITNA RIVER
Fog Lakes
Fog Creek
Stephan Lake
TALKEETNA RIVER
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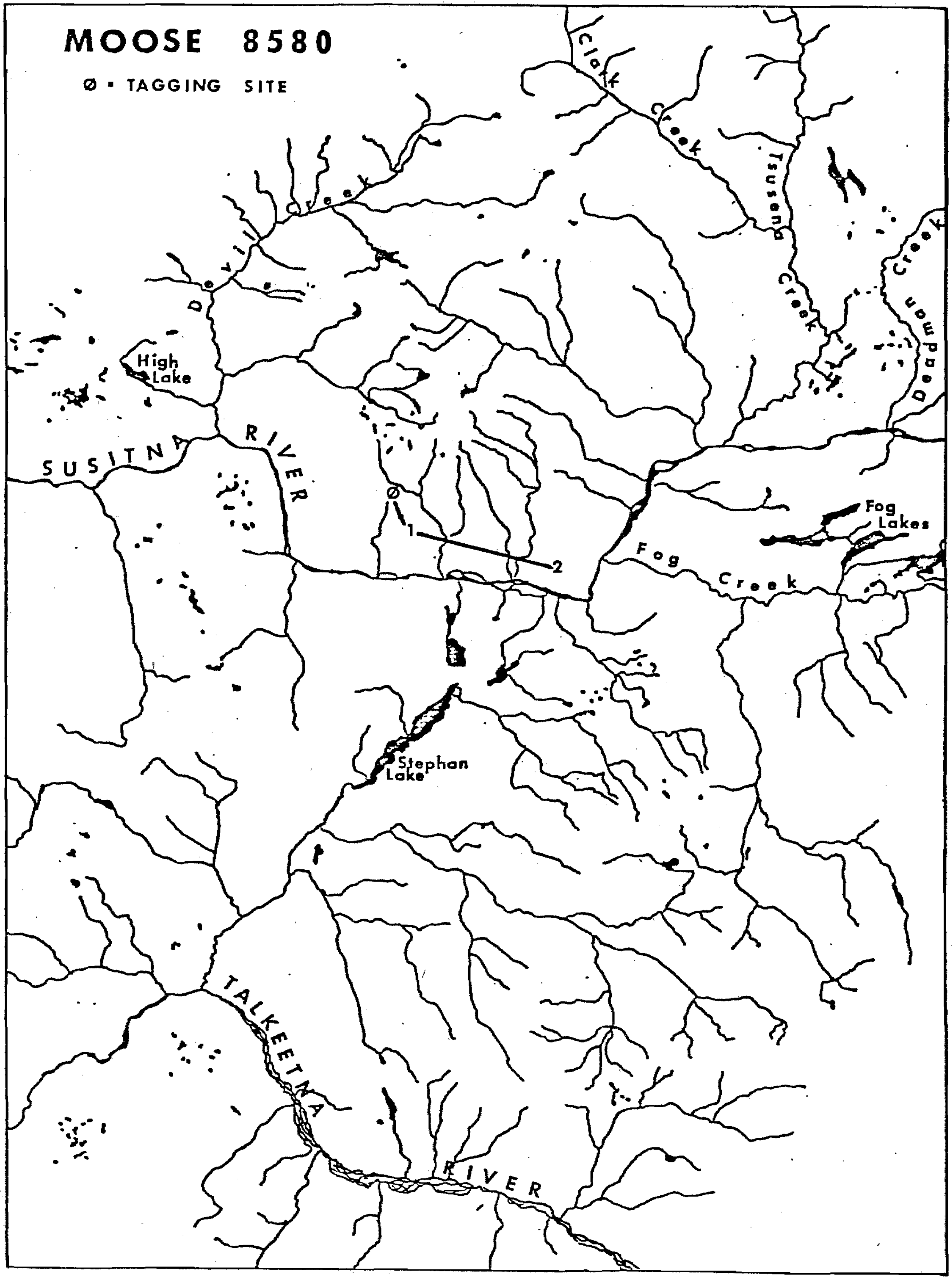
Number	Collar Color	Collar Number	Date	Remarks
8586	Orange	11	18 March 1977	Pregnant, with one calf and 3 cows 1/4 mile

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
Ø = TAGGING SITE
Clark Creek
Tsusena Creek
Deadman Creek
Devil Creek
High Lake
SUSITNA RIVER
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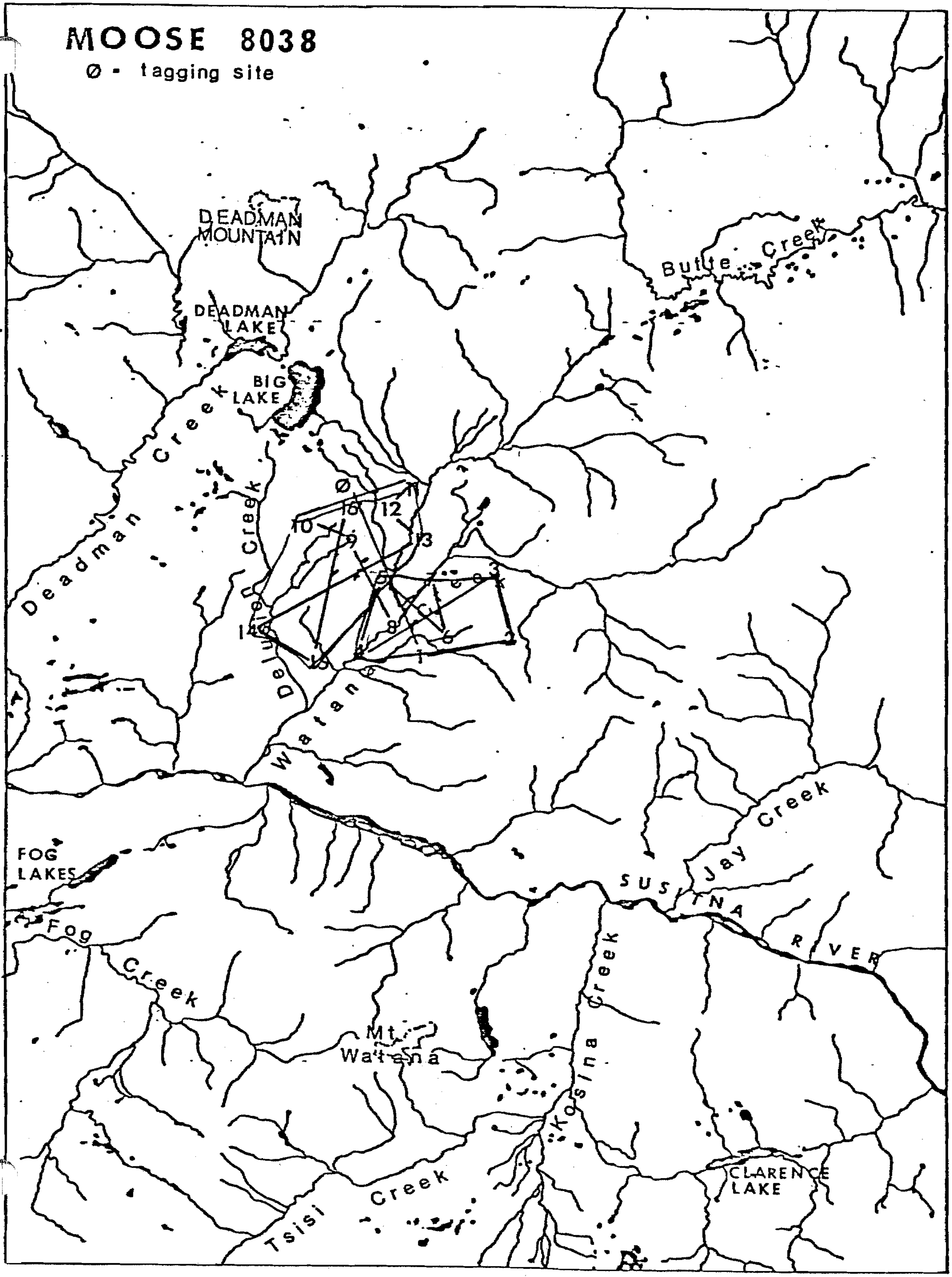
Fog Lakes
Fog Creek
Stephan Lake
TALKEETNA RIVER

Number	Collar Color	Collar Number	Date	Remarks
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

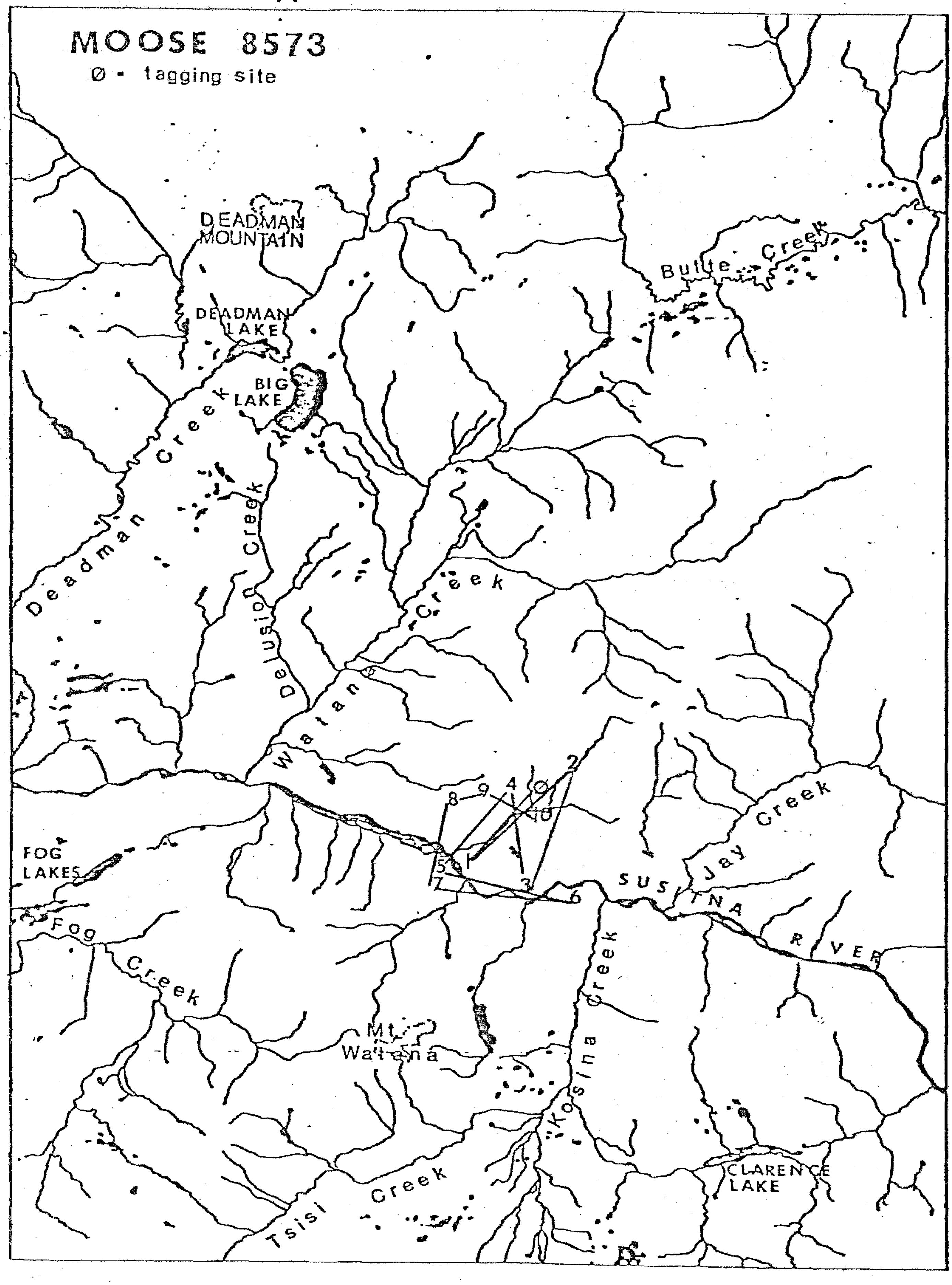
1 (3:00 PM)	31 March 1977	With 1 adult, spruce (SE-KB)
2	22 April 1977	Alone, no ear tags, tall riparian spruce (WB-KB)


MOOSE 8038
Ø - tagging site
DEADMAN MOUNTAIN
DEADMAN LAKE
BIG LAKE
Deadman Creek
Deadman Creek
Butte Creek
Watana
Jay Creek
SUSITNA RIVER
FOG LAKES
Fog Creek
Mt. Watana
Kosina Creek
Tsisi Creek
CLARENCE LAKE

Number	Collar Color	Collar Number	Date	Remarks
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
∅	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
DEADMAN MOUNTAIN
DEADMAN LAKE
BIG LAKE
Deadman Creek
Delusion Creek
Watana Creek
Butte Creek
FOG LAKES
Fog Creek
Jay Creek
SUSITNA RIVER
Kosina Creek
Mt Watana
Tsisi Creek
CLARENCE LAKE
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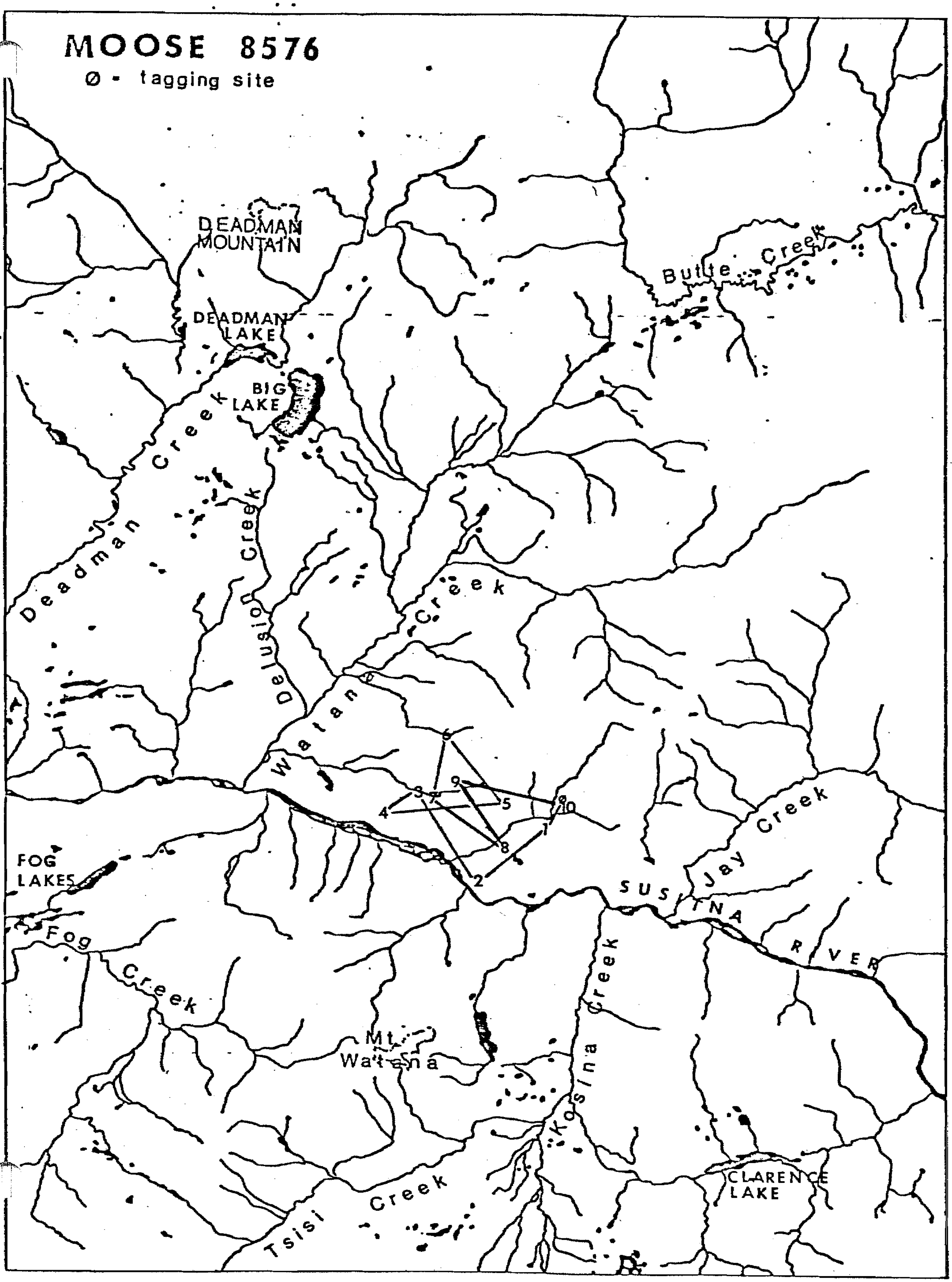
Number	Collar Color	Collar Number	Date	Remarks
8573	Orange	5	19 March 1977	Pregnant

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
DEADMAN MOUNTAIN
DEADMAN LAKE
BIG LAKE
Deadman Creek
Delusion Creek
Watana Creek
Butte Creek
FOG LAKES
Fog Creek
Mt. Watana
SUSITNA RIVER
Jay Creek
Kosina Creek
Tsisi Creek
CLARENCE LAKE
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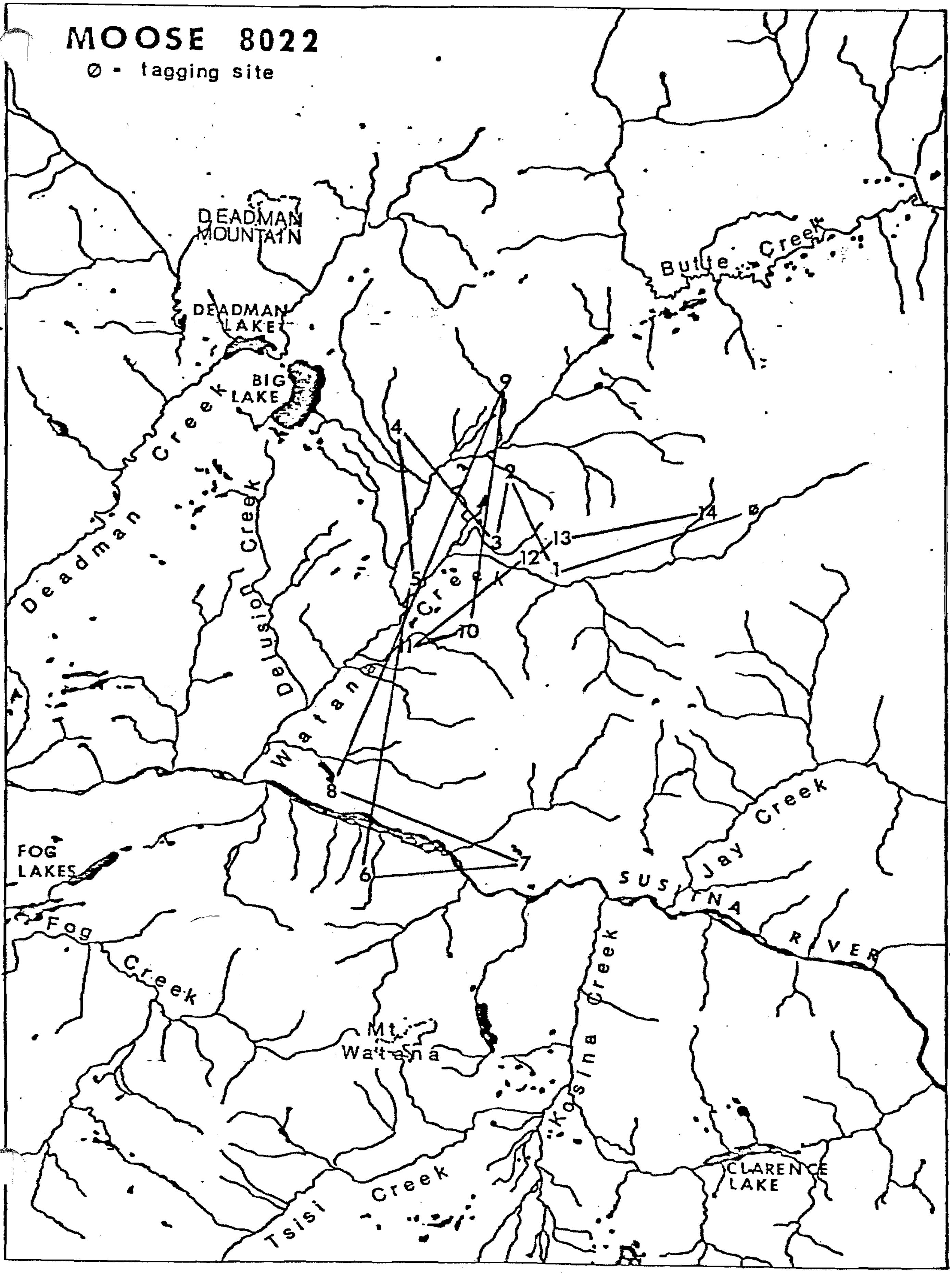
Number	Color	Collar Number	Collar Date	Remarks
8576	Orange	6	19 March 1977	With 1 bull, pregnancy status unknown

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



MOOSE 8022
Ø - tagging site
DEADMAN MOUNTAIN
DEADMAN LAKE
BIG LAKE
Deadman Creek
Delusion Creek
Watana Creek
Butte Creek
FOG LAKES
Fog Creek
Mt. Watana
Kosina Creek
Tsisi Creek
Jay Creek
SUSITNA RIVER
CLARENCE LAKE
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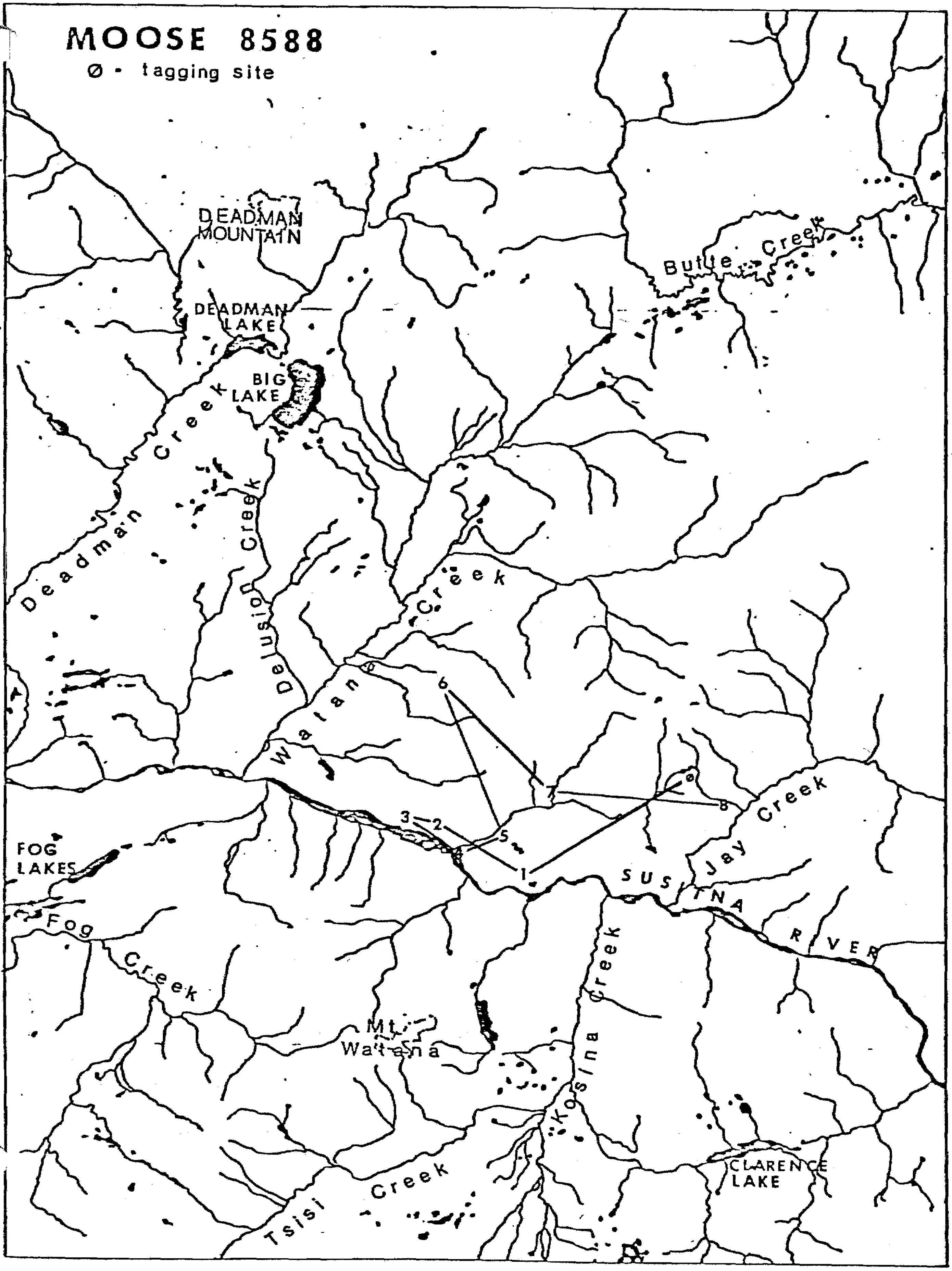
Number	Collar Color	Collar Number	Date	Remarks
8022	Red	NA	28 October 1976	Artificial respiration for 10-15 min.

Observations

1 (1:30 PM)	22 November 1976	Unable to observe due to poor snow conditions and dense vegetation
2 (1:45 PM)	3 December 1976	With 1 cow
3 (11:00 AM)	24 December 1976	With 1 cow
4	19 January 1977	Alone
5 (11:00 AM)	4 February 1977	Not visually observed due to high winds
6	3 March 1977	Alone, standing, sparse medium spruce
7 (4:05 PM)	6 April 1977	With 2 moose
8 (9:00 AM)	22 April 1977	Alone, medium medium spruce
9	25 May 1977	Alone, riparian willow
Ø	1 June 1977	No visual observation, in steep wall canyon, near radio 8040
10	8 June 1977	Alone, medium medium spruce
11	16 June 1977	Alone
Ø	28 June 1977	Couldn't locate
12	5 July 1977	Not observed, alder
13 (11:00 AM)	5 August 1977	With 1 cow, tall alder
14	5 October 1977	With radio 8040, alder
15	30 November 1977	With 1 cow, willow


MOOSE 8588
Ø - tagging site
DEADMAN MOUNTAIN
DEADMAN LAKE
BIG LAKE
Deadman Creek
Delusion Creek
Butte Creek
Watana Creek
FOG LAKES
Fog Creek
Jay Creek
SUSITNA RIVER
Mt Watana
Kosina Creek
Tsisi Creek
CLARENCE LAKE
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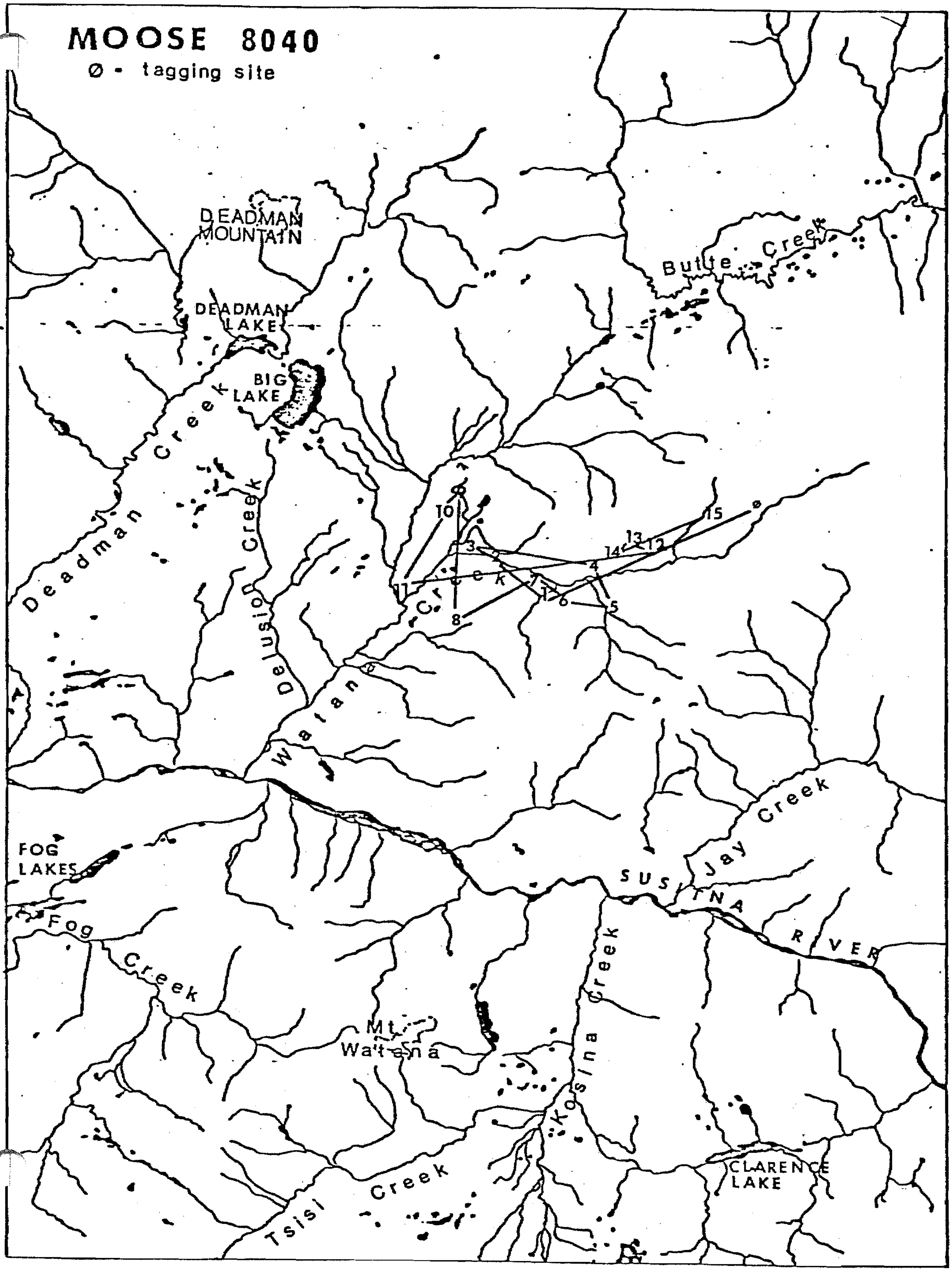
Number	Collar Color	Collar Number	Date	Remarks
8588	Orange	16	19 March 1977	none

Observations

1 (4:05 PM)	6 April 1977	Close to radio 8022, medium medium spruce
2	22 April 1977	With 2 cows, sparse short spruce
3	27 May 1977	With 1 yearling and 1 cow, sparse short spruce
Ø	31 May 1977	Not visually observed
4	3 June 1977	Not visually observed on island, dense tall spruce
5	8 June 1977	Alone, spruce (KT)
6	16 June 1977	Alone, willow-alder
Ø	5 July 1977	Alone
7	21 August 1977	Alone, sparse tall spruce
Ø	5 October 1977	Could not locate
8	3 November 1977	With one bull and 3 cows
9	30 November 1977	With one yearling, willow

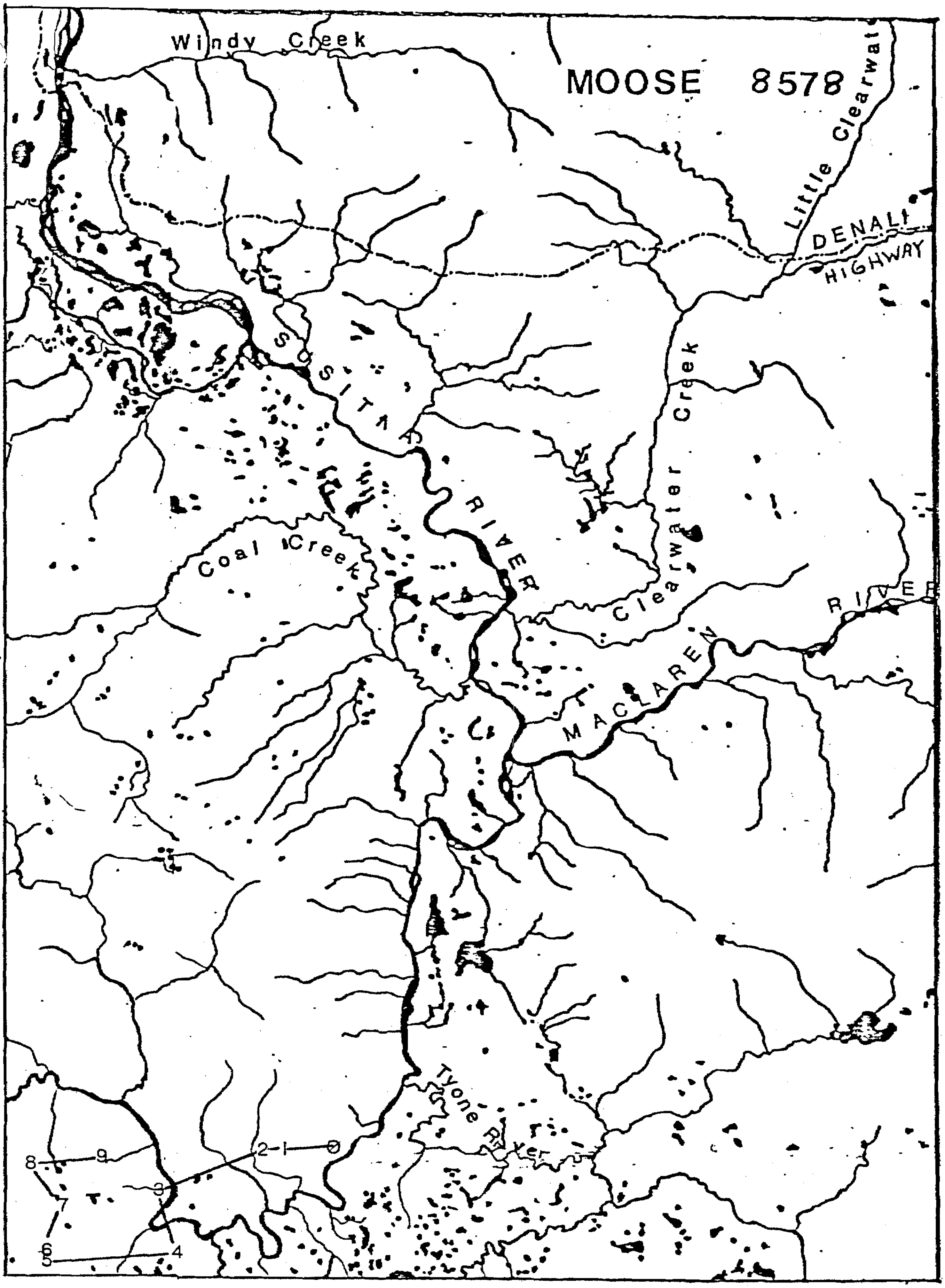


MOOSE 8040
Ø - tagging site
DEADMAN MOUNTAIN
DEADMAN LAKE
BIG LAKE
Deadman Creek
Delusion Creek
Watana Creek
Butte Creek
Jay Creek
SUSITNA RIVER
FOG LAKES
Fog Creek
Mt. Watana
Kosina Creek
Tsisi Creek
CLARENCE LAKE

Number	Collar Color	Collar Number	Date	Remarks
8040	Green	NA	28 October 1976	Lone cow, old moose (10+), artificial respiration-5 minutes

Observations

1 (11:50 AM)	22 November 1976	With 1 cow and 1 large bull
2	3 December 1976	With 1 yearling and 2 cows
3	27 December 1976	With 2 cows, 1 small bull and 2 large bulls
4 (9:30 AM)	17 January 1977	Alone
5 (10:30 AM)	3 March 1977	Alone
6 (6:16 PM)	6 April 1977	Alone
7 (9:20 AM)	22 April 1977	With 1 cow, riparian willow, condition 4
8	26 May 1977	Alone, sparse short spruce
Ø	31 May 1977	Not visually observed
Ø	1 June 1977	Alone
9	3 June 1977	Alone, willow
10	8 June 1977	With 2 new calves, alder
11	16 June 1977	Alone, alder
12	28 June 1977	Not observed, alder
13	5 July 1977	Not observed, tall alder
14 (11:00 AM)	5 August 1977	Not observed
15	5 October 1977	With 1 cow and 1 small bull, alder
16	30 November 1977	With 1 yearling, riparian willow



MOOSE 8578
Windy Creek
Little Clearwat
DENALI HIGHWAY
SUSITNA RIVER
Clearwater Creek
Coal Creek
MACLAREN RIVER
Tyone River
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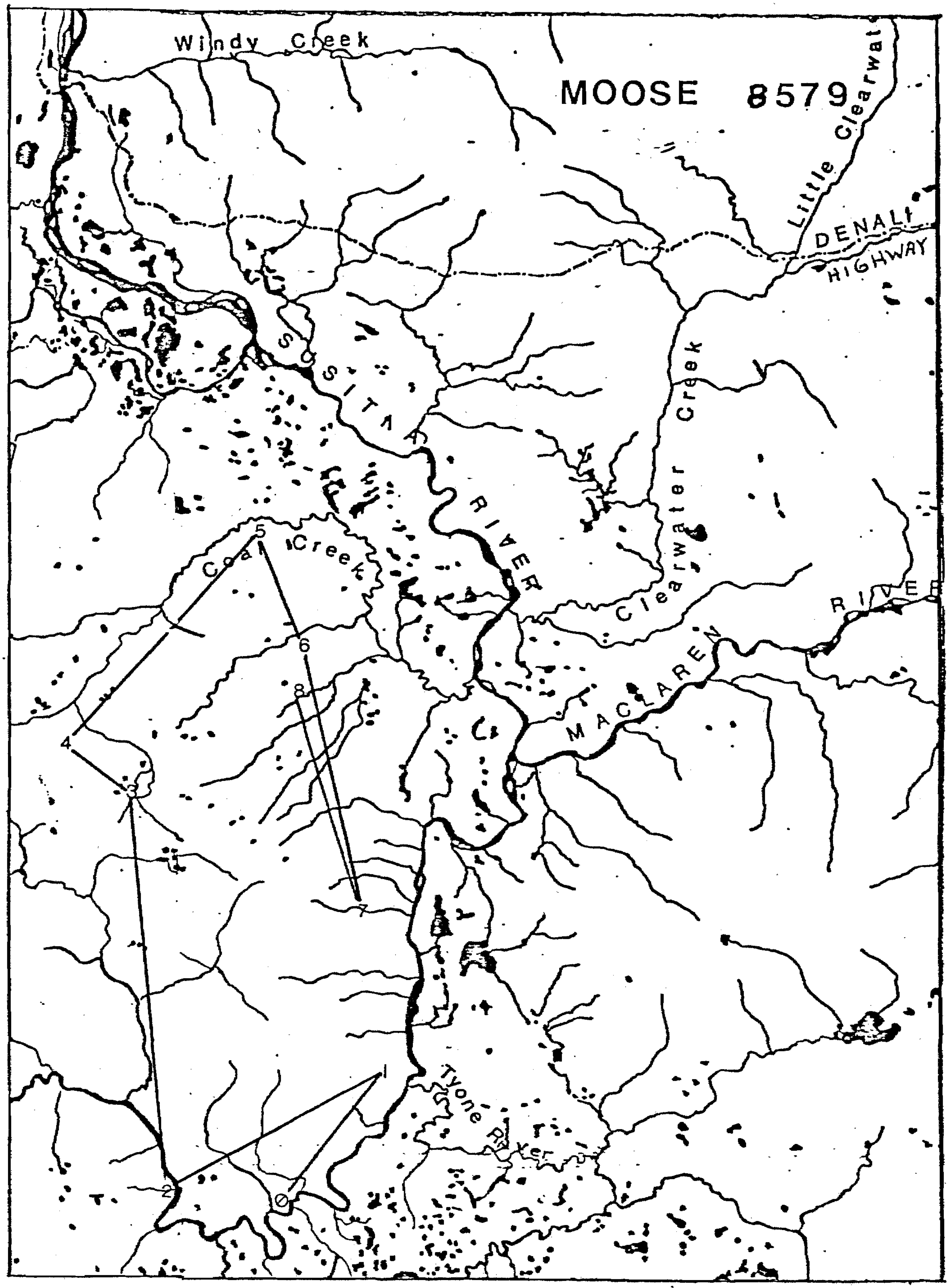
Number	Collar Color	Collar Number	Date	Remarks
8578	Orange	10	20 March 1977	Not pregnant, with 1 bull

Observations

1	30 March 1977	Not visually observed (TB-AL)
2 (10:30 AM)	22 April 1977	Alone, upland small spruce bog
3	13 May 1977	No visual observation due to two other cows in area, steep river banks and heavy spruce (TB-AL)
(11:00 AM)	30 May 1977	No calf, with 1 bull and 2 cows (TS-KB)
4 (2:00 PM)	3 June 1977	With 10 cows and 1 bull, open spruce, no calf (TB-KB)
5 (2:30 PM)	6 June 1977	Up high in scrub sparse spruce, with 1 cow and yearling
	10 June 1977	No calf, with a cow with calf an 1 lone cow, yearling male grizzly present (SE-KB)
	17 June 1977	With 1 adult, no calf
(10:30 AM)	27 June 1977	Alone (TB-AL)
	30 June 1977	With 1 cow and bull, cow with calf 1/8 mile away (KB-TB)
(10:00 AM)	6 July 1977	Alone, upland tundra, no calf, feeding (WB-KB)
6 (10:15 AM)	23 July 1977	Bedded down with 3 adults and 1 small bull, mixed brush upland tundra with short scattered spruce (WB-KB)
7	22 August 1977	Alone within 1/4 mile is cow with yearling, in sparse medium spruce with lots of dwarf birch almost alpine (WB-KB)
(8:55 AM)	30 August 1977	With cow and calf in sparse short spruce, feeding (WB-KB)
8 (5:00 PM)	5 October 1977	Alone, standing in scrub spruce, willow (WB-KB)
9 (1:40 PM)	22 November 1977	Alone, standing in upland short sparse spruce (WB-KB)


MOOSE 8579
Windy Creek
Little Clearwat
DENALI HIGHWAY
SUSITNA RIVER
Coal Creek
Clearwater Creek
MACLAREN RIVER
Tyone River
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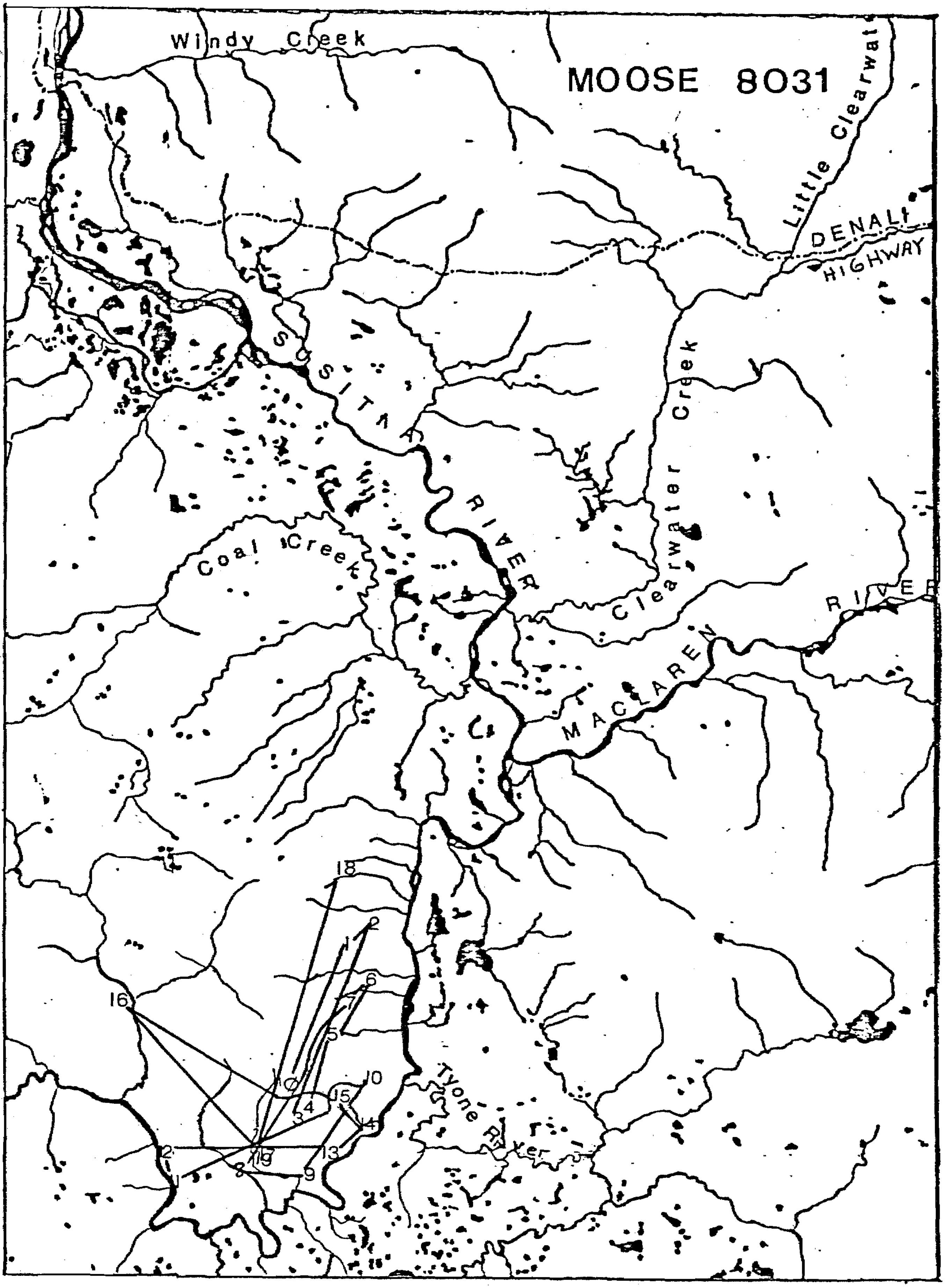
Number	Collar Color	Collar Number	Date	Remarks
8579	Orange	14	20 March 1977	Pregnant, 15 minutes artificial respiration (broke couple of ribs), with 1 calf

Observations

1	22 March 1977	With cow, upland willow surrounding medium spruce, condition 4 (WB-KB)
2	13 May 1977	Definite location didn't see due to steep riverbanks and heavy spruce (TB-AL)
3 (11:30 AM)	3 July 1977	Alone, feeding in upland tundra (WB-KB)
4 (10:15 AM)	25 July 1977	Alone, no calf, riparian willow habitat in upland tundra, bedded down
5 (5:30 PM)	18 August 1977	With a cow with calf in tall spruce sparse and dwarf birch (WB-KB)
6 (2:00 PM)	5 October 1977	With 10 cows, 1 small bull in upland short spruce (WB-KB)
7	3 November 1977	With #61 which has calf (SE)
8 (2:00 PM)	22 November 1977	Alone, running, in tall riparian spruce (WB-KB)


MOOSE 8031
Windy Creek
Little Clearwat
DENALI HIGHWAY
SUSITNA RIVER
Clearwater Creek
Coal Creek
Clear
MACLAREN RIVER
Tyone River
18
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7
5
16
10
15
4
3
14
12
13
19
9
8
1

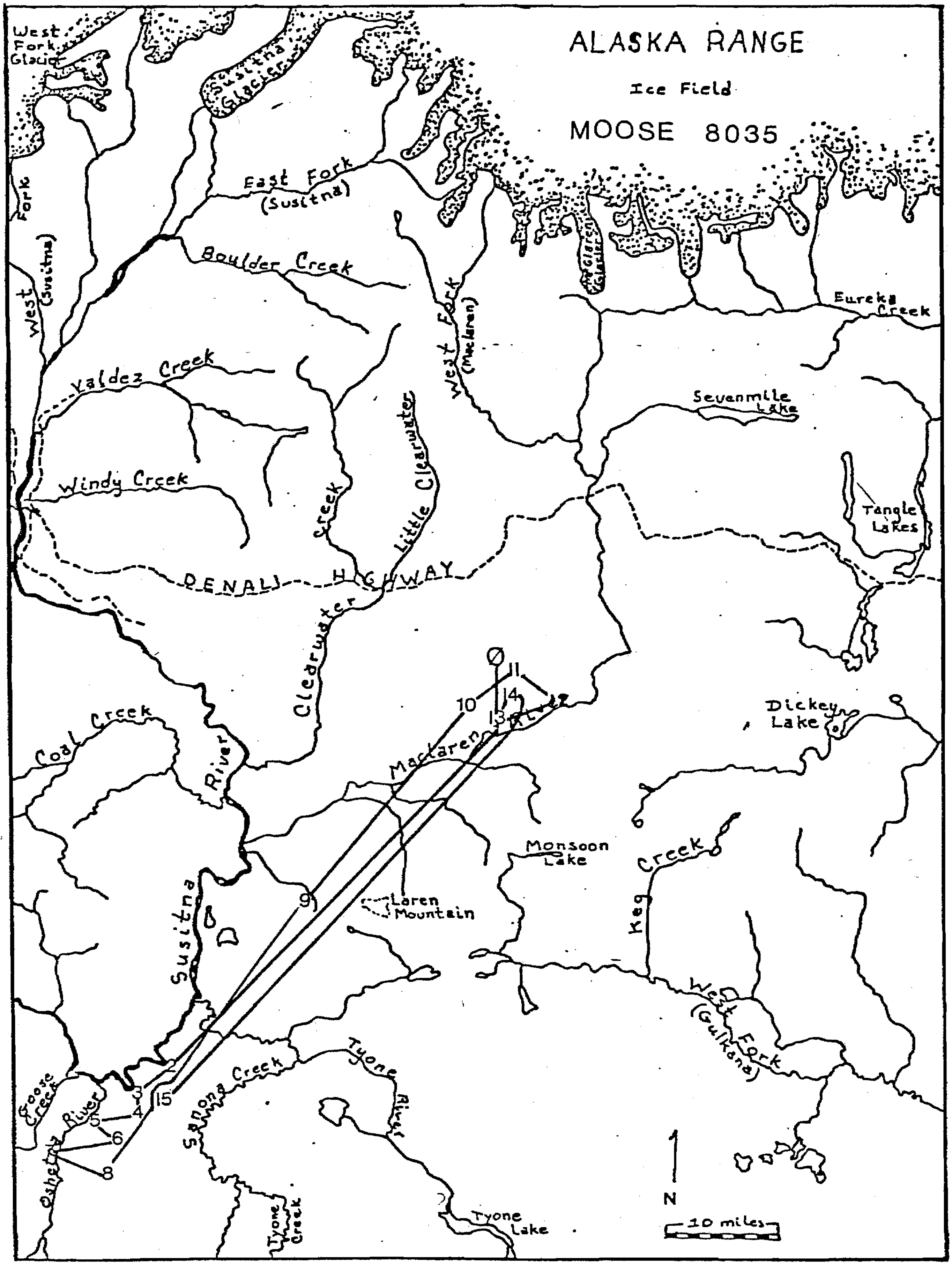
Number	Collar Color	Collar Number	Date	Remarks
8031 Visual	Green Blue	NA 3	22 October 1976	none

Observations

1	2 November 1976	With several bulls and cows within 1/4 mile, also #2 with calf (TB)
2 (11:15 AM)	19 November 1976	Unobserved due to vegetations and poor snow (WB)
3 (10:15 AM)	16 December 1976	With a yearling cow
4 (Noon)	24 December 1976	With a calf
5 (3:30 PM)	19 January 1977	With a calf, within 1/4 mile 2-3 year old bull with 1 antler and cow with calf
6 (1:00 PM)	3 February 1977	Did not attempt to observe (TS)
7 (Noon)	4 February 1977	Visually observed accompanied by calf
8 (3:00 PM)	22 February 1977	With calf, with cow with twins (TS)
9 (Noon)	5 March 1977	With calf
10 (3:30 PM)	30 March 1977	Didn't visually observe (TB-AL)
11 (8:15 AM)	25 April 1977	With calf and another cow, tall spruce-willow
12 (3:15 PM)	13 May 1977	Didn't see due to steep river banks but definately there, singnal not heard until almost overhead (TB-AL)
(2:00 PM)	20 May 1977	With calf, also 2 cows with calves, 1 cow, medium spruce upland, 2500'
13 (11:00 AM)	30 May 1977	With yearling and 1 cow, no calf, feeding, less than 40' spruce and muskeg (TS-KB)
14	3 June 1977	With yearling and 1 cow
(1:30 PM)	6 June 1977	With a yearling in scrub spruce 200' above river (WB-KB)
	10 June 1977	With yearling, sparse medium spruce (SE-KB)

8031 continued

	17 June 1977	With yearling (SE-KB)
15	24 June 1977	Couldn't see due to wind (TB-AL)
16 (11:45 AM)	3 July 1977	Bedded down with yearling (bull) at least 17 other moose there (WB-KB)
17 (10:35 AM)	23 July 1977	With bull yearling in dense medium spruce, 2700', standing together
(5:30 PM)	18 August 1977	Bedded down with her yearling bull with 1 large bull in dense medium spruce (WB-KB)
(9:15 AM)	30 August 1977	Unable to observe, probably bedded down in thick medium spruce
18 (1:15 PM)	5 October 1977	With 4 cows, 1 cow with calf, 1 yearling in dense medium spruce upland (WB-KB)
19 (1:30 PM)	22 November 1977	With 4 cows, 1 calf, 2 large bulls, 1 yearling bull, standing, feeding, dense medium tall spruce, essentially same location as 17


ALASKA RANGE
Ice Field
MOOSE 8035
West Fork Glacier
Susitna Glacier
East Fork (Susitna)
Boulder Creek
West Fork (Susitna)
West Fork (Maclaren)
Eureka Creek
Valdez Creek
Windy Creek
Little Clearwater
Creek
Sevenmile Lake
Tangle Lakes
DENALI HIGHWAY
Clearwater
Coal Creek
River
Maclaren River
Dickey Lake
Monsoon Lake
Keg Creek
Laren Mountain
Susitna
West Fork (Gulkana)
Goose Creek
River
Oshetna
Sanona Creek
Tyone River
Tyone Creek
Tyone Lake
N
10 miles
1
3
4
5
6
8
9
10
11
12
13
14
15

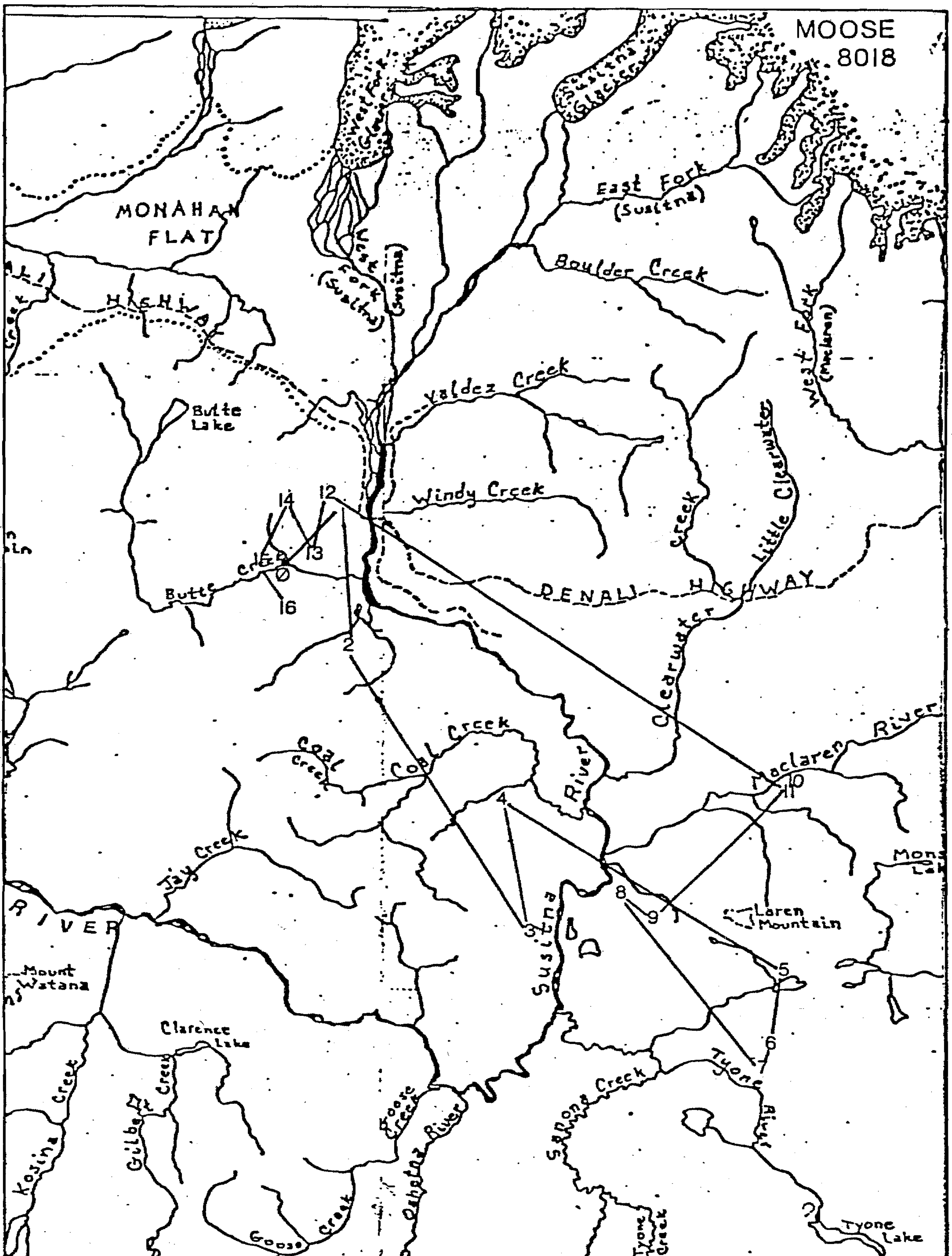
Number	Collar Color	Collar Number	Date	Remarks
8035	Blue	NA	27 October 1977	3-4 minutes artificial respiration, with one #11, probably 3 other cows, 1 large bull, 1 small bull

Observations

1	2 November 1976	With 1 cow
Ø	19 November 1976	Not visually observed, with radio 8030 and cow
2 (10:15 AM)	16 December 1976	Did not visually observe due to fog
3 (Noon)	24 December 1976	With 1 cow, within 1/4 mile 1 cow with calf and 5 cows
4 (3:45 PM)	19 January 1977	With 2 yearlings (1 is bull), over 1/4 mile a total of 11 moose which included 2 medium bulls with 1 antler and 2 calves
5 (1:00 PM)	3 February 1977	No attempt to observe
6 (1:00 PM)	4 February 1977	With 2 yearlings (1 bull), other moose in area but no count
7 (3:30 PM)	22 February 1977	With 2 moose
8	5 March 1977	With 1 yearling
Ø	30 March 1977	No visual observation
9	22 April 1977	Condition 5-6, riparian willow
10 (2:30 PM)	25 May 1977	Alone, medium medium spruce, feeding
(2:00 PM)	1 June 1977	Alone, bedded down, sparse medium spruce
(Noon)	6 June 1977	Alone, dense riparian tall spruce
(8:30 AM)	10 June 1977	With cow, standing in riparian spruce
	17 June 1977	With 1 cow
11	25 June 1977	Alone
	6 July 1977	With 1 cow in upland tundra, resting

8035 continued

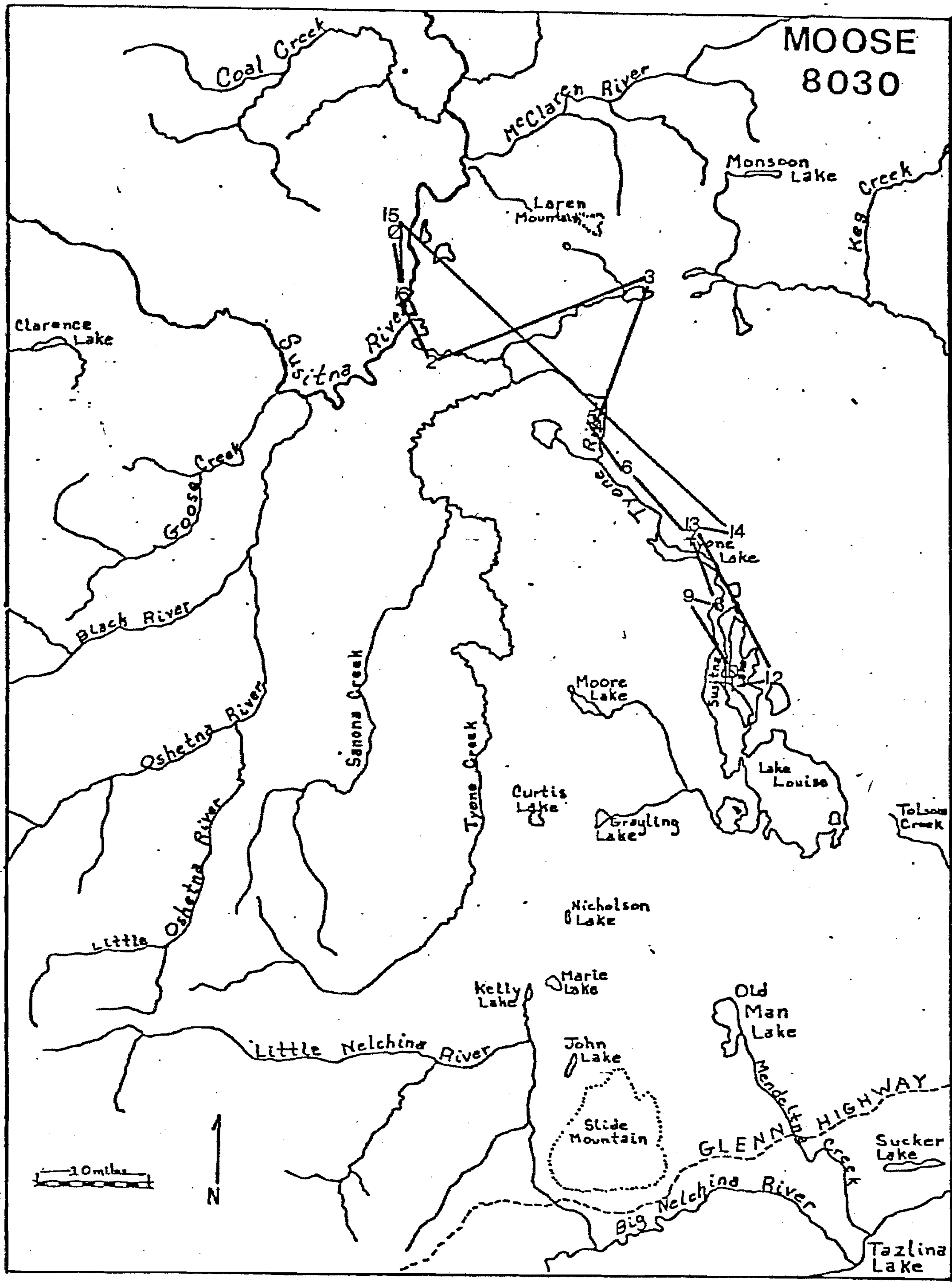
(Noon)	12 July 1977	With 1 cow, upland riparian
12 (1:15 PM)	23 July 1977	Bedded down, sparse medium spruce
13 (4:45 PM)	18 August 1977	Bedded with a cow and yearling bull, sparse short spruce
14 (4:30 PM)	5 October 1977	With 1 large bull, 13 cows, small moose 1 calf, scrub willow with medium medium spruce
15 (2:00 PM)	22 November 1977	Feeding, alone, medium short spruce



MOOSE
8018
MONAHAN FLAT
HIGHWAY
Butte Lake
Butte Creek
East Fork (Susitna)
Boulder Creek
West Fork (Maclaren)
Valdez Creek
Windy Creek
Little Clearwater
Creek
DENALI HIGHWAY
Clearwater
Maclaren River
Coal Creek
Susitna River
Jay Creek
RIVER
Mount Watana
Clarence Lake
Laren Mountain
Tyone River
Sanona Creek
Oshetna River
Goose Creek
Kosina Creek
Tyone Creek
Tyone Lake

Number	Collar Color	Collar Number	Date	Remarks
8018	Green	NA	27 October 1976	Probably with a calf, with one cow

Observations		
1 (12:10 PM)	22 November 1976	With calf, 3 cows and 3 calves (1 set twins)
2 (1:50 PM)	3 December 1976	With medium bull, within 1/4 mile 5 cows, and 3 cows with 2 calves
3 (11:15 PM)	24 December 1976	With 1 cow
4 (1:20 PM)	19 January 1977	Alone
5 (1:00 PM)	7 February 1977	Alone
6 (1:00 PM)	5 March 1977	With calf
7 (11:02 AM)	30 March 1977	With calf
8	25 April 1977	With calf, medium medium small spruce
9 (7:45 PM)	10 May 1977	With 3 cows, sparse medium spruce
Ø	27 May 1977	
10 (Noon)	30 May 1977	With 1 new calf, feeding, near a cow with twins
Ø (4:30 PM)	6 June 1977	With calf, resting, river floodplain with medium medium spruce
11 (8:00 AM)	10 June 1977	With calf, lying down in sparse tall spruce
12 (10:30 AM)	12 July 1977	Unable to observe, in thick upland tundra, within 1/2 mile cow with calf
13 (12:30 PM)	23 July 1977	No visual, dense willow and alder must be bedded down
14 (9:00 AM)	22 August 1977	Unable to observe due to dense alder-willow within 1/4 mile cow with calf
15 (2:15 PM)	5 October 1977	Alone, standing, riparian willow
16 (10:30 AM)	22 November 1977	With 2 cows, 3 calves, bedded riparian willow


MOOSE
8030
Coal Creek
McClaren River
Monsoon Lake
Keg Creek
Laren Mountain
Clarence Lake
Susitna River
Goose Creek
Black River
Tyone River
Tyone Lake
Oshetna River
Sanona Creek
Tyone Creek
Moore Lake
Susitna
Lake Louise
Curtis Lake
Grayling Lake
Tolsona Creek
Little Oshetna River
Little
Nicholson Lake
Kelly Lake
Marie Lake
Old Man Lake
Little Nelchina River
John Lake
Mendeltna Creek
Slide Mountain
GLENN HIGHWAY
Sucker Lake
Big Nelchina River
Tazlina Lake
10 miles
N
15
3
2
6
13
14
9
8
12

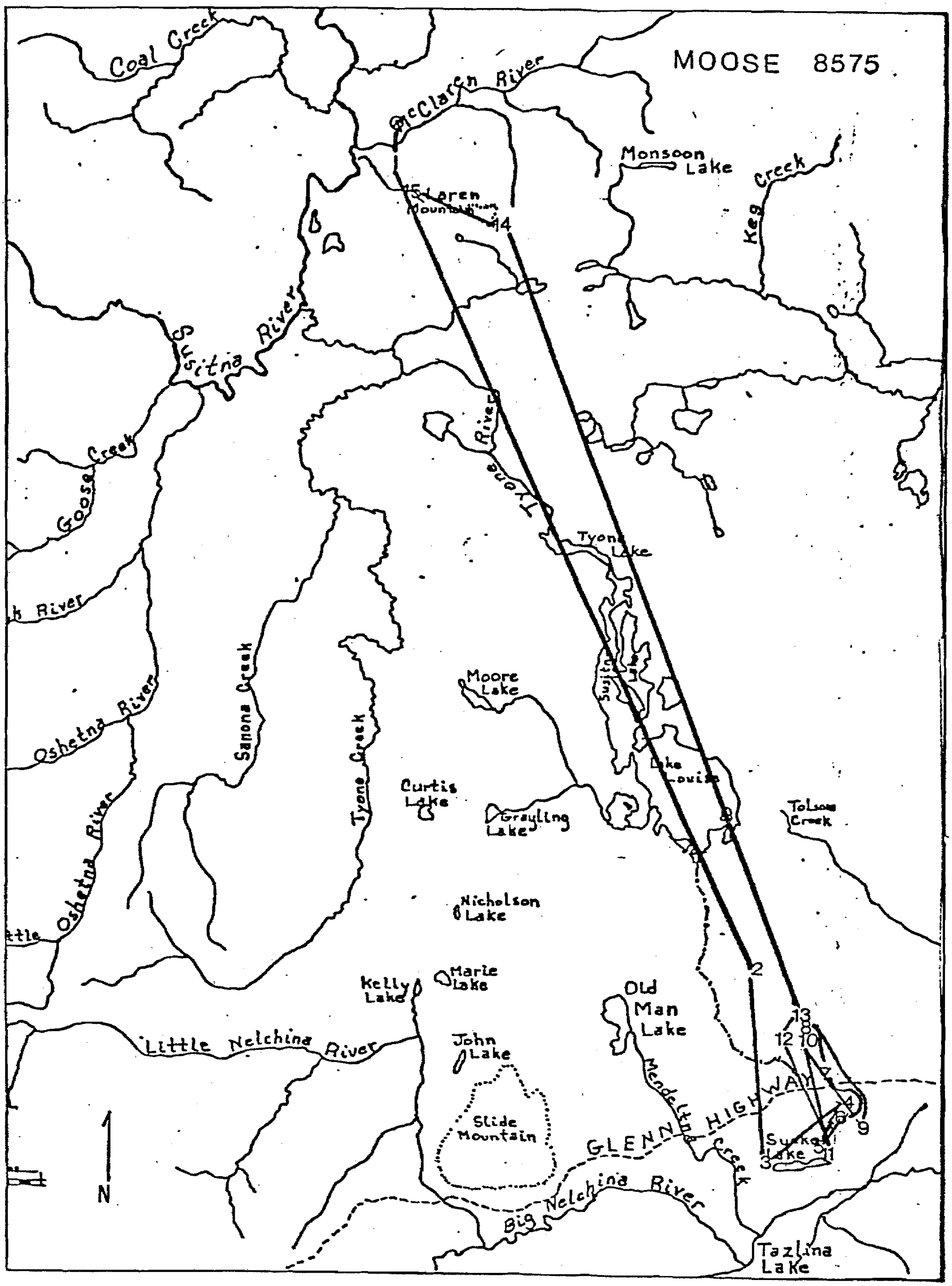
Number	Collar Color	Collar Number	Date	Remarks
8030	Black	NA	22 October 1976	With 5-6 cows

Observations

1	2 November 1976	
2	19 November 1976	With 1 cow, and close to radio 8035
3 (9:07 AM)	16 December 1976	With cow and calf
4	19 January 1977	Alone, however, large concentration moose in area
5	3 February 1977	No attempt to observe
6 (Noon)	5 March 1977	Alone
7 (10:22 AM)	30 March 1977	
8 (12:30 PM)	22 April 1977	With 2 cows, medium medium spruce
9 (5:00 PM)	10 May 1977	No attempt to observe
Ø (9:52 AM)	13 May 1977	Walking, dense tall spruce
10 (10:00 AM)	30 May 1977	With one new calf on island, feeding, sparse medium spruce
Ø (11:45 AM)	6 June 1977	With calf, feeding, sparse tall spruce
Ø (Noon)	10 June 1977	With calf on island, resting, sparse tall spruce
11 (1:15 PM)	15 June 1977	Alone, moved to next island, feeding on shore in water
Ø	17 June 1977	Alone
Ø	25 June 1977	Unable to observe due to dense vegetation
Ø	30 June 1977	With calf on island, medium medium spruce
Ø (10:15 AM)	7 July 1977	With calf
Ø (10:00 AM)	12 July 1977	With calf, bedded, medium medium spruce
12 (10:00 AM)	23 July 1977	With calf, running dense medium spruce

8030 continued

13	25 August 1977	With calf and 1 cow, sparse medium spruce
14	30 August 1977	With calf, bedded, dense medium spruce
15 (1:00 PM)	5 October 1977	With calf, 1 cow with calf, and 1 small bull, medium short spruce
16 (1:15 PM)	22 November 1977	With calf, standing in dense short spruce



MOOSE 8575
Coal Creek
McClaren River
Monsoon Lake
Keg Creek
Susitna River
Goose Creek
Tyone River
Tyone Lake
River
Sanona Creek
Oshetna River
Tyone Creek
Moore Lake
Lake Louise
Curtis Lake
Grayling Lake
Tolsona Creek
Oshetna River
Nicholson Lake
Kelly Lake
Marie Lake
Old Man Lake
Little Nelchina River
John Lake
Slide Mountain
GLENN HIGHWAY
Mendeltna Creek
Big Nelchina River
Tazlina Lake
N

Number	Collar Color	Collar Number	Date	Remarks
8575	Orange	3	21 March 1977	Pregnant, with group of 3 moose

Observations

1 (2:40 PM)	30 March 1977	Alone
2 (7:45 AM)	22 April 1977	Alone, bedded
∅	10 May 1977	Did not attempt to observe
3 (9:10 AM)	11 May 1977	Within 1/2 mile of 3 cows, dense tall spruce
4 (8:30 AM)	25 May 1977	Alone, appeared pregnant, medium medium spruce
5 (2:45 PM)	26 May 1977	With cow that has new calf, resting, medium medium spruce
6	30 May 1977	Alone, feeding, sparse tall spruce
7	10 June 1977	Alone, traveling, willow
∅	17 June 1977	Alone
8 (8:00 PM)	22 June 1977	Alone, feeding, sparse tall spruce
9 (1:00 PM)	28 June 1977	Alone, bedded, dense medium spruce
10 (9:00 PM)	6 July 1977	Alone, bedded, dense medium spruce
11 (1:00 PM)	12 July 1977	Alone, bedded, riparian willow
12 (7:30 AM)	2 August 1977	Alone, bedded, medium medium spruce
13 (9:45 AM)	17 August 1977	Alone, bedded, sparse medium spruce
∅ (2:00 PM)	18 August 1977	With 2 cows, bedded, medium medium spruce
∅ (9:45 AM)	13 September 1977	Alone, bedded, dense medium spruce
∅	30 September 1977	No visual, cow was traveling
14 (5:00 PM)	5 October 1977	Alone, in dense medium spruce, within 1 mile 1 cow with twins and 1 cow with calf
15 (1:00 PM)	22 November 1977	With 1 cow, bedded, dense tall spruce

APPENDIX II

Wildlife Studies

Introduction

The proposed Susitna Hydropower Project will have impacts on several wildlife species which either reside in the project area, use the area for migration or other seasonal purposes or use habitat downstream which will be altered by the stabilization of water flow. The following individual proposals comprise an integrated program to provide information needed to predict the impacts of the Project on wildlife and to provide a basis for making decisions which might minimize those impacts.

This program will not answer all questions. It is designed to provide an acceptable basis of knowledge in a limited time period using presently available techniques. Emphasis has been placed on species which are likely to be most adversely affected by the project and are of greatest interest to man.

The design, timing, manpower requirements and funding levels of the individual projects have been coordinated for efficiency. No single project can be conducted by itself without considerable change in design and increase in cost. For example the moose study is the core of the entire package. The wolf, wolverine, bear and caribou studies are dependent on the moose study for manpower equipment and logistic support. The moose, habitat mapping and vegetation studies are also dependent on each other as each will influence the design of the others and their results must be compatible for final data analysis. If one project does not produce results at the proper time other projects will be delayed, reducing the quality of information and increasing the overall cost of the program.

Title: Habitat mapping and vegetation studies required for analysis of the effects of the Susitna Hydropower Project on wildlife.

Objectives: To prepare a vegetative type map of areas within and adjacent to proposed impoundments, along transmission corridors and along the downstream floodplain.

To identify key moose browse species and determine the condition and trends of selected moose habitats.

To determine the effects of altered water flow on key plant species and map areas where substantial vegetation changes will occur.

Background: Most impacts of the Susitna Hydropower Project on wildlife will occur through loss or alteration of habitat. Where habitat is totally lost to a population through inundation or blocking of migrations it is necessary to know the importance of that particular habitat to the population and the availability of alternative habitats. Where habitat will be merely altered, it is also necessary to know what elements within that habitat are important to the population and what changes will occur in those elements. Direct studies of wildlife species can delineate a population and tell us where various components of the population are at different times and to a certain extent why they are there. However, wildlife studies must be accompanied by habitat studies if we are to determine the full significance of habitat alteration to the population.

This project is not an actual proposal. Several of the studies outlined here could be expanded to meet the needs of other disciplines. Therefore, this is a statement of information needed to evaluate the effects of the Susitna Project on wildlife. Actual study proposals should be developed to provide this information on the schedule outlined.

Procedures: A habitat type map of the proposed impoundment areas, all drainages flowing into the impoundments, access and transmission corridors and the downstream floodplain should be prepared during the first two years of the study. This map should be of sufficient detail to permit delineation of specific habitats favored by moose and must be accompanied by sufficient ground truth data to identify the distribution and abundance of moose browse species. In order to accomplish this it is essenital that the principal investigators of moose studies work directly with the habitat mappers.

Studies of the effects of water table and influence of water level fluctuations on vegetation, particularly moose browse species, along the floodplain of the Susitna River should be initiated immediately. A map of areas where changes in flow caused by the dams will alter the vegetation, either through changes in soil moisture or by allowing plant succession to occur, should be prepared. Emphasis should be placed on areas of high moose use such as the lower Susitna River.

Detailed studies of vegetation in important moose wintering areas should be conducted to identify plant species used by moose and quantify their presence, use and trends. Study areas would be identified from data collected under the moose studies.

Schedule:

FY 78	Habitat mapping, effects of water level studies
FY 79	Habitat mapping, effects of water level studies
FY 80	Map areas of expected plant composition changes. vegetation studies on moose winter range
FY 81	Moose winter range studies
FY 82	Moose winter range studies

Title: Impact of the Susitna Hydropower Project on Moose Populations

Objectives: To identify moose subpopulations using habitat subject to direct and indirect impact of the Susitna Hydropower Project.

To determine the seasonal distribution, movement patterns, size and trends of those subpopulations.

To determine the timing and degree of dependency of those subpopulations on habitat to be impacted by the Susitna Hydropower Project.

Background: Several subpopulations of moose occupy habitats that may be inundated or substantially altered by the proposed Susitna Hydropower Project. Limited studies conducted in 1977 identified one subpopulation which occupied the upper ends of tributaries north of the proposed impoundment areas during spring, summer and fall, then migrated to the Susitna River bottomlands during winter. Similar populations almost certainly occupy drainages to the south of the impoundments. There is also strong evidence that riparian habitat along the mainstem, which may be significantly altered by the stabilization of water flow, also serves as winter range for several subpopulations of moose. These habitats may be critical to these populations in severe winters. Other subpopulations may be nonmigratory and use areas to be affected all year. Some migratory populations may not rely on the river bottoms for seasonal range but may migrate through them on their way between seasonal ranges.

The degree of impact will vary depending on the subpopulations size, status and degree of dependence on altered habitat and the nature of the habitat alteration. Many factors must be considered including: the sex and age composition of members of the subpopulation using the habitat (often pregnant cows or cows with calves are more dependent on lowland areas than bulls), the overall range of the subpopulation (some members of a nearby subpopulation migrate up to 60 miles indicating that reductions in moose densities could occur over a vast area), the availability of alternative ranges particularly during severe winters (habitat alterations which may be relatively insignificant in normal or mild winters may be devastating when heavy snowfall makes alternative ranges unavailable), etc.

An adequate assessment of the potential impacts of the Susitna Project on moose requires a thorough understanding of moose populations using the area. This information must then be related to a knowledge of the habitat and the elements within that habitat that are necessary for moose. This study is designed to provide the necessary information on moose. It is essential that certain habitat studies be conducted concurrently. A habitat map of sufficient detail to delineate types selected by moose, covering the impoundment area, surrounding drainages, transmission corridors and the floodplain of the Susitna River to its mouth, should be prepared at an early stage of the studies. Detailed browse studies should be conducted at sites selected on the basis of use by moose to identify important browse species, measure the degree of use and identify other elements of the habitats that are important to moose. The role of the water table and spring flooding in maintaining moose habitat below Devils Canyon should be determined and maps delineating areas where the alteration of the flow will result in vegetation changes should be prepared.

This moose study and the habitat studies outlined above should be closely coordinated as each will influence the final design of the other and all are necessary to relate habitat changes to moose.

Procedures: During 1977, 12 moose were radio collared and 14 others were collared with visually identifiable collars. These moose were tracked from March to December 1977. Under this study, tracking of those moose will be continued, to further delineate the ranges of that subpopulation.

Additional moose will be radio collared in drainages along the south side of the proposed impoundment area and in riparian habitats along the mainstem below Devils Canyon.

Each radio collared moose will be relocated regularly. For each relocation the exact location, habitat type, activity of the moose and association with other animals will be recorded.

A random stratified census and seasonal sex and age composition counts will be conducted on subpopulations most likely to be affected by the Susitna Hydropower Project. Concentrations of moose will be mapped throughout the area whenever the opportunity arises.

These data will be used to identify subpopulations using areas to be impacted, to determine the seasonal ranges and migration routes of each subpopulation and to estimate the size and composition of those subpopulations most likely to be impacted. Locations of moose will be overlayed on habitat maps to determine the degree of use of certain habitat types as well as specific habitats. This information will be analyzed by subpopulation, season, sex and age class and reproductive status. Areas likely to be altered by the project that are critical to a subpopulation will be identified and recommended for more detailed vegetation studies.

Schedule:

FY 78	Radio collar moose, tracking flights, composition counts
FY 79	Tracking flights, composition counts, random stratified count. Review habitat map and map of downstream areas to be impacted and identify data gaps. Identify areas for detailed vegetation studies.
FY 80	Replace radios and radio collar new moose to fill identified data gaps, tracking flights, composition counts.
FY 81	Tracking flights, composition counts, random stratified counts.
FY 82	Tracking flights, composition count, start final analysis of data.
FY 83	Tracking flights, complete analysis of impact of Susitna Hydropower Project on moose, write final report.

Cost:

FY 78	$220,000
FY 79	$210,000
FY 80	$180,000
FY 81	$210,000
FY 82	$175,000
FY 83	$ 85,000

Title: Mitigation measures for lost moose habitat.

Objectives: To identify and evaluate measures for enhancing moose habitat.

To locate areas where moose habitat enhancement would effectively mitigate loss or deterioration of moose habitat resulting from the Susitna Hydropower Project.

Background: Important and perhaps critical moose habitat will be totally lost or reduced in quality by the Susitna Hydropower Project. The proposed moose and habitat studies should quantify this loss and its resulting impact on moose populations.

Moose tend to favor subclimax ranges. In recent years several agencies have recognized a potential for enhancing habitat for moose by setting back plant succession through artificial means. The Alaska Department of Fish and Game, U.S. Fish and Wildlife Service and U.S. Forest Service have all experimented with such techniques as mechanical crushing, prescribed burning and fertilizing. At present these techniques have not been fully evaluated.

Such techniques are probably effective only in certain types of habitats. In some cases it might be possible to fully mitigate the impact on a particular subpopulation of moose. For example, if an effective technique can be found to maintain willow habitats on river bars without periodic flooding, impacts on subpopulations dependent on downstream habitat might be kept to a minimum.

In other cases where critical habitat will be completely destroyed it might be possible to make alternative habitat available to the affected subpopulation of moose. However, there will likely be some subpopulations for which mitigation measures will not be possible. In these cases the loss to human users could be offset by enhancing the range of populations of moose away from the Project area.

In order to assess these possibilities it is necessary to evaluate the various techniques and to delineate habitat where these techniques would have a positive effect on moose.

This project is designed to provide information to assess the feasibility of mitigation and to initiate long term studies which would direct actual mitigation efforts. Evaluation of these long term studies will take many years. The need to complete the long term studies will depend on the results of the feasibility study.

Procedures: A complete review of potential moose habitat manipulation techniques will be made. Areas which have been experimentally manipulated in the past will be visited and the quantity and quality of potential moose browse produced will be assessed. Information gaps will be identified and if necessary further experimental manipulation will be recommended.

Data from the habitat mapping, vegetation and moose studies will be used to identify areas where habitat manipulation might offset adverse impacts on each of the subpopulations of moose that are identified.

Schedule:

FY 79	Preliminary review of techniques and identification of areas of past experimentation.
FY 80	Evaluation of success of previous manipulation efforts. Identification of data gaps. Recommendations on future experimentation.
FY 81	Continue evaluation of manipulated areas. Initiate manipulation experiments to fill data gaps.
FY 82	Evaluate techniques. Identify potential areas for mitigation.
FY 83	Evaluate techniques. Identify potential areas for mitigation.

Cost:

FY 79	\$ 5,000
FY 80	\$ 20,000
FY 81	\$275,000 (actual cost will depend on results of FY 79 and 80 studies)
FY 82	\$ 20,000
FY 83	\$ 20,000

Title: Impact of the Susitna Hydropower Project on caribou populations.

Objectives: To identify subpopulations of caribou in the Nelchina Basin.

To determine the seasonal ranges and migration routes of these subpopulations with emphasis on traditional migration routes across proposed impoundment areas and potential alternative routes.

To determine the availability of suitable alternative seasonal ranges to caribou subpopulations that might be isolated from traditional ranges by the proposed impoundments.

Background: The Nelchina basin has been the most important sport hunting area for caribou in Alaska. Although caribou numbers were reduced from a recorded high of 72,000 to a low of 10,000 the population is presently increasing and is now estimated to exceed 14,000 cariobu. Proposed management plans state that the population will be allowed to increase until it numbers 20,000 caribou.

Caribou traditionally have used a variety of ranges on both sides of the Susitna River and varying numbers have crossed the Susitna at least twice a year. Major crossing locations have been recorded in areas which would be affected by the proposed hydropower project. Because caribou frequently migrate long distances and may periodically overgraze one range and shift to another, it is necessary to examine the status of caribou and identify alternative ranges over a large area.

Range studies conducted by the Alaska Department of Fish and Game have shown that the most desirable winter ranges remaining in the Nelchina basin are located in the Clearwater Mountains, Chunilna Hills, Susitna Uplands and Monahan Flats. Most of these ranges are north of the Susitna River while historical and recent calving and summer ranges exist south of the river. The preferred lichens south of the river have generally declined and have not shown substantial recovery even with lowered caribou populations. Meanwhile, the Nelchina population has used this area to a greater extent than the other portions of its range. A portion of the winter range exists east of the Richardson Highway in the Wrangell Mountains but movement into this range may be affected by the recent construction of the oil pipeline from Prudhoe Bay to Valdez. All of these factors make it likely that the ability to cross the Susitna will remain critical to the well being of the Nelchina caribou herd.

To determine the extent that the impoundments will affect this movement is difficult. Other migration routes may be used in addition to those already shown in the literature or sufficient range may be available to the east to support the proposed population level. It is also possible that a separate but smaller population exists north of the Susitna which may increase to fill the available range in that area even if the existing Nelchina population were confined to the area south of the proposed impoundments.

Procedures: Caribou on both sides of the Susitna River will be radiocollared during the breeding season. Monitoring flights will be made at a relatively low intensity (approximately monthly) throughout most of the year to determine if more than one population exists in the area and to determine seasonal ranges of each population identified. More intensive monitoring flights will be made during the periods of precalving and postcalving movements and winter shift to determine present migration routes and the timing of migration. It will be necessary to repeat this procedure for several years to determine variation among years.

Traditional migration routes will be determined by mapping trails and will be compared with present routes.

Potential alternative ranges will be identified and evaluated using the modified Hult Surlander method of range analysis. These ranges will be compared with Nelchina ranges that have been studied for a number of years.

Schedule:

FY 79	Radio collar caribou, monitor movements. Conduct range analysis.
FY 80	Replace inoperative radios, monitor movements.
FY 81	Replace inoperative radios, monitor movements.
FY 82	Replace inoperative radios, monitor movements.
FY 83	Monitor movements. Repeat range analysis to determine trends.

Cost:

FY 79	$120,000
FY 80	$ 95,000
FY 81	$ 95,000
FY 82	$ 95,000
FY 83	$102,000

Title: Effects of the Susitna Hydropower Project on wolves.

Objectives: To determine the number of wolf packs and the number of wolves in each pack that inhabit areas to be directly affected by the Susitna Hydropower Project.

To determine the proportions of each pack's territory that lies within areas of impact.

To determine the location of dens, rendezvous sites, hunting areas and the other essential activity areas of each pack in relation to proposed impoundments and construction activities.

To determine the dependence of each pack on prey populations that may be adversely affected by the Project.

Background: Wolves are of considerable national concern as evidenced by recent newspaper and magazine articles. They are known to inhabit the entire project area and information on population size and movements is needed to determine project impacts.

Studies in other areas of southcentral Alaska have demonstrated that some wolves have home ranges as large as 2,000 square miles while many packs have territories ranging from 200 to 600 square miles. It is known that the immediate project area may contain five or more wolf packs. It appears that some of these packs use the Susitna River as a territory boundary, and inundation and associated development could have a dramatic influence on them. These packs depend heavily on moose populations that use the impoundment areas. In addition other studies have shown that any human disturbance relatively close to a wolf den may cause abandonment of the traditional site and perhaps reproductive failure.

Procedures: Two to four wolves will be radio collared in each pack whose territory is believed to include potential impoundment areas and construction sites. The numbers of wolves in each pack will be determined, each pack's territory will be delineated and the degree and nature of use of potential impact areas will be determined through repeated relocations and observation of activities. Specifically, all den sites, rendezvous sites and favored hunting areas will be mapped. These data will be used to determine the degree of dependence of wolves on various areas that will be impacted by the Project.

Dependency on various prey species will be determined by scat analysis and observation of hunting behavior and kills. This information will be used in conjunction with data from the accompanying studies of prey species, particularly the moose study, to estimate indirect impacts on wolves caused by a reduction in prey availability.

Field activities and manpower for this study will be integrated with the moose study. Wolves frequently will be tagged and relocated at the same time as moose. Full funding of the moose study is required for the successful implementation of this study.

Schedule:

FY 78	Radiocollar wolves, monitoring flights.
FY 79	Replace lost radios, monitoring flights.
FY 80	Replace lost radios, monitoring flights.
FY 81	Radiocollar new wolves to fill data gaps. Monitoring flights.
FY 82	Monitoring flights.
FY 83	Monitoring flights.

Cost:

FY 78	$55,000
FY 79	$36,000
FY 80	$29,000
FY 81	$40,000
FY 82	$25,000
FY 83	$13,000

Title: Effects of the Susitna Hydropower Project on black and brown/grizzly bears.

Objectives: To estimate the numbers of black and brown/grizzly bears using the area to be impacted by the Susitna Hydropower Project.

To determine the dependency of these bears on areas to be impacted, with emphasis on identification of denning areas and seasonal feeding areas.

Background: Very little is known of either brown or black bear populations in the Susitna Basin except that brown bear densities appear to have been very high for several years. We do not know how many bears inhabit the area or how dependent they are on the impoundment areas. Studies should be conducted to estimate bear numbers in and surrounding project area, determine whether the same bears are resident or whether a larger number have a seasonal dependency on the area, and determine the location and extent of denning activities.

A major problem with any large construction project is the attraction of bears to camps and construction sites. This usually results in threats to human safety, delays in construction and destruction of bears. If areas of bear concentration can be identified and avoided during construction, these problems can be substantially reduced.

Procedures: Bears will be radiocollared in the project area. Movements in and around the area will be monitored. Den sites and concentration areas will be mapped.

Bear numbers will be estimated through marked/unmarked ratios observed during spring and fall composition counts and by recording all bears seen during tracking flights.

Field activities for this study will be closely integrated with those for the moose and wolf studies. Full funding of the moose study is required for the successful implementation of this study.

Schedule:

FY 79	Radiocollar bears, monitoring flights composition counts.
FY 80	Monitoring flights, composition counts.
FY 81	Monitoring flights, composition counts.
FY 82	Monitoring flights.

Cost:

FY 79	$95,000
FY 80	$57,000
FY 81	$50,000
FY 82	$35,000

Title: Effects of the Susitna Hydropower Project on wolverine.

Objectives: To determine the population status of wolverines using areas to be impacted by the Susitna Hydropower Project.

To determine movement patterns and identify habitats of seasonal importance to wolverines.

Background: Less is known about the wolverine than any other big game species in Alaska. Threatened with extinction throughout most of its range in the Scandinavian countries, parts of Russia, the continental United States and Eastern Canada, it is still considered relatively abundant in Alaska. Studies in Idaho and Sweden indicate that wolverines have exceptionally large home ranges. Records of males moving 15 miles in a 24 hour period are not uncommon.

The Talkeetna mountains on either side of the Susitna River between Gold Creek and the MacLaren River presently support a healthy population of wolverines. Although their density is not known at this time, it is probably as high or higher there than in any other portion of their range in Southcentral Alaska. Because the welfare of this species in Alaska is of both national and international concern, some intensive efforts to determine the status, distribution, and movement patterns of wolverine in the project area are warranted.

Procedures: A limited number of wolverines will be radiocollared and tracked in conjunction with other telemetry studies in the area. Home ranges, movement patterns, and seasonal habitat use will be determined by systematic relocation of radiocollared animals.

A systematic aerial survey of wolverines and their tracks will be made in conjunction with wolf studies to determine the distribution and numbers of wolverines using the area.

These data will be used to estimate the number of wolverines using the impoundment areas, determine the degree of dependency of certain wolverines on those areas and identify specific areas of importance to wolverines.

Schedule:

FY 79	Radiocollar, monitoring flights, census.
FY 80	Radiocollar, monitoring flights, census.
FY 81	Monitoring flights.

Cost:

FY 79	$30,000
FY 80	$25,000
FY 81	$10,000

Title: Distribution and status of Dall sheep adjacent to the Susitna Hydropower Project area.

Objectives: To determine the numbers of Dall sheep inhabiting mountains adjacent to proposed dam sites.

To delineate the seasonal ranges of the sheep population.

Background: A relatively isolated sheep population inhabits mountains adjacent to the proposed dam sites. While there will probably be little direct impact on this population by the proposed project, there is a possibility of adverse impacts from human disturbance as a result of dam construction activities and increased access.

Procedures: Aerial surveys will be conducted to determine the size of the sheep population and to delineate seasonal ranges.

Schedule:

FY 79	Aerial surveys.
FY 80	Aerial surveys.
FY 81	Aerial surveys.

Cost:

FY 79	$3,000
FY 80	$3,000
FY 81	$1,000

Title: Distribution and abundance of furbearers and small game in the proposed Susitna Hydropower Project impoundment areas.

Objectives: To determine the distribution and relative abundance of furbearers and small game in the proposed impoundment areas and determine the degree of use of those species by humans.

To determine the dependence of furbearers and waterfowl on downstream habitats which will be altered by changes in water flow.

Background: Little is known about the distribution and abundance of either furbearers or small game. In order to assess the potential impact of the project on small game it will be necessary to conduct a basic biological reconnaissance. It is known from data collected incidentally to other projects that the Susitna River Basin provides habitat for large numbers of fox, wolverine, and river otter. All three of these species are highly sought by trappers.

Stabilization of water flow could substantially alter aquatic furbearers and waterfowl habitat downstream.

Procedures: Limited aerial surveys will be conducted to determine the presence, distribution and relative abundance of fox, otters, beavers, ptarmigan, waterfowl and raptors. On the ground observations will be made in conjunction with the nongame project.

Trappers and residents of the area will be interviewed.

Surveys of aquatic furbearers and waterfowl will be conducted in downstream areas of probable habitat alteration that will be identified by studies on the effects of water flow on habitat.

Schedule:

FY 79	Surveys in impoundment areas, interviews.
FY 80	Surveys in impoundment areas, interviews.
FY 82	Surveys downstream.
FY 83	Surveys downstream.

Cost:

FY 79	$35,000
FY 80	$35,000
FY 82	$25,000
FY 83	$25,000

Title: Distribution and abundance of nongame species of wildlife in the area to be impacted by the Susitna Hydropower Project.

Objectives: To determine the occurrance, distribution and relative abundance of small mammals and passerine birds in the proposed impoundment areas.

Background: Little is known about the occurrence, distribution or abundance of small mammals and both resident and migratory passerine birds in the Project impact area. A limited reconnaisance should be conducted.

Procedures: A literature search will be conducted. Surveys from the ground will be made and limited trapping will be done. Portions of this study will be coordinated with small game and furbearer studies.

Schedule:

FY 79	Literature search, initiate surveys.
FY 80	Complete surveys.

Cost:

FY 79	$7,000
FY 80	$8,000