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

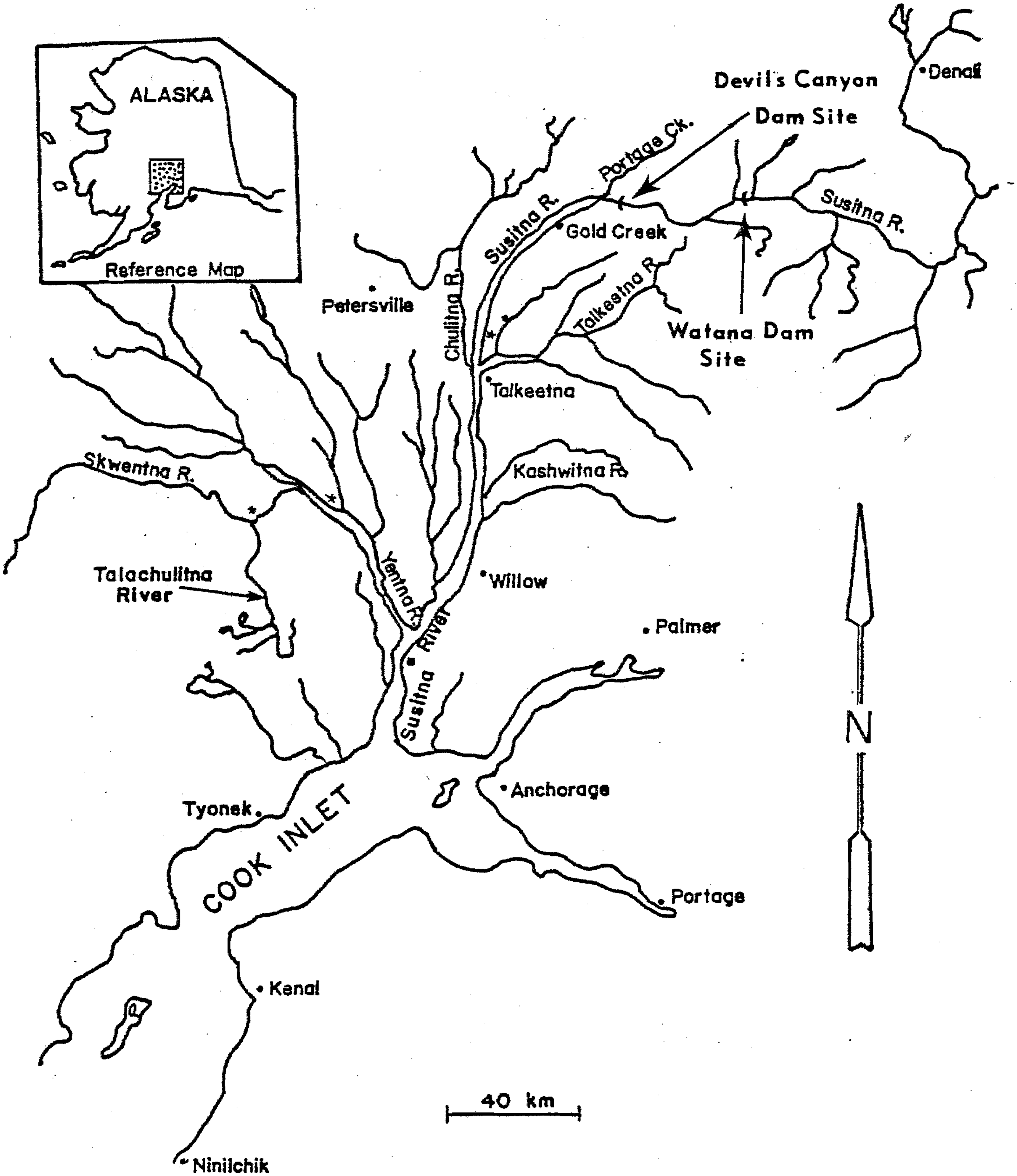

Figure 1. The Susitna River drainage, Devils Canyon Project, 1977.

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).

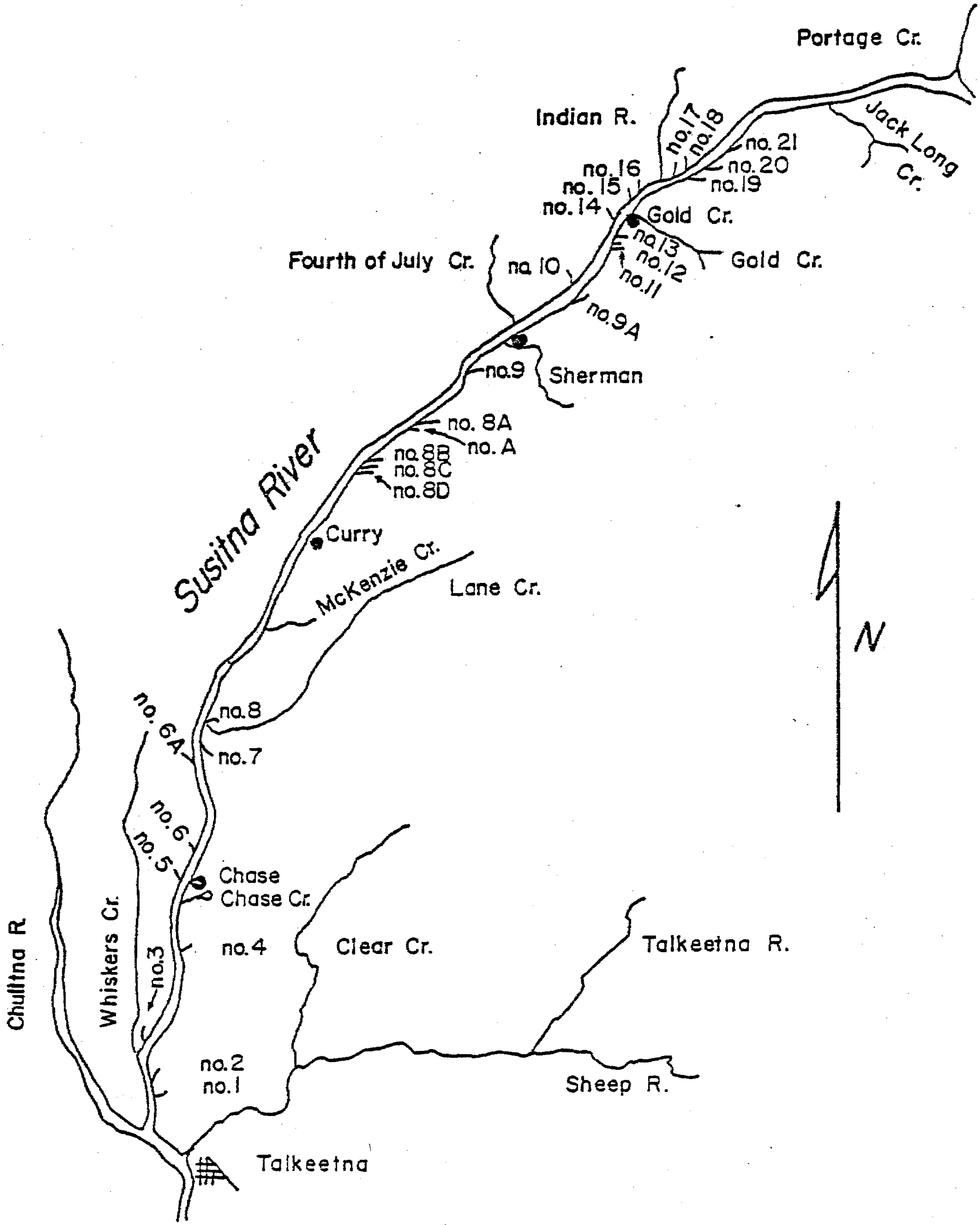

Figure 2. Upper Susitna River study area, Devils Canyon Project, 1977.

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	69,122	Total Count	14,199
Estimated Total Count	93,411	Estimated Total Count	17,028

Total Count	83,321
Estimated Total Count	109,439

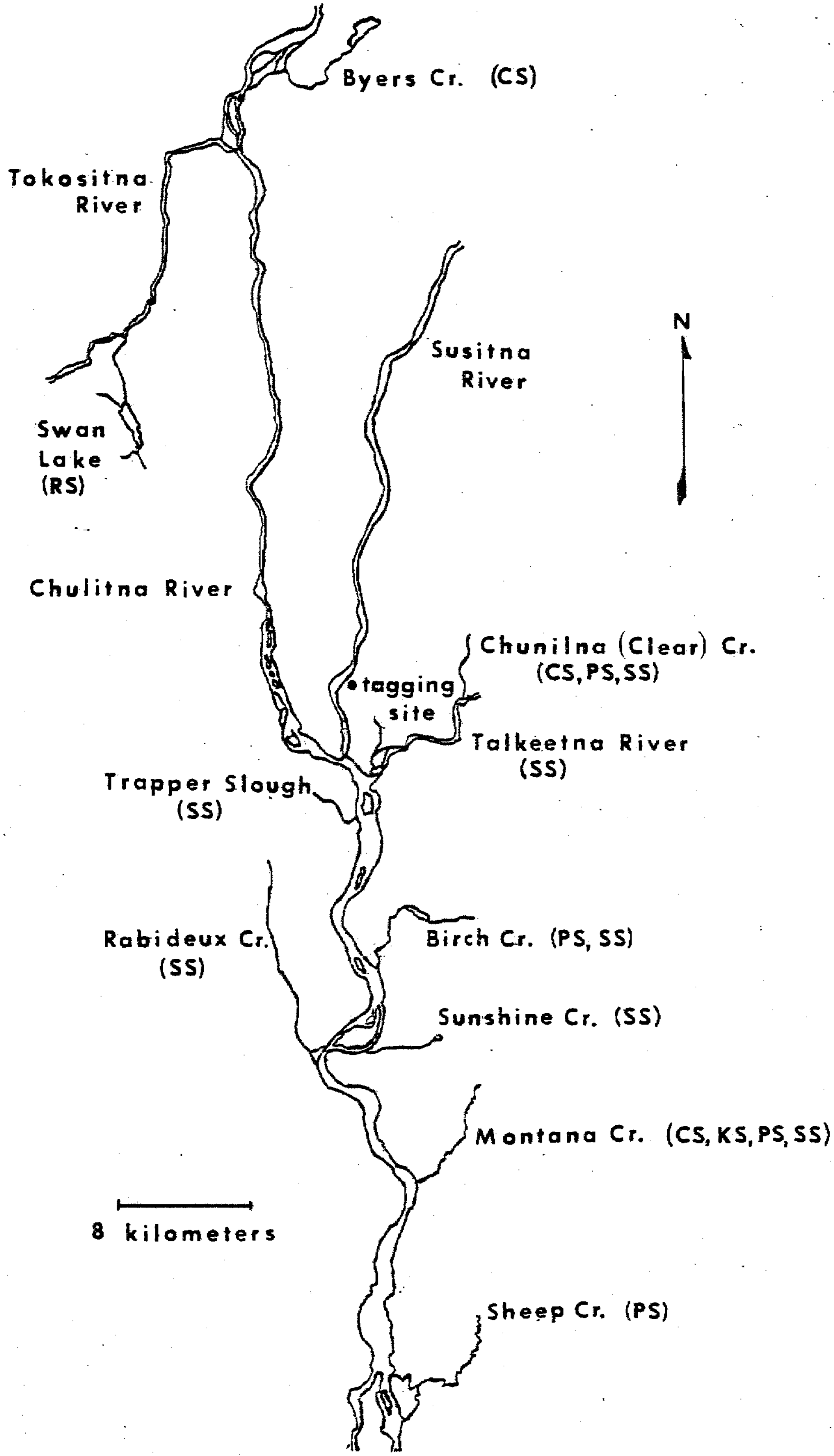

Figure 3. Locations of adult salmon tag recoveries occurring downstream of the Susitna River fishwheel sites, Devils Canyon Project, 1977 (RS-sockeye salmon; PS-pink salmon; CS-chum salmon; SS-coho salmon; KS-chinook salmon).

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.

Index Area	Catch/Trap Hour 1977 8/23	10/26	12/1	1978 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.

Species	Sample Size		Mean Percent Per Fish: 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

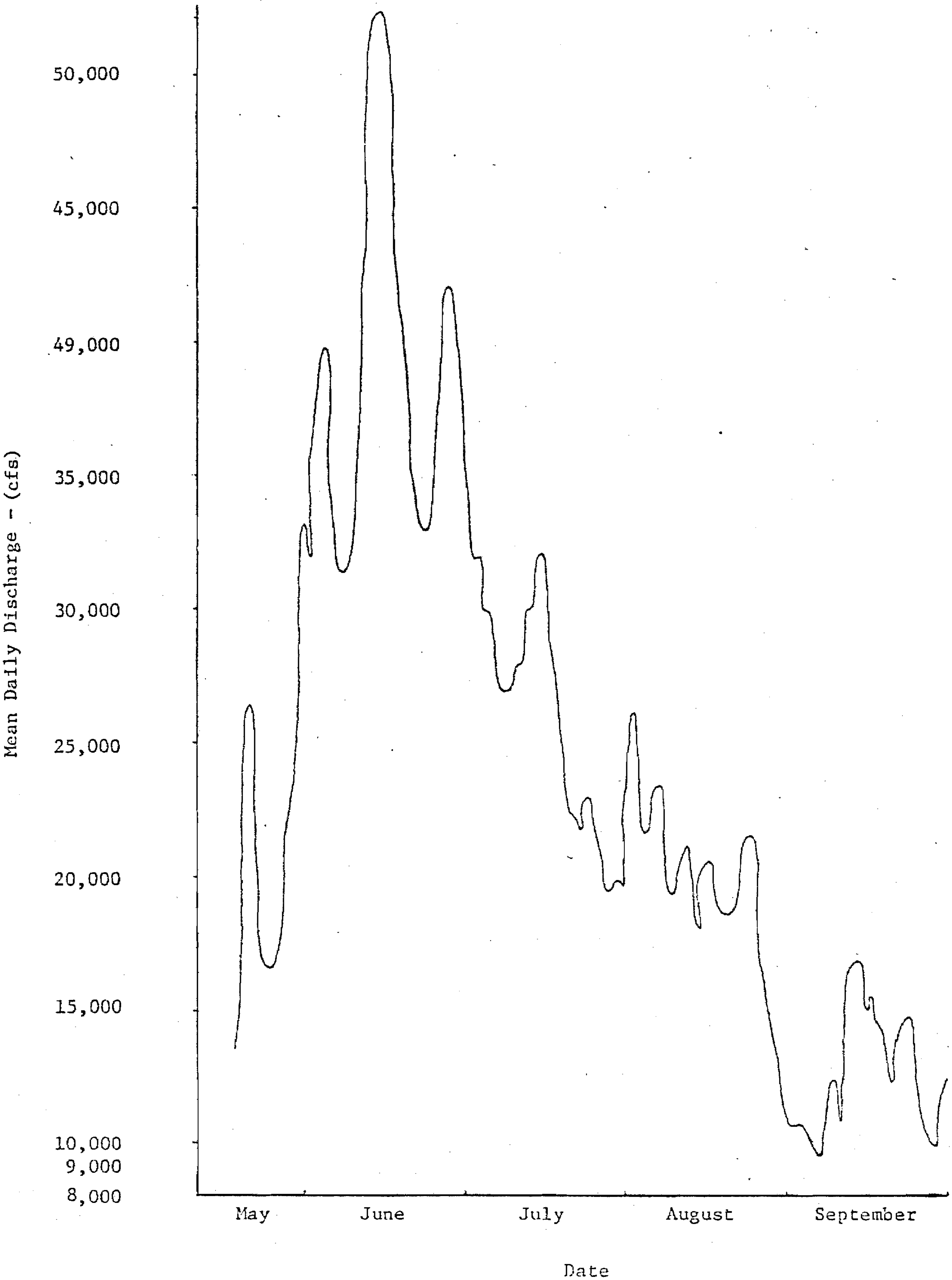

Figure 4. Susitna River discharge at Gold Creek, Devils Canyon Project, 1977.

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/l to 68 mg/l. 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/l.

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

Appendix I

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.

Location	Age Class	Date	Length (mm) Mean	Length (mm) Standard Deviation	Length (mm) Range	Weight (g) Mean	Weight (g) Standard Deviation	Weight (g) Range	Condition Factor Mean	Condition Factor Standard Deviation	Condition Factor 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.

Location	Age Class	Date	Length (mm) Mean	Length (mm) Standard Deviation	Length (mm) Range	Weight (g) Mean	Weight (g) Standard Deviation	Weight (g) Range	Condition Factor Mean	Condition Factor Standard Deviation	Condition Factor Range	Percent1/ 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	Percent 1/ 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	Percent 1/ 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) Mean	Length (mm) Standard Deviation	Length (mm) Range	Weight (g) Mean	Weight (g) Standard Deviation	Weight (g) Range	Condition Factor Mean	Condition Factor Standard Deviation	Condition Factor Range	Percent1/ Composition	n
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)

Location	Age Class	Date	Length (mm) Mean	Length (mm) Standard Deviation	Length (mm) Range	Weight (g) Mean	Weight (g) Standard Deviation	Weight (g) Range	Condition Factor Mean	Condition Factor Standard Deviation	Condition Factor 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				Predominate Organisms
			Crustacea	Immature Insecta	Adult Insecta	Other	
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				Predominate Organisms
			Crustacea	Immature Insecta	Adult Insecta	Other	
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				Predominate Organisms
			Crustacea	Immature Insecta	Adult Insecta	Other	
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
Slough #21 (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
Whisker's Creek (26N 05W 03AAC)										
Downstream Gage										
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	—
Upstream Gage										
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
McKenzie Creek (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
Chase Creek (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.

	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	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

Appendix II Table 7.

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

624941149221500 - 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	TEMPERATURE (DEG C) (00010)	AIR TEMPERATURE (DEG C) (00020)	SURFACE AREA (SQUARE MILES) (00049)	INSTANTANEOUS DISCHARGE (CFS) (00061)	COLOR (PLATINUM-COBALT UNITS) (00080)	SPECIFIC CONDUCTANCE (MICROMHOS) (00095)	DISSOLVED OXYGEN (MG/L) (00300)	PH (UNITS) (00400)	CARBON DIOXIDE (CO2) (MG/L) (00405)	ALKALINITY 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)	SUSPENDED SEDIMENT (MG/L) (80154)	SUSPENDED SEDIMENT DISCHARGE (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 — PROCESS DATE 0

15292000 - SUSITNA RIVER AT GOLD C AK — 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 [illegible]

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
15292780 - SUSITNA R AT SUNSHINE AK

PROCESS DATE 03/16/78
DISTRICT CODE 02

WATER QUALITY DATA, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977

DATE	TIME	TYPE	TEMPER-ATURE (DEG C) (00010)	INSTAN-TANEOUS DIS-CHARGE (CFS) (00061)	COLOR (PLAT-INUM-COBALT UNITS) (00080)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS) (00095)	DIS-SOLVED OXYGEN (MG/L) (00300)	PH (UNITS) (00400)	CARBON DIOXIDE (CO2) (MG/L) (00405)	ALKA-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
15292780 - SUSITNA R AT SUNSHINE AK

PROCESS DATE 0341
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. Physio-chemical 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