UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
ANCHORAGE, ALASKA

SOUTH CENTRAL RAILBELT AREA - SUSITNA RIVER BASIN

FISH AND WILDLIFE STUDIES RELATED TO THE CORPS OF ENGINEERS DEVIL CANYON, WATANA RESERVOIR HYDROELECTRIC PROJECT

STUDIES WERE CONDUCTED BY THE ALASKA DEPARTMENT OF FISH AND GAME UNDER A CONTRACT AGREEMENT WITH THE U. S. FISH AND WILDLIFE SERVICE

FEBRUARY 1976

STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

JAY S. HAMMOND, GOVERNOR

333 RASPBERRY ROAD
ANCHORAGE 99502

January 19, 1976

Mr. Gordon Watson
Fish and Wildlife Service
U.S. Department of the Interior
813 D Street
Anchorage, Alaska 99501

Dear Mr. Watson:

Contained herein are reports submitted by the Alaska Department of Fish and Game to fulfill contract obligations to the U. S. Fish and Wildlife Service for studies of the proposed Susitna River hydroelectric project.

The biological studies attached were conducted by three separate divisions of this agency, resulting in a segmented report. The Game Division conducted studies of moose and caribou within and adjacent to the impoundment area. The Commercial Fish Division studied primarily the anadromous fish populations and aquatic habitat downstream of the proposed impoundment site, and the Sport Fish Division conducted a limnological study supplemented with fishery information for both resident and anadromous fish species.

The full impacts of hydroelectric development of the Susitna River are as yet undetermined. The potential impacts depicted in each of the fish division report segments are not necessarily impacts this project will have, but illustrate areas of biological concern. As stated previously, inadequate funding and time have been limiting factors in carrying out more extensive studies.

We think the collective findings of these reports will be valuable as preliminary baseline data and as an aid in planning future investigations.

If I may be of assistance in interpreting or clarifying any of the attached study findings feel free to contact me.

Yours truly,

Larry J. Heckart

Larry J. Heckart
Mgt-Research Coordinator
Division of Sport Fish

Attachments:

PREAUTHORIZATION ASSESSMENT OF ANADROMOUS FISH POPULATIONS
OF THE UPPER SUSITNA RIVER WATERSHED IN THE VICINITY
OF THE PROPOSED DEVIL CANYON HYDROELECTRIC PROJECT

by:
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Alaska Department of Fish and Game
Division of Commercial Fisheries
Anchorage, Alaska

November, 1975

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A 1972 Senate Public Works Committee resolution requested the U.S. Corps of Engineers to consider the possibilities of hydroelectric power development along the Upper Susitna River in the area of Devil Canyon. In 1974 the National Marine Fisheries Service (NMFS) contracted the Alaska Department of Fish and Game, Division of Commercial Fisheries, to conduct a preauthorization assessment of the salmon populations (Oncorhynchus sp.) utilizing the Susitna River in the vicinity of the proposed Devil Canyon damsite. The objectives of these studies were to determine the spawning distribution, relative abundance, migrational timing, representative age-length-sex composition by species, and juvenile rearing areas (Barrett, 1974, 1975a, 1975b, 1975c). Investigations were expanded in 1975 to include the lower reaches of the Talkeetna and Chulitna Rivers through funds provided by U.S. Fish and Wildlife Service.

Several sites within the Susitna River drainage have been under consideration for construction of a hydroelectric complex since the early 1950's. The current recommended plan includes the construction of dams and powerplants on the Susitna River at Devil Canyon and Watana and electric transmission facilities to the Alaska Railbelt load centers. Construction is expected to commence in 1981 with Watana Dam followed by Devil Canyon Dam. Proposed construction time for the project is 12 years.

The proposed plan for the Watana site includes the construction of an earthfill dam with a structural height of 810 feet (247 m) at river mile 165 (266 km). The reservoir would have an elevation of 2,200 feet (671 m) and a crest elevation of 2,210 feet (674 m). It would cover a surface area of approximately 43,000 acres and extend about 54 river miles (87 km) upstream from the damsite, i.e., 4 miles (6 km) above the confluence of the Susitna and Oshetna Rivers (personal communication, J. Reid, 1975).

The plans for the Devil Canyon site include the construction of a concrete thin-arch dam with a structural height of 635 feet (194 m) located at river mile 134 (216 km). The reservoir created would have a surface area of about 7,550 acres and would extend upstream approximately 23 river miles (37 km) to the Watana Dam site (personal communication, J. Reid, 1975).

Barrett's studies (1974) provide the only recent information available on the extent of salmon utilizing the Susitna River and its tributaries between Devil Canyon and its confluence with the Chulitna River. Investigations by U.S. Fish and Wildlife Service in 1956 documented the presence of salmonid populations in the Susitna River and four tributary streams between Gold Creek and the Devil Canyon site (Anonymous, 1957). Anadromous species were not found above Devil Canyon.

This study included continued monitoring of spawning distribution, relative abundance and representative age-length-sex composition by species and surveys of juvenile rearing areas. Reconnaissance surveys were initiated on the Talkeetna and Chulitna Rivers in June 1975 and weekly surveys were conducted from July through September 1975. Adult and juvenile fish populations were monitored in the Susitna River and its tributaries between Devil Canyon and its confluence with the Chulitna River from July through September 1975.

Description of Study Area

The Susitna River rises in Alaska Range of southcentral Alaska and drains an area exceeding 19,000 square miles (49,210 sq km). The Susitna River is approximately 275 miles (443 km) long from its source to its point of discharge into Cook Inlet (Figure 1). The major tributaries of lower basin originate in glaciers and carry a heavy load of glacial silt. Most of the tributaries are turbulent in their upper reaches and slow-flowing in the lower regions. Thirty-seven sampling sites were monitored on the Susitna River between Devil Canyon and the confluence of the Chulitna River in 1975 (Figure 2). Twenty-eight of these sites were clearwater slough areas adjunct to the Susitna River. The remaining locations were clearwater creeks and rivers flowing into the Susitna River (Appendix I, Figures 1-27).

The Talkeetna River originates in the Talkeetna Mountains and flows in a westerly direction to its point of discharge into the Susitna River 80 miles (129 km) upstream from its mouth. An aerial reconnaissance of the river was conducted in June 1975. Potential spawning and rearing areas were mapped and later surveys by riverboat established 16 sampling sites from Clear Creek downstream to the confluence of the Talkeetna and Susitna Rivers (Figure 3). Two of these sites are clearwater streams and 14 are slough areas adjunct to the Talkeetna River (Appendix I, Figures 28-40).

The Chulitna River originates in the Alaska Range and flows in a southerly direction, joining the Susitna River opposite the Talkeetna River confluence. The braided nature of this river at its mouth prevents extensive surveying by riverboat. One sampling location was established on the Chulitna River approximately one-half mile (0.8 m) above its confluence with the Susitna River (Appendix I, Figure 41).

METHODS OF INVESTIGATION

Sampling Procedures

Winter Sampling

Winter sampling was conducted from a base camp located at Indian River. Access to slough areas was provided by a single track snow vehicle. Fifteen sloughs and 3 clearwater streams were surveyed from March 11 to March 14, 1975. Sloughs were sampled for temperature, dissolved oxygen, pH, relative water height and flow, ice cover and thickness, and snow depth. Dissolved oxygen was measured with a Edmondson-Wilson D.O. and temperature analyzer (Model #60-620). Fry were sampled from sloughs with minnow traps when water depths permitted. Samples caught were frozen and returned to the Anchorage laboratory for analysis. Standard length (SL) data was obtained for all specimens. Scale samples were taken for age analysis.

A Ryan thermograph was installed at Gold Creek (river mile 119) to monitor daily water temperature fluctuations. Water conditions at Gold Creek and the Anchorage-Fairbanks Highway Bridge crossing below Talkeetna were monitored biweekly. Water conditions at Chase Creek, river mile 91 (146 km), were sampled monthly. Two liter water samples were collected at each site for total dissolved solid analysis. Temperature, dissolved oxygen, pH, water depth, ice cover and snow cover were recorded at each site.

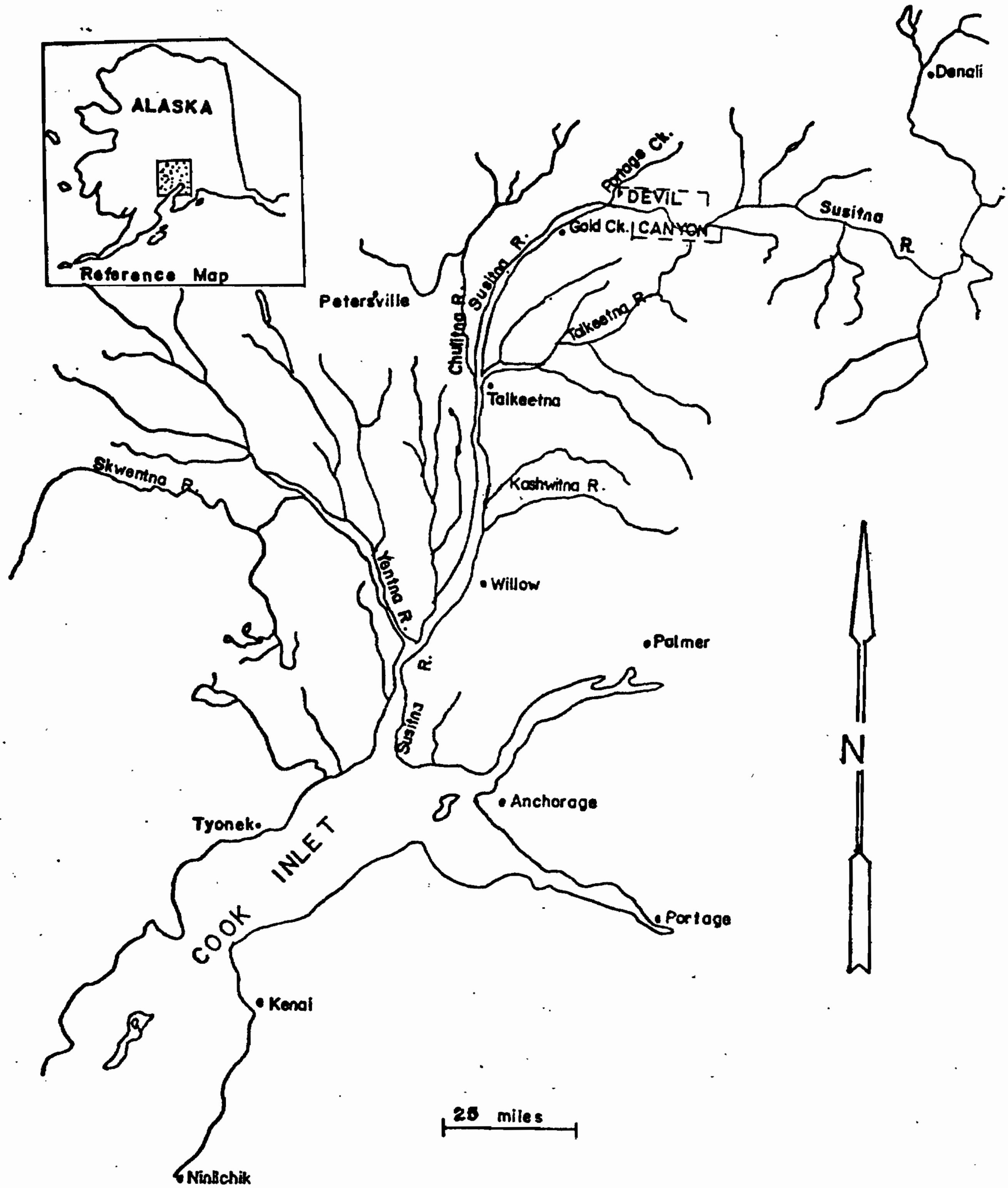

Figure 1. Devil Canyon in reference to the Susitna River watershed and northern Cook Inlet, Devil's Canyon Project, 1975.

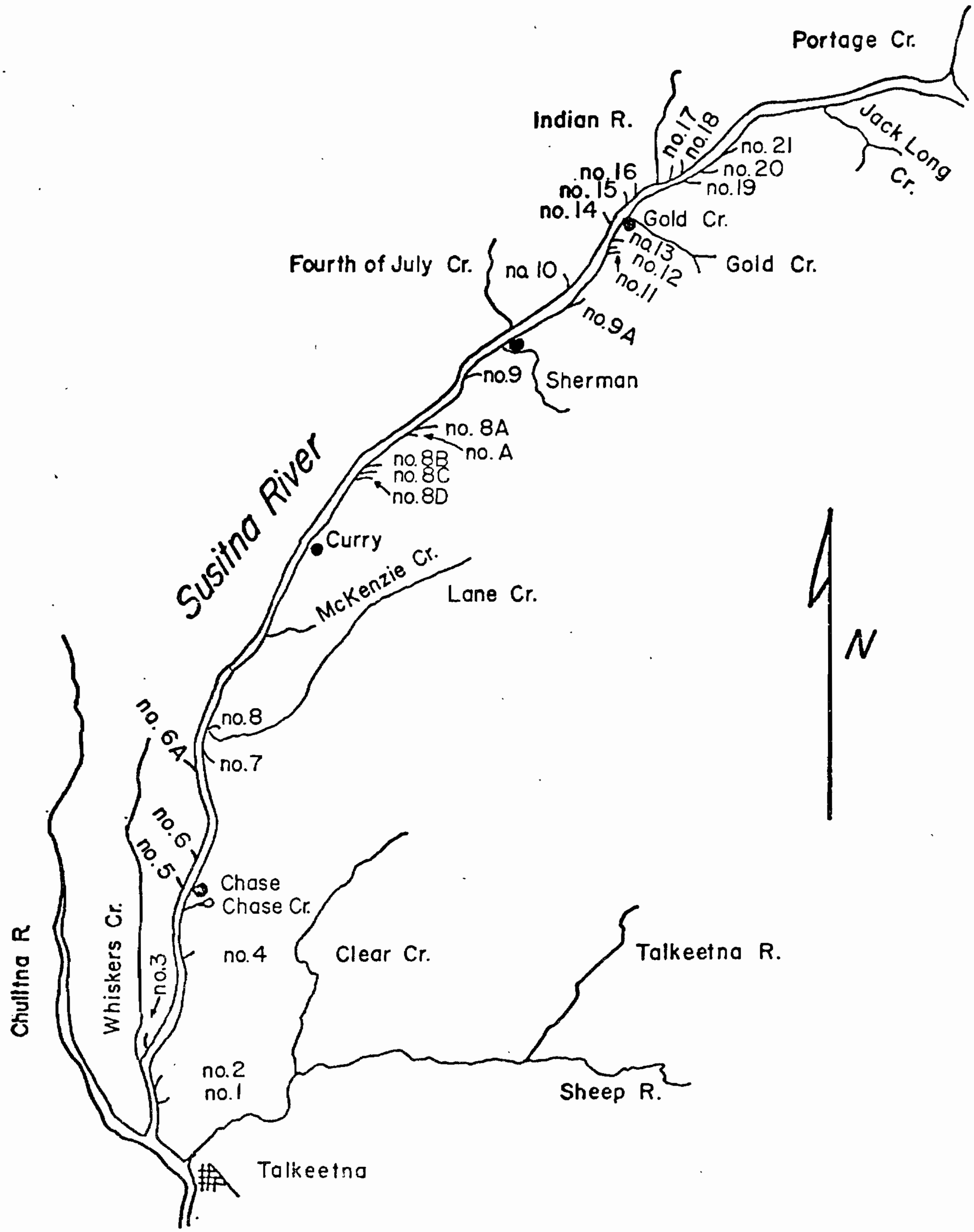

Figure 2. Map of the upper Susitna River study area encompassed in the Devil's Canyon Project, 1975.

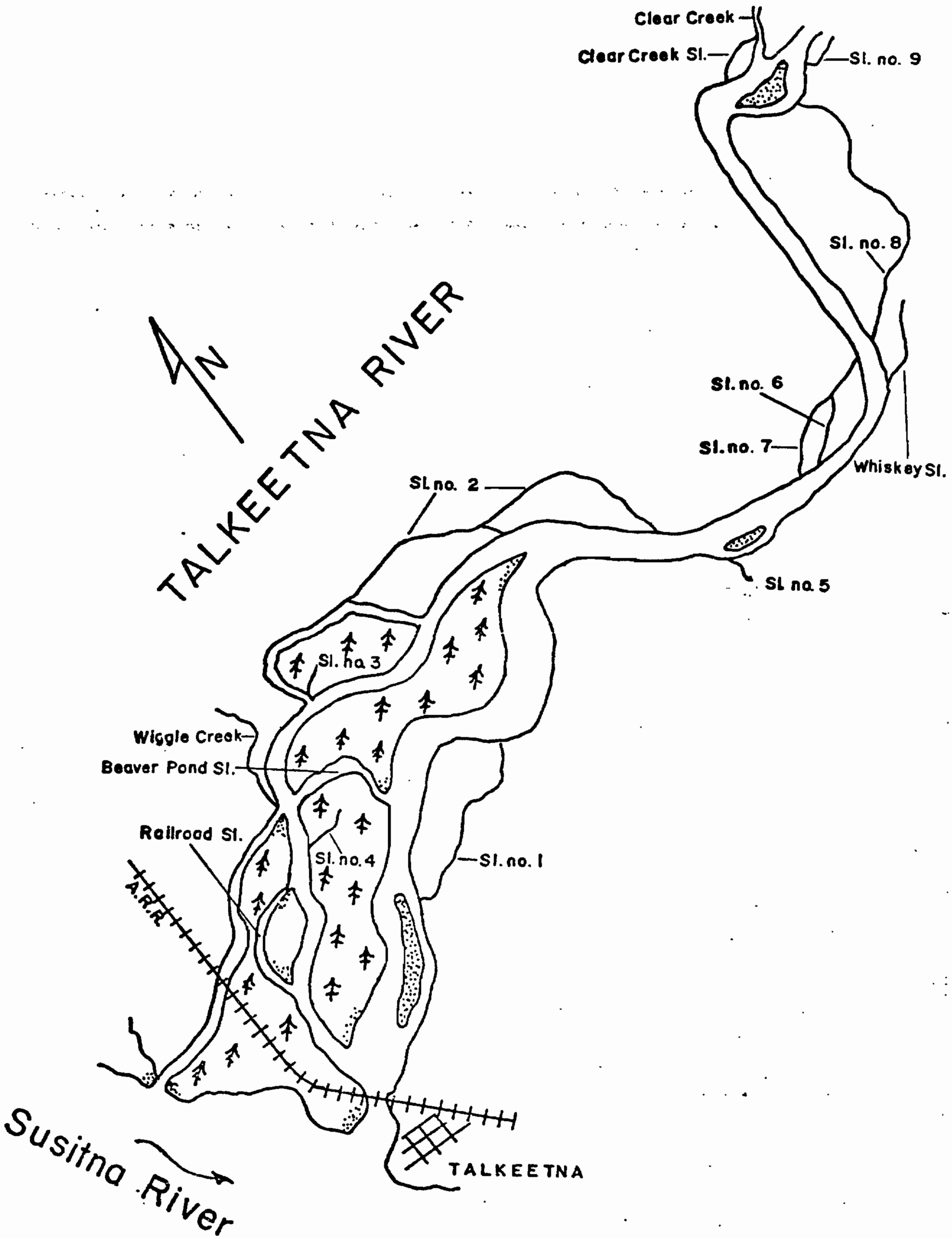

Figure 3. Map of the Talkeetna River study area encompassed in the Devil's Canyon Project, 1975.

Spring Sampling

A base camp was established on Billion Slough at the confluence of the Susitna and Talkeetna Rivers June 2, 1975. Surveys by riverboat were conducted on the Talkeetna, Chulitna, and Susitna (from Talkeetna downstream to the Anchorage-Fairbanks Highway bridge crossing) Rivers to investigate potential adult spawning areas and locate areas utilized by rearing fry. High water conditions during this period made surveying difficult and in some areas impossible. Slough areas were identified and mapped where the mainstem river was not flowing through them. Permanent depth stakes were installed. Fry samples were taken with a dip net or minnow seine and preserved in 10 percent formalin solution.

Two liter water samples were taken in the Talkeetna River at the Alaska Railroad bridge and the Susitna River at the Anchorage-Fairbanks Highway bridge biweekly. Air and water temperature and depth were taken when possible. Samples were processed in the Anchorage laboratory for total dissolved solids.

An aerial survey of the area was conducted June 26, 1975. Additional slough areas were noted.

Summer Sampling

Fishwheels were operated on the Susitna River from July 7 through August 27, 1975 at the same locations as 1974 studies. One wheel was located adjacent to the east bank of the river approximately 5 miles (8 m) upstream from the town of Talkeetna; the second was located adjacent to the west bank of the river approximately 2.3 miles (3.7 m) downstream from the first. Fishwheels were operated on a twenty-four hour a day schedule with exception of occational breakdown periods. The east and west bank fishwheels averaged 2.25 and 2.5 revolutions per minute, respectively, during the season. Fishwheels were normally fished 2 feet (0.6 m) above the river bottom due to daily fluctuation of water levels. Fishwheel design is discussed by Barrett (1974). Complete structural failure of the west bank fishwheel axel occurred on August 1. Fishwheel sampling at this site was discontinued due to the low catch prior to the breakdown. Gill net sets were made on the west bank approximately 100 yards (91 m) above the fishwheel site to continue monitoring salmon migration.

Fishwheel catches were recorded daily by species and all salmon were tagged immediately below their dorsal fin with a color and number coded 1 inch (2.54 cm) diameter Peterson disc. Buffer discs were also applied. Length and sex data were collected on all species of salmon. Scale samples for age analysis were taken on all species with the exception of pink salmon (*O. gorbuscha*). Fish were measured from mid-eye to fork of tail. Fish were released immediately after sampling.

A stream survey camp was established July 17 and maintained through September 27 at the mouth of Gold Creek. Boat, foot, and aerial surveys monitoring spawning and rearing areas between Devil Canyon and the confluence of the Susitna and Chulitna Rivers and the Talkeetna River were conducted. All spawning and rearing areas were scheduled to be surveyed weekly, but due to poor weather, substandard survey conditions, and the distance involved in surveying, a strict schedule could not be adhered to. The section of the Susitna River from the community of Chase downstream to the Chulitna River and the one accessible slough on the Chulitna River was surveyed by the crew stationed at the fishwheel camp.

Sloughs were surveyed in their entirety. Streams were surveyed within established index areas, usually located from the mouth upstream 0.5 mile (0.8 km). Limited manpower did not permit surveying the streams in their entirety, although adults do occur above most established index areas. Water and air temperature, survey conditions as determined by the survey crew, and water depth were recorded on each slough survey. Stream flow was taken on limited streams with a flow rod.

A two man crew conducted escapement surveys in streams and sloughs; one person counted live fish while the other individual counted carcasses. Tagged fish observed were recorded by tag color and, when permissable, by tag number. Sampling adult salmon for age and length in the spawning areas was discontinued in 1975 due to the condition of the scales. Most scales sampled were reabsorbed and accurate age determination could not be made.

Rearing fry data was collected in sloughs of the Susitna, Talkeetna and Chulitna Rivers. The total number of fry observed was recorded and species composition noted. A dip net and/or minnow seine was employed to capture fry for positive species identification, age-length composition samples and foregut analysis.

Biweekly water samples were collected from three locations for total dissolved solid content. The Susitna River was sampled at Gold Creek and Anchorage-Fairbanks Highway bridge below Talkeetna. The Talkeetna River was sampled at the Alaska Railroad bridge above the confluence of the Susitna River. Air and water temperatures were recorded.

Benthic invertebrates were collected with artificial substrates. The artificial substrates consisted of a wire vegetable basket lined with nylon cloth with 210 micrometer (μm) mesh and filled with rocks collected from the streambed sampled. Four traps were installed in Indian River and Waterfall Creek. Four types of habitat were sampled in Indian River. These included a deep pool, deep riffle, shallow riffle and quiet water. Two traps were placed in a shallow riffle and two in a shallow pool near the mouth of Waterfall Creek. The substrate was placed in a bucket immediately after retrieval. Specimens were preserved in 70 percent methyl alcohol. Insects were identified to the generic level in most cases with the aid of a Bausch and Lomb dissecting scope.

Juvenile insects are often good indicators of water conditions, i.e., dissolved oxygen and temperature. Many groups are extremely sensitive to even slight changes in temperature. A temperature change of 5°C could result in the elimination of certain insect populations within slough areas, resulting in a complete change in the food chain.

Climatological observations were recorded daily at the fishwheel camp. Conditions monitored included air and water temperature, relative water level and general atmospheric conditions, such as cloud cover and precipitation.

Laboratory Analyses

Total dissolved solids were determined by methods adapted from Standard Methods (APHA, et. al., 1971). The water sample was shaken vigorously for a minimum of 15 seconds and then 1000 milliliters (ml) was poured into a graduated cylinder and allowed to settle for a 24 hour period. After settling, the water was filtered through preweighed 1.2 μ (0.0012 mm) Millipore filters. The first few hundred ml were filtered taking care not to disturb the residue of the sample. The volume of water filtered was recorded. The remainder of the sample was filtered through a second Millipore filter, using distilled water to completely rinse the residue from the graduated cylinder.

Millipore filters were placed in Petri dishes and dried in a drying oven at 103-105°C until constant weights were attained. The settlable and nonfilterable residue weights were computed by determining the difference between the weights of the filters before and after filtration. Total suspended solids (mg/l) are the summation of the settlable and nonfilterable residues.

Age data presented in this report is expressed by the European method. The number of winters spent in freshwater is written to the left of the decimal. The number of winters reared in saltwater appears to the right of the decimal.

RESULTS

Adult Investigations

A total of 618 salmon (Oncorhyncus sp.) were captured in the two fishwheels from July 7 through August 27, 1975. The composition by species was 291 pink (O. gorbuscha), 139 chum (O. keta), 27 coho (O. kisutch), 103 sockeye (O. nerka) and 58 king salmon (O. tshawytscha). The catch of the east bank fishwheel comprised 98.7 percent of the total catch for the season. The west bank fishwheel was removed from the water on August 1. Limited gill netting was initiated on the west bank of the river at that time. Sampling on the west bank indicated only a minor portion of the fish migrate along this bank. Catch of the east and west bank fishwheels by species and date is presented in Tables 1 and 2, respectively. Average hourly catch of pink and chum salmon is presented in Figure 4. The chum salmon fishwheel catches peaked on August 14. Fishwheel catches indicate about 70.5 percent of the chum salmon migration occurred between August 5 and August 15. Approximately 69 percent of the pink salmon migration occurred during the 9 day period between August 1 and August 9. Sockeye salmon catch was significantly higher than that of 1974. About 48.5 percent of the migration occurred between August 2 and August 10 (Figure 5). The accumulative catch of coho salmon shows a marked decline over 1974. About 52 percent of the coho catch occurred from August 12 through August

Table 1. East bank fishwheel catch of salmon by species from July 7 through August 27, Devil's Canyon Project, 1975.

Date	No. Hours Fished	Pink		Chum		Coho		Sockeye		King	
		Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
July											
7	24	0	0	0	0	0	0	0	0	5	5
8	24	0	0	0	0	0	0	0	0	3	8
9	24	0	0	0	0	0	0	0	0	6	14
10	24	0	0	0	0	0	0	0	0	4	18
11	24	0	0	0	0	0	0	0	0	4	22
12	24	0	0	0	0	0	0	0	0	0	22
13	24	0	0	0	0	0	0	0	0	2	24
14	24	0	0	0	0	0	0	0	0	2	26
15	24	0	0	0	0	0	0	0	0	4	30
16	24	0	0	0	0	0	0	0	0	2	32
17	24	0	0	0	0	0	0	0	0	2	34
18	24	0	0	0	0	0	0	0	0	2	36
19	24	0	0	0	0	0	0	0	0	1	37
20	24	0	0	0	0	0	0	0	0	0	37
21	24	0	0	0	0	0	0	1	1	0	37
22	24	0	0	0	0	0	0	1	2	0	37
23	24	1	1	0	0	0	0	3	5	1	38
24	24	4	5	0	0	0	0	1	6	0	38
25	24	6	11	0	0	0	0	1	7	0	38
26	24	13	24	0	0	0	0	4	11	1	39
27	24	9	33	0	0	0	0	1	12	2	41
28	24	7	40	1	1	0	0	6	18	2	43
29	24	14	54	0	1	1	1	5	23	1	44
30	20.0	5	59	0	1	0	1	0	23	0	44
31	0	0	59	0	1	0	1	0	23	0	44
August											
1	2.5	13	72	0	1	0	1	0	23	0	44
2	24	46	118	5	6	1	2	10	33	1	45
3	24	36	154	9	15	0	2	4	37	0	45
4	24	31	185	1	16	0	2	6	43	0	45
5	24	32	217	10	26	2	4	9	52	0	45
6	24	17	234	14	40	0	4	4	56	0	45
7	24	11	245	2	42	2	6	3	59	0	45
8	24	8	253	7	49	3	9	2	61	0	45
9	24	8	261	2	51	0	9	5	66	0	45
10	24	4	265	9	60	0	9	7	73	0	45
11	24	2	267	8	68	0	9	3	76	1	46
12	24	6	273	10	78	0	9	2	78	0	46
13	24	6	279	12	90	3	12	3	81	0	46
14	24	4	283	15	105	0	12	2	83	0	46
15	24	2	285	9	114	3	15	4	87	1	47
16	24	0	285	2	116	2	17	0	87	2	49
17	24	1	286	1	117	1	18	0	87	0	49
18	24	0	286	1	118	1	19	5	92	1	50
19	24	1	287	3	121	0	19	0	92	1	51
20	24	0	287	8	129	3	22	4	96	0	51
21	24	1	288	1	130	1	23	1	97	1	52
22	24	0	288	4	134	1	24	2	99	0	52
23	24	0	288	2	136	1	25	2	101	1	53
24	24	0	288	1	137	1	26	2	103	0	53
25	24	0	288	0	137	0	26	0	103	0	53
26	24	0	288	0	137	0	26	0	103	0	53
27	24	0	288	2	139	1	27	0	103	0	53
Season Total	1198.5		288		139		27		103		53

Table 2. West bank fishwheel catch of salmon from July 9 through July 31, Devil's Canyon Project, 1975.

Date	No. Hours Fished	Pink		Chum		Coho		Sockeye		King	
		Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
July											
9	22	0	0	0	0	0	0	0	0	0	0
10	24	0	0	0	0	0	0	0	0	2	2
11	24	0	0	0	0	0	0	0	0	0	2
12	24	0	0	0	0	0	0	0	0	1	3
13	24	0	0	0	0	0	0	0	0	0	3
14	24	0	0	0	0	0	0	0	0	0	3
15	24	0	0	0	0	0	0	0	0	0	3
16	24	0	0	0	0	0	0	0	0	0	3
17	24	0	0	0	0	0	0	0	0	1	4
18	24	0	0	0	0	0	0	0	0	1	5
19	2	0	0	0	0	0	0	0	0	0	5
20	21	0	0	0	0	0	0	0	0	0	5
21	24	0	0	0	0	0	0	0	0	0	5
22	24	0	0	0	0	0	0	0	0	0	5
23	24	1	1	0	0	0	0	0	0	0	5
24	24	0	1	0	0	0	0	0	0	0	5
25	24	0	1	0	0	0	0	0	0	0	5
26	24	1	2	0	0	0	0	0	0	0	5
27	24	1	3	0	0	0	0	0	0	0	5
28	24	0	3	0	0	0	0	0	0	0	5
29	24	0	3	0	0	0	0	0	0	0	5
30	24	0	3	0	0	0	0	0	0	0	5
31	24	0	3	0	0	0	0	0	0	0	5
Season Total	549	3		0		0		0		5	

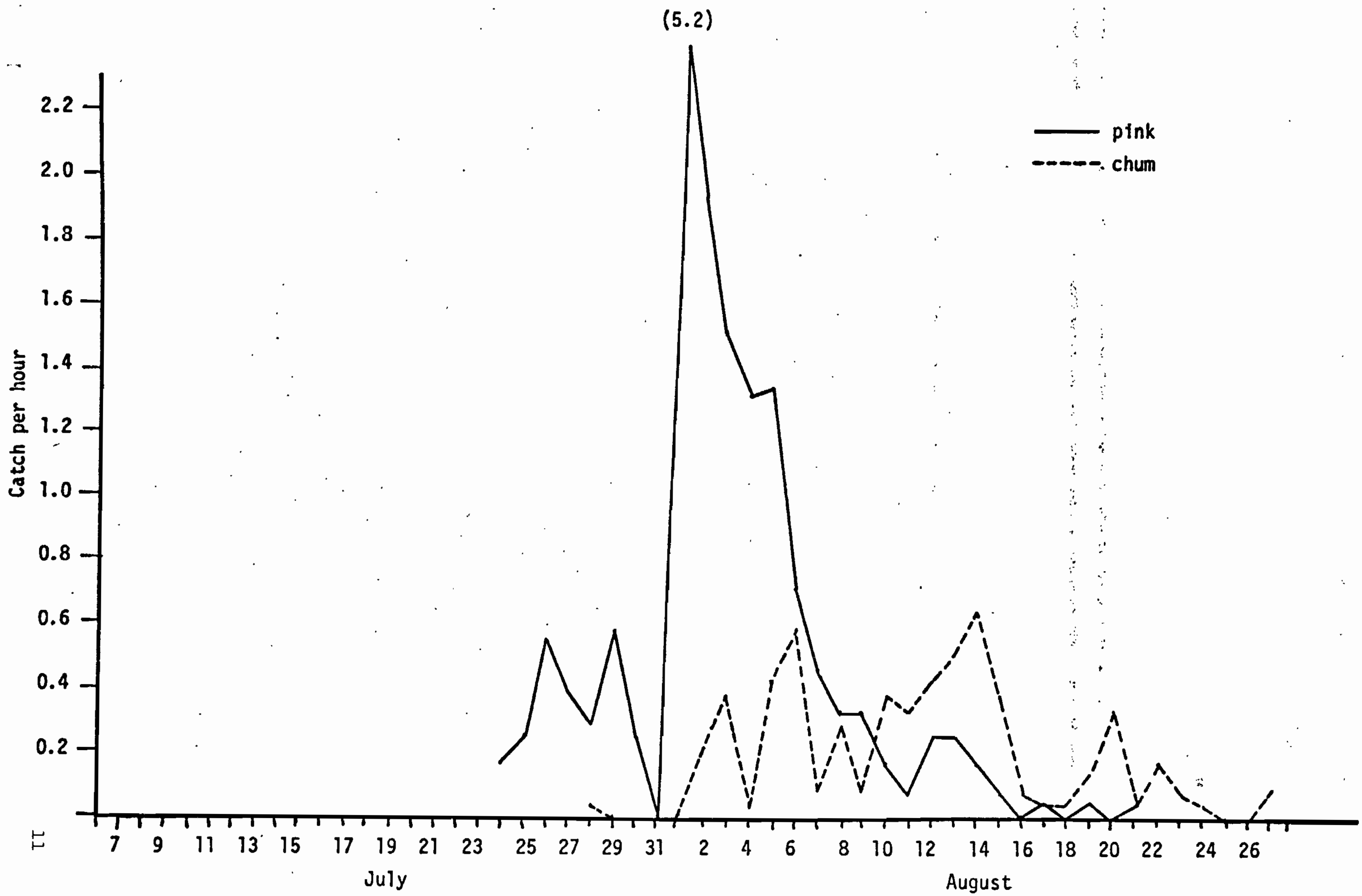

Figure 4. Average hourly catch of pink (<u>Oncorhynchus gorbuscha</u>) and chum (<u>O. keta</u>) salmon per day from the east bank fishwheel, Devil's Canyon Project, 1975.

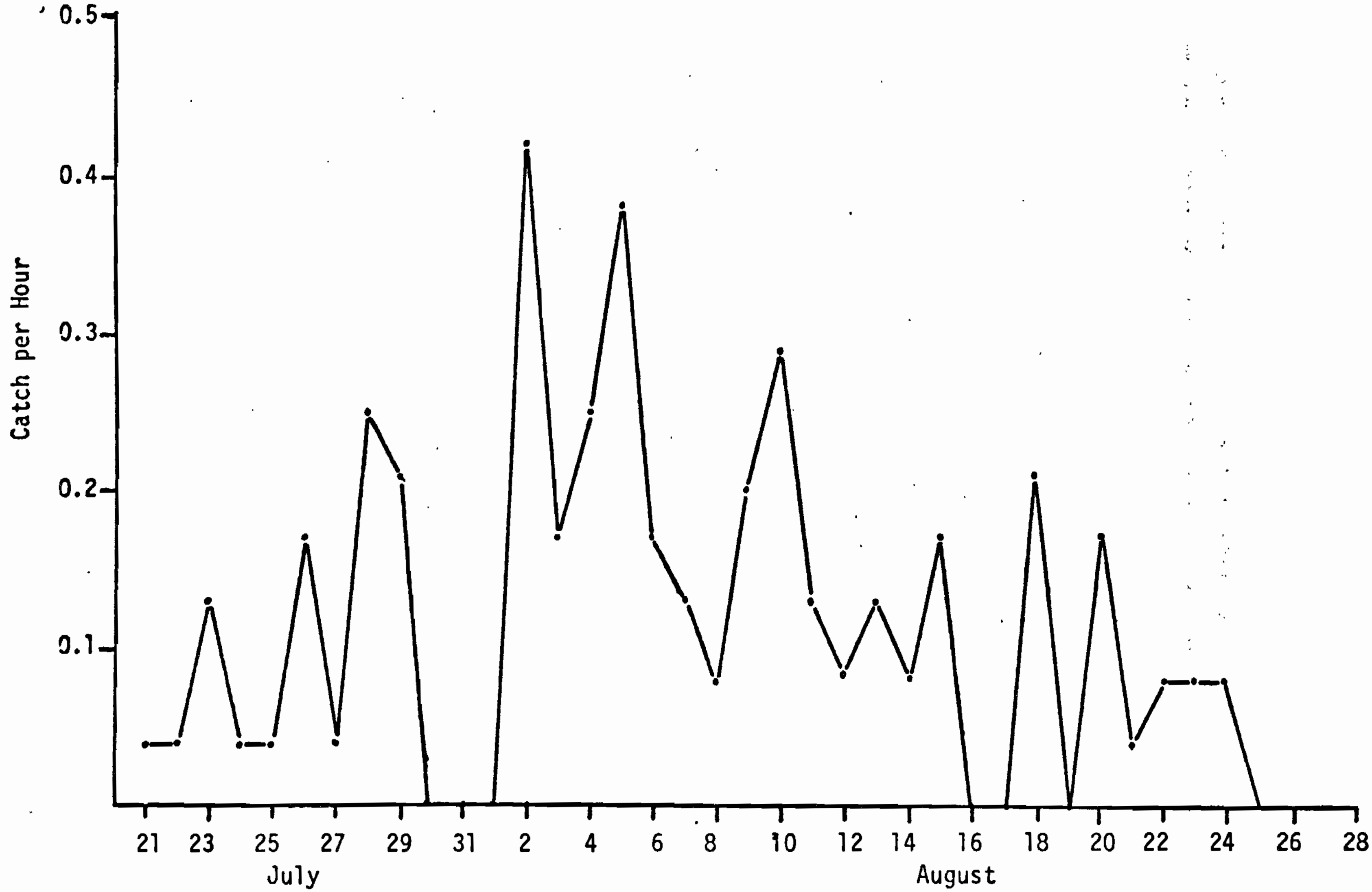

Figure 5. Average hourly catch of sockeye salmon from the east bank fishwheel at the Devil's Canyon fishwheel camp, Devil's Canyon Project, 1975.

24, 1974. The peak in migration may have occurred after removal of the fishwheels in 1975, but escapement surveys of coho salmon were also significantly less in 1975. The peak king salmon migration occurred prior to installation of the fishwheels and a steady decline in catch was observed a few days after operations began. Catch did increase over 1974, but this was due to earlier installation of fishwheels.

Population estimates were obtained for pink, chum and sockeye salmon migrating into the Susitna River and susceptible to capture at the fishwheel sites by the Peterson mark and recapture formula (Table 3). The number of fish tagged in the population (m), number of fish sampled (c), and number of fish sampled (r), were used to calculate the estimated size of the population with 95 percent confidence limits using the following expressions:

$$N = \frac{mc}{r} \pm N\sqrt{\frac{(N-m)}{mc}\frac{(N-c)}{(N-1)}}$$

The population estimates for each species were as follows:

Chum	11,850 ± 4,044
Pink	6,257 ± 261
Sockeye	1,835 ± 337

The population estimates reflect the density of the salmon populations that were susceptible to capture at the fishwheel sites rather than the spawning ground density above the fishwheel sites. The number of live fish sampled were from sloughs and index areas of streams above the fishwheel sites surveyed by the escapement survey crew (Appendix II, Table 1).

Insufficient numbers of coho salmon were observed to obtain population estimates for this species. The peak king salmon migration occurred prior to installation of fishwheels so population estimates based on catch and recovery data could not be determined.

The population estimates would be increased directly proportional to possible tag loss and/or tag induced mortalities. The possibility of either of these having occurred above the fishwheel sites is unlikely since no tag scarred fish were observed on spawning grounds and tags were difficult to remove from carcasses. The population estimates contain some positive bias since these factors are not taken into consideration in the computation.

Sportfishermen provided tag recoveries from below the fishwheel camp (Table 4). This is concurrent with 1974 findings. Two possible implications still exist: (1) a proportion of the tagged fish become disoriented after the capture-tag process and finally migrate downstream spawning in a different location than their homestream, or (2) fish passing the tagging site are not all destined for upstream areas and later migrate downstream to spawn in areas below the site. Further studies are needed to provide an explanation for this phenomenon. Either possibility adds bias to estimates of population size above the fishwheel sites.

Table 3. Number of fish tagged at the fishwheel site and the number of tagged to untagged fish observed on the spawning grounds with the resultant population estimates by species, Devil's Canyon Project, 1975.

Species	No. Fish Tagged (m) (Fishwheel)	No. Fish Sampled (live counts)			Population Estimates (N)
		Untagged	Tagged (r)	Total (c)	
Chum	139	674	8	682	11850 ± 4044
Pink	291	943	46	989	6257 ± 261
Sockeye	103	370	22	392	1835 ± 337

Table 4. Record of tagged salmon recovered below the Devil Canyon fishwheel camp, Devil's Canyon Project, 1975.

Species	Tagging Date	Recovered Date	Location	Activity
Sockeye	8/2-8/3	8/24	Stephan Lake	Spawning
Pink	7/27	8/3	Birch Creek	
	8/3-8/4	8/17	Clear Creek	
Chum	8/12-8/14	8/17	Chunilna Creek	Spawning
	8/9-8/11	8/20	Montana Creek	Spawning
	8/9-8/11		Byers Creek	
	8/12-8/14		Byers Creek	
King	7/7-7/10	7/15	Montana Creek	
Coho	8/2	8/11	Birch Creek	
	8/5-8/7	8/23	Clear Creek	
	8/21-8/23	7/29	Clear Creek	

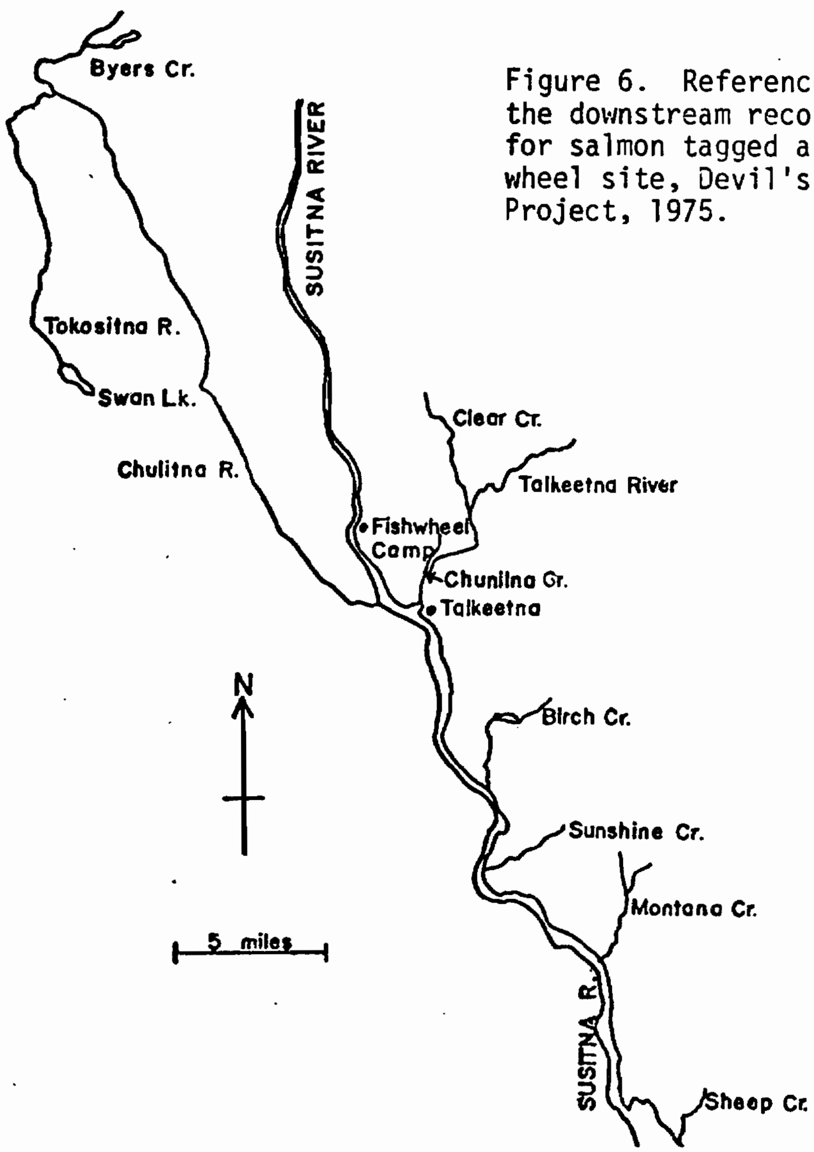

Figure 6. Reference map of the downstream recovery areas for salmon tagged at the fish-wheel site, Devil's Canyon Project, 1975.

Analysis of chum salmon age samples revealed the 1975 escapement was composed of primarily three and four-year-old fish produced from the 1971 and 1972 brood year, respectively (Table 5). Eighty-two percent of the samples collected at the fishwheel camp were four-year-old fish. The sex ratio was 1 female to 1.1 males. Length frequency distribution for chum salmon is presented in Figure 8.

Sockeye salmon sampled at the fishwheels were represented by five age classes produced from the 1970 through 1972 parent years (Table 6). The largest percentage of individuals (46.3 percent) spent one year in freshwater and two years in the ocean prior to returning as adults to spawn. The sex ratio was 1.3 females to 1 male. Precocious males (1.1 age) comprised 14.8 percent of the fish sampled. The mean length frequency of sockeye, including precocious males, was 511.7 mm (Figure 9).

Pink salmon were not sampled for age composition. Sex composition and length frequency were recorded. The sex ratio was 2.1 females to 1 male (Table 7). The mean length of pink salmon sampled was 445.8 mm (Figure 10).

Escapement sampling of coho salmon for age was limited due to the small number of fish captured and condition of the scale samples. The prominent age class of the migrants was 2.1 or four-year-old fish from the 1971 brood year. Males comprised 48.3 percent of the samples. The 29 individuals sampled had a mean length of 522.1 mm (Figure 7).

Rearing Fry and Escapement Investigations

Susitna River Winter Sampling

Winter investigations were continued in March 1975 to monitor the distribution of rearing fry and winter conditions of the sloughs and mainstem Susitna River. Studies conducted during December, January and February established that coho fry were wintering in Sloughs Numbers 8-A, 9, 9-A, 11 and 19 (Barrett 1975a, 1975b, 1975c).

All sloughs upstream from Slough Number 8 were monitored for winter conditions and fry distribution during March (Table 8). Sloughs surveyed had ice cover ranging from 25 to 100 percent. Minnow traps were installed in sloughs with sufficient water levels. Rearing fry were found in Sloughs 13, 17 and 21. Dissolved oxygen was below minimum levels required for fish survival at all sampling locations. Data is presented in the report, although the proper functioning of the dissolved oxygen analyzer is in question.

Slough Number 13 was 60 percent ice free and water temperature was 38°F. Minnow traps were fished for a 26 hour period. Seven 0.0 age class coho fry were captured (Table 8).

Slough Number 21 had a 100 percent ice cover and water temperature was 33°F. Minnow traps installed in the slough for a 21.4 hour period captured five 0.0 age coho fry (Table 8).

Table 5. Analysis of chum salmon age and sex data by percent from escapement samples collected at fishwheel camp, Devil's Canyon Project, 1975.

Year of Return		Age Class 0.2	Age Class 0.3	Age Class 0.4	Brood Year 1972	Brood Year 1971	Brood Year 1970	Sample Size
1975	percent	16.4	82.0	1.6	16.4	82.0	1.6	100.0
	number	21	105	2	21	105	2	128

	Sex Ratio Male	Sex Ratio Female	Sample Size
percent	52.5	47.5	100
number	73	66	139

Table 6. Analysis of sockeye salmon age and sex data by percent from escapement samples collected at fishwheel camp, Devil's Canyon Project, 1975.

Year of Return		Age Class 1.1	Age Class 1.2	Age Class 1.3	Age Class 2.1	Age Class 2.2	Brood Year 1972	Brood Year 1971	Brood Year 1970	Sample Size
1975	percent	14.8	46.3	25.9	3.7	9.3	14.8	50.0	35.2	100.0
	number	8	25	14	2	5	8	27	19	54

	Sex Ratio Male	Sex Ratio Female	Sample Size
percent	43.3	56.7	100.0
number	42	55	97

Table 7. Analysis of pink salmon sex data by percent from escapement samples collected at fishwheel camp, Devil's Canyon Project, 1975.

Year of Return		Sex Ratio Male	Sex Ratio Female	Sample Size
	percent	31.8	68.2	100.0
	number	92	197	289

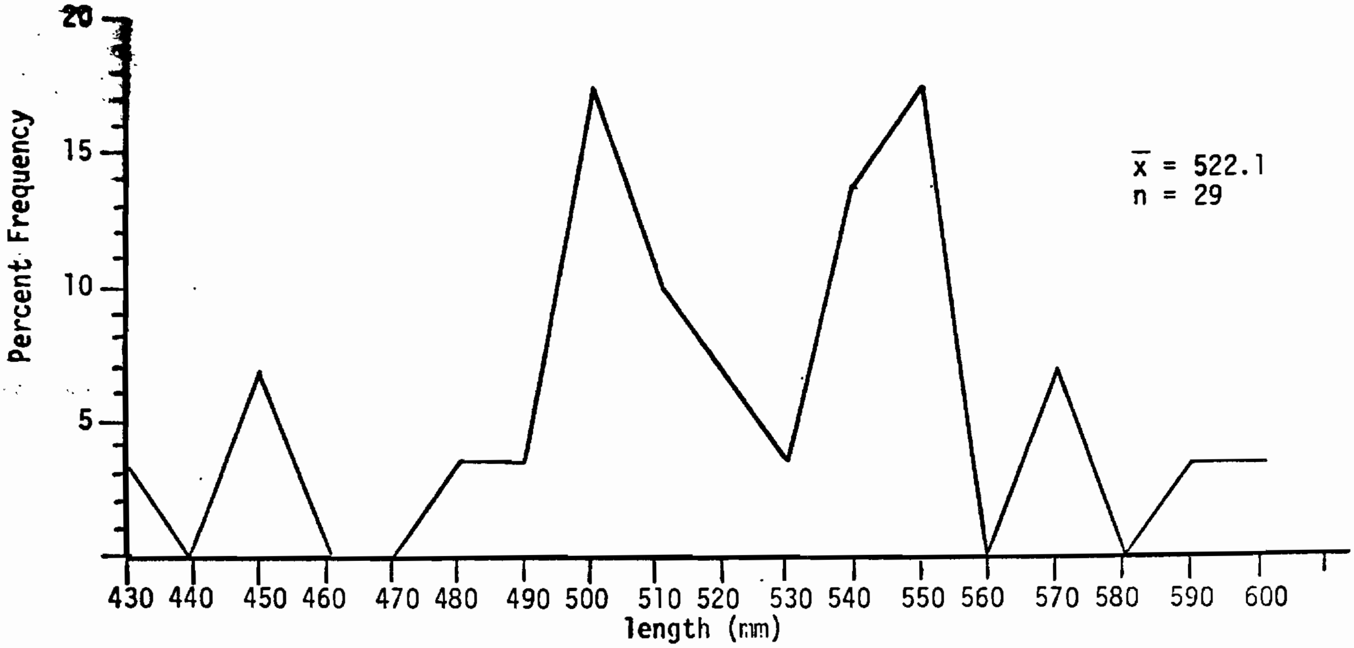

Figure 7. Length frequency of the coho salmon (Oncorhynchus kisutch) catch from the east and west bank fishwheels, Devil's Canyon Project, 1975.

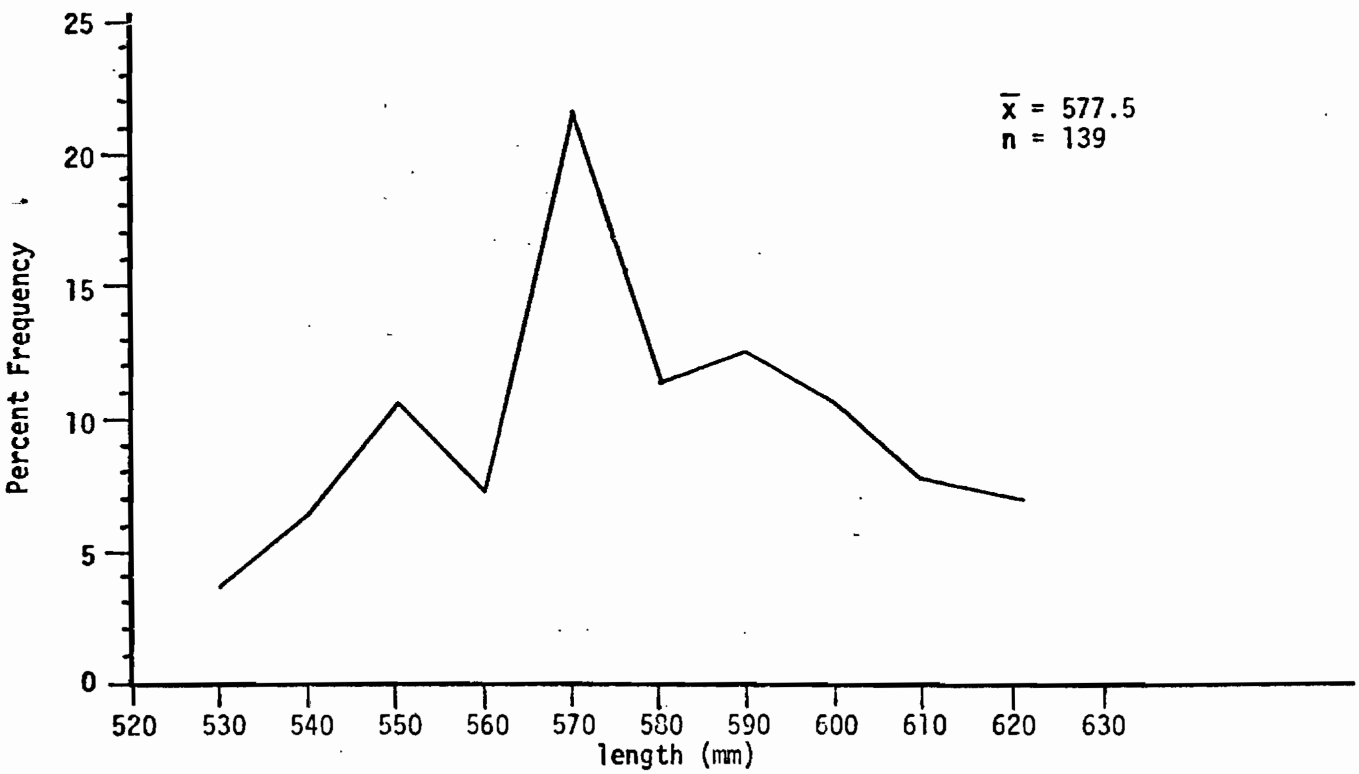

Figure 8. Length frequency of the chum salmon (O. keta) catch from the east and west bank fishwheels, Devil's Canyon Project, 1975.

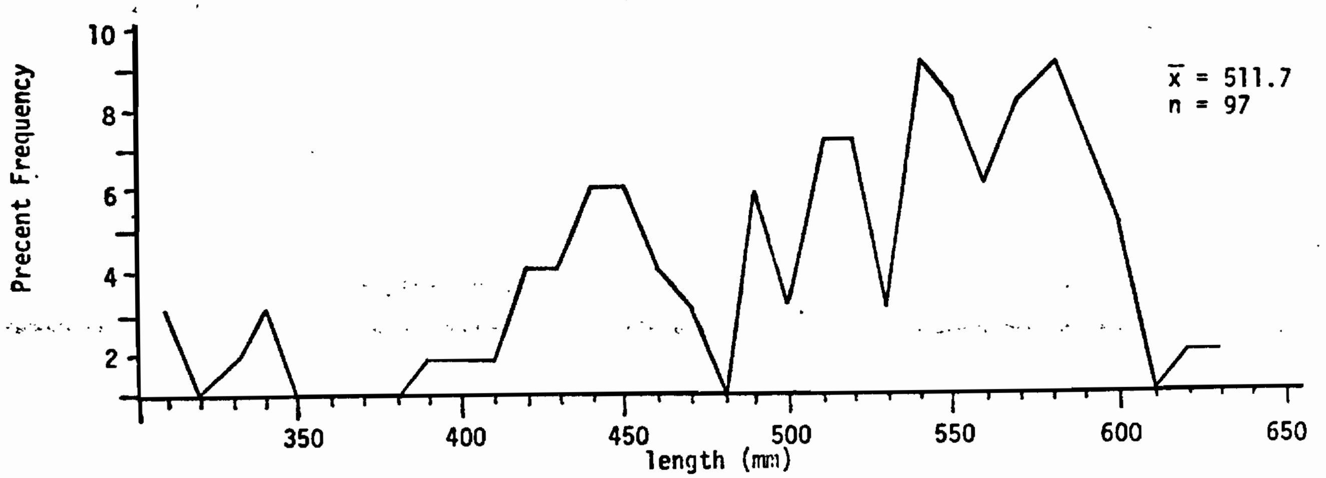

Figure 9. Length frequency of the sockeye salmon catch from the east and west bank fishwheels, Devil's Canyon Project, 1975.

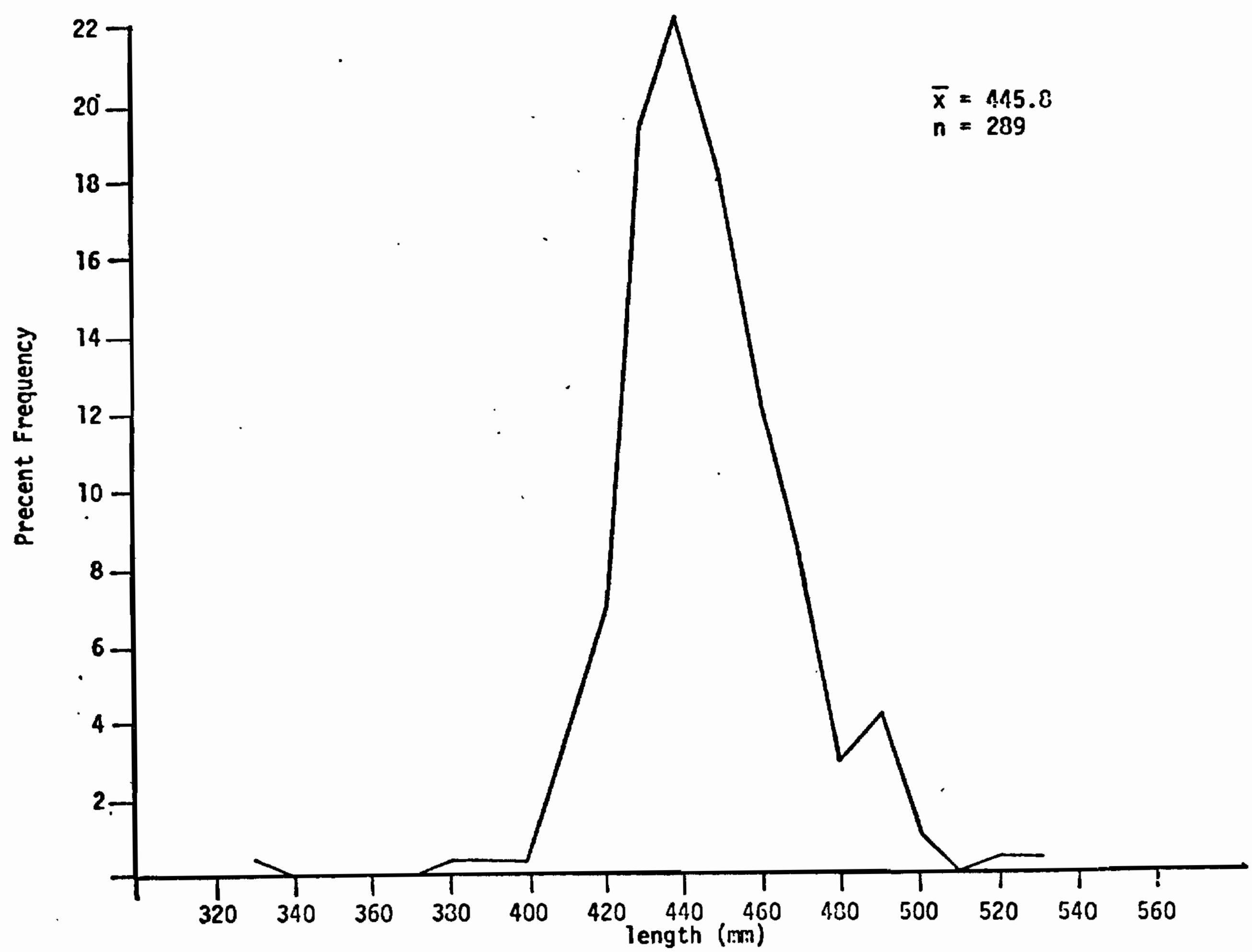

Figure 10. Length frequency of the pink salmon catch from the east and west bank fishwheels, Devil's Canyon Project, 1975.

Table 8. Survey of winter conditions and fry distribution in Slough Numbers 8, 8A, 9, 9A, 10, 11, 12, Devil's Canyon Project, 1974-1975.

Slough No.	Survey Site	Date	Time (military)	Temperature (°F) Air	Temperature (°F) Water	D.O. (ppm)	pH	Ice Thickness (inches)	Ice Cover (%)	Snow Depth in ice (inches)	Water Depth (inches)	Water Flow Detectable	Anchor Ice present	Number hours fished	Minnow Trap Catch Fish Species: Coho	Grayling	Rainbow	Sculpin
8	A	12/6/74	1530	28	35	13.6	5.1	0.3-0.5	30	5-24	3.0	yes	no	0.0				
		1/13/75	1415	6	34	13.4	5.5	0.1-3	75	0-12	4.5	yes	no	0.0				
		2/18/75	1344	30	36	8.8	5.4	0.1-3	50	4-28	2.0	yes	no	0.0				
		3/14/75	1345	30	36	1.8	5.3	0.0-1	25	0-3	4.0	yes	no	0.0				
8A	A	12/6/74	1200	26	34	12.8	5.4	0.5-1	20	5-24	5.0	yes	no	0.0				
		1/17/75	1210	29	34	----	5.4	0.5-2	80	6-12	4.0	yes	no	68.1	0	0	0	0
		2/17/75	1420	25	33	8.5	5.8	0.5-4	95	2-14	3.0	yes	no	0.0				
		3/12/75	1545	32	36	7.5	5.3	0.3-3	40	0-6	2.5	yes	no	0.0				
8A	B	12/5/75	1215	26	34	11.7	5.5	0.3-1	20	1-24	7.0	yes	no	0.0				
		1/17/75	1225	29	34	----	5.4	0.3-1.8	90	1-10	8.5	yes	no	68.0	2	0	0	3
		2/17/75	1448	24	33	7.2	5.8	0.5-6	99	2-30	4.5	yes	no	21.8	0	0	0	0
		3/12/75	1530	32	34	11.0	5.4	0.0-2	60	2-18	3.5	yes	no	0.0				
9	A	12/5/75	0930	30	34	11.0	5.5	2.0	80	0-36	16.5	yes	no	25.5	4	0	0	0
		1/17/75	1107	25	34	11.4	5.5	0.5-4	95	2-36	13.0	yes	no	66.0	2	0	0	0
		2/17/75	1245	27	33	9.0	5.3	0.8-10	95	1-30	9.5	yes	no	0.0				
		3/13/75	1600	30	36	13.0	5.5	0.5-1	60	0-4	6.5	yes	no	0.0				
9	B	12/5/74	1000	30	34	10.5	5.3	2.8	80	5-2	17.3	yes	no	25.5	6	0	0	0
		1/17/75	1128	25	33	----	5.5	0.2-3	80	5-15	13.0	yes	no	66.5	0	0	0	0
		2/17/75	1315	26	34	7.4	5.3	0.4-10	95	5-16	10.0	yes	no	45.4	7	0	0	0
		3/12/75	1220	30	33	1.9	5.4	4.0	90	0-18	11.0	no	no	0.0				
9A	A	2/17/75	1545	24	35.5	6.1	5.4	0.5-2	65	2-5	9.5	yes	no	20.3	21	0	0	0
		3/13/75	1600	30	36	1.3	5.5	0.5-1	60	0-4	6.5	yes	no	0.0				
9A	B	3/13/75	1600	30	37	1.2	5.6	0.0-1	80	0-1	8.5	yes	no	0.0				
10	A	2/17/75	1615	24	34.5	7.4	5.4	0.1-4	55	3-16	6.0	yes	no	0.0				
11	A	12/4/74	1300	15	34	9.6	5.6	0.5	80	1-2	14.5	yes	no	43.5	2	0	0	0
		1/14/75	1445	4	35	7.0	5.7	0.5-3	95	5-3	12.0	yes	no	24.8	1	0	1	0
		2/13/75	1025	-6	36	8.1	5.8	0.4-9	95	0-0.3	20.0	yes	no	24.5	0	0	0	0
		3/12/75	1420	32	36	9.5	6.0	0.1-3	60	1-2	18.0	yes	no	0.0				
11	B	12/4/74	1320	--	--	----	---	-----	--	-----	----	yes	no	43.2	6	0	0	0
		1/14/75	1430	4	35	8.8	5.7	0.5-2.5	95	1-3	9.0	yes	no	24.8	6	0	0	0
		2/13/75	1100	-2	36	7.4	5.4	0.3-8	95	0-0.3	14.0	yes	no	68.5	2	0	0	0
		3/12/75	1430	31	37	9.5	5.9	0.1-3	80	1-2	11.5	yes	no	0.0				
12	A	12/4/74	1330	15	32.5	5.0	6.0	4.6	95	1	7.8	no	yes	0.0				
12	B	12/4/74	1345	15	32.5	----	---	4.3	95	2-36	5.8	no	yes	0.0				
		1/14/75	1515	4	33	5.8	5.7	6.25	100	3-24	8.0	yes	no	0.0				
		2/13/75	1230	0	34	8.5	5.8	0.5-2	99	8-18	11.5	yes	no	0.0				
		3/12/75	1500	33	34	14.5	5.8	0.0-2	99	0-36	8.5	yes	no	0.0				
12	C	12/4/74	1400	15	34	5.2	5.8	0.1-2	95	1	2.0	yes	no	0.0				
		1/14/75	1506	4	34	6.8	5.6	0.1-3	70	5-36	4.0	yes	no	0.0				
		2/13/75	1155	3	34	9.4	5.2	0.3-9	98	1-24	4.5	no	no	0.0				
		3/12/75	1510	32	36	18.0	5.9	0.0-13	30	0-5	3.5	yes	no	0.0				

Table 8. Survey of winter conditions and fry distribution in Slough numbers 13, 14, 15, 16, 17, 18, 19, 20, 21, Devil's Canyon Project, 1974-1975. (continutation page 2 of 2).

Slough No.	Survey Site	Date	Time (military)	Temperature (°F) Air	Temperature (°F) Water	D.O. (ppm)	pH	Ice Thickness (inches)	Ice Cover (%)	Snow Depth in ice (inches)	Water Depth (inches)	Water Flow Detectable	Anchor Ice present	Number hours fished	Minnow Trap Catch Fish Species: Coho	Grayling	Rainbow	Sculpin
13	A	12/4/74	1440	15	33	6.8	5.6	0.8	95	3-48	1.9	yes	no	0.0				
		1/14/75	1531	8	34	7.4	5.5	9.5-2	90	1-12	3.5	yes	no	0.0				
		2/13/75	1355	1	34	9.2	5.7	0.5-2	75	0-10	4.0	yes	no	0.0				
		3/12/75	1520	31	37	16.0	6.2	0.0-1	50	0-24	1.5	yes	no	0.0				
13	B	12/4/74	1500	15	33	5.2	5.6	1.0	95	1	7.6	yes	no	0.0				
		1/14/75	1541	8	34	7.0	5.6	0.5-4.5	90	5-12	8.0	yes	no	0.0				
		2/13/75	1420	0	34	9.2	5.6	0.5-2	75	5-10	7.5	yes	no	0.0				
		3/12/75	1535	32	38	17.0	5.9	0.2	40	0-24	1.5	yes	no	26.0	7	0	0	1
14	A	12/5/74	1530	25	34	11.8	5.4	1.0	50	8-36	3.3	yes	no	0.0				
		1/14/75	1105	6	35	9.1	5.5	0.5-3	98	5-9	5.0	yes	no	0.0				
		2/16/75	1140	16	34	8.8	5.7	0.3-10	90	1-15	3.3	yes	no	0.0				
		3/12/75	1325	31	32.5	13.5	5.3	0.3-1	50	5-6	5.5	yes	no	0.0				
14	B	1/14/75	1035	6	35	8.2	5.5	2.5-5	100	5-12	3.0	yes	no	0.0				
		2/16/75	1210	16	33	9.7	5.7	0.3-3	100	1-14	4.5	yes	no	0.0				
		3/12/75	1310	31	35	1.7	5.3	3.5	100	1-8	4.0	yes	no	0.0				
15	A	12/4/74	1000	10	--	----	---	9.8	100	19	0.0	no	no	0.0				
		3/12/75	1230	28	33	----	5.4	22	100	3-24	4.0	no	no	0.0				
15	B	12/4/74	1015	10	34	12.4	5.2	9.0	100	11	7.3	yes	no	0.0				
		1/15/75	1000	18	32	6.4	5.4	10	100	36-48	14.0	---	no	0.0				
		2/15/75	1205	9	33	8.1	5.5	12	100	7-16	9.0	no	no	0.0				
		3/12/75	1240	32	34	11.8	5.5	0.3-5	90	0-36	2.0	yes	no	0.0				
15	C	1/15/75	0930	18	34	7.4	5.3	0.5-3	95	2-24	3.0	yes	no	0.0				
		2/15/75	1230	8	34	7.4	5.3	0.1-7	100	5-30	5.0	no	no	0.0				
16	A	2/17/75	0942	26	35	6.5	5.2	0.5-2	70	1-18	3.0	yes	no	0.0				
		3/12/75	1210	28	33	12.0	5.3	0.5-12	100	1-12	5.0	no	?	0.0				
17	A	1/16/75	1145	28	35	9.6	5.7	0.5-1	20	5-36	10.5	yes	no	0.0				
		2/13/75	1700	-2	33	8.5	5.3	0.3-3	95	0-12	13.0	yes	no	23.5	0	0	0	0
		3/11/75	1400	26	35	1.4	5.4	0.5-4	35	0-12	6.5	yes	no	20.4	3	0	0	0
17	B	1/16/75	1145	28	34	10.2	5.7	0.2	10	8-24	3.0	yes	no	0.0				
		2/13/75	1700	-3	36	8.3	5.5	0.3-4	50	0-8	4.0	yes	no	0.0				
		3/11/75	1410	27	36	1.4	5.5	0.0-5	40	0-36	2.5	yes	no					
18	A	1/16/75	1225	29	34	9.2	5.5	6.5	100	12-24	6.0	no	no	0.0				
		2/14/75	1035	6	33.5	7.2	5.7	0.5-9	100	0-28	6.5	no	no	0.0				
		3/11/75	1330	28	34.5	1.3	5.4	0.3-5	95	0-24	7.3	yes	no					
19	A	2/16/75	1720	16	34	9.0	5.5	0.5-6	98	14-28	9.5	no	no	16.6	1	0	0	0
		3/11/75	1305	26	34	1.3	5.4	0.3-2	75	0-12	18.0	yes	no	22.1	0	0	0	0
19	B	3/11/75	1300	25	34	1.4	5.6	0.3-2	75	0-20	17.0	yes	no					
20	A	2/16/75	1430	17	32	10.3	5.5	0.6-15	100	23-36	2.0	yes	no	0.0				
		3/11/75	1130	--	--	----	---	0.9-12	100	12-36	0.0	none	yes	0.0				
20	B	2/16/75	1530	16	32	----	5.4	14	100	23-36	9.0	no	no	0.0				
		3/11/75	1115	24	32	----	5.7	24.5	100	12-36	2.5	none	no					
21	A	2/16/75	1620	17	34	9.4	5.7	0.1-12	100	5-10	5.0	yes	no	0.0				
		3/11/75	1200	24	32	1.7	5.5	0.5-5	100	0-24	11.5	yes	no	21.4	4	0	0	1
21	B	2/16/75	1635	16	32.5	9.4	5.4	0.3-10	100	5-16	8.5	no	no	0.0				
		3/11/75	1215	24	33	16.5	5.3	0.5-4	100	0-24	9.5	yes	no	21.4	1	0	0	0

The mainstem Susitna River was sampled for rearing fry at three locations. A minnow trap installed in the mainstem river near Slough 17 captured 3 coho fry. There was a 35 percent ice cover at this location. One age 0.0 coho fry was captured in the mainstem Susitna River at Curry. This specimen was 69.0 mm in length, weighed 3.3 gm, and had a condition factor of 1.005 (Table 9).

Twelve coho fry were captured in the mainstem Susitna River, 2.5 river miles south of the Talkeetna River during April. Age analysis revealed all were 0.0 age fish produced from the 1973 brood year. Mean length, weight and condition factor were 64.2 mm, 2.7 gm and 1.020, respectively.

Winter conditions were monitored on Indian River, Lane Creek and Gold Creek (Table 10). Water flow was noted in all three locations. Ice cover was 50 percent in Lane Creek, 95 percent in Gold Creek and 99.5 percent in Indian River. Water samples were taken at Gold Creek, Chase Creek, and the Anchorage-Fairbanks Highway bridge. Total suspended solid content decreased from the previous three months. Total suspended solid levels at Chase Creek were 4.0 mg/l (Table 11). The settleables, that portion of the total suspended solids which settle within a 24 hour period, comprised 50 percent of the sample. Ice cover was 100 percent and anchor ice was present on the stream bottom.

Total dissolved solid levels averaged 6.5 and 3.5 mg/l at Gold Creek and the Anchorage-Fairbanks Highway bridge, respectively (Tables 12 and 13). The settleable portions were approximately 54 percent at Gold Creek and 71 percent at Anchorage-Fairbanks Highway bridge. Dissolved oxygen levels average 5 ppm higher at Gold Creek.

Susitna River summer and fall surveys

Surveys during 1974 located 21 potential spawning and rearing sloughs on the Susitna River between Devil Canyon and the Chulitna River. Seven additional slough areas were located during the winter and summer of 1975 (Figure 2). Rearing fish were observed in 22 of the slough areas. Adult salmon were present in 8 of the 21 backwater areas. Seven clearwater streams along the Susitna River were also surveyed. Adult salmon were observed spawning in all streams and rearing fry were observed in four. The adult salmon and rearing fry densities are summarized in Appendix II, Table 2.

Coho fry populations were the most numerous rearing fry species observed. Coho fry were observed in 19 slough areas and 3 streams (Appendix II, Tables 2-6). The majority of fry sampled for age analysis were 0.0 age fish (Table 14).

Only three 1.0 age fry were collected during the season and these were located above a beaver dam in Fishwheel Slough (located at the east bank fishwheel camp) suggesting a possible migrational barrier to these individuals. Coho fry were found in Whisker's, Chase, Lane and McKenzie Creek (Appendix II, Table 7). All fry sampled were 0.0 age class. The mean length ranged from 49.8 to 61.3 mm (Table 15).

Table 9. Age, length and weight analysis of coho fry collected in the Susitna River and Sloughs Numbers 8A, 9, 9A, 11, 13, 17, 19, 21, Devil's Canyon Winter Project, 1974-1975.

Slough No.	Date	Sample Size	0.0 Age Class Percent Composition	Length (mm)	Standard Deviation	Weight (g)	Standard Deviation	Condition Factor	Brood Year	1.0 Age Class Percent Composition	Length (mm)	Standard Deviation	Weight (g)	Standard Deviation	Condition Factor	Brood Year
8A	1/17/75	2	50.0	64		3.0		1.144	1973	50	74		4.8		1.185	1972
9	11/6/74	10	100.0	64.3	5.8	3.1	1.1	1.166	1973							
	1/17/75	2	50.0	64		3.0		1.144	1973	50.0	83		5.8		1.014	1972
	2/18/75	7	100.0	70.1	4.3	3.7	0.6	1.074	1973							
9A	2/18/75	8	100.0	73.5	4.5	4.9	0.9	1.234	1973							
11	11/6/74	8	100.0	61.0	6.5	2.8	0.9	1.242	1973							
	1/15/75	6	85.7	62.3	5.0	3.4	0.8	1.406	1973	14.3	83		5.8		1.014	1972
	2/15/75	2	100.0	62.0	2.8	2.8	0.1	1.175	1973							
13	3/12/75	7	100.0	67.4	4.6	3.1	0.8	1.013	1973							
Susitna R.	1/16/75	1	100.0	62.0		2.7		1.133	1973							
at Gold Cr.	2/14-16/75	6	100.0	70.0	4.9	3.9	0.9	1.137	1973							
(Sl. No. 17)	3/12/75	3	100.0	68.0	1.0	2.9	0.7	0.922	1973							
19	2/17/75	1	100.0	67.0		3.4		1.130	1973							
21	3/12/75	5	100.0	65.2	3.8	2.6	0.5	0.938	1973							
Susitna R. at Curry	3/14/75	1	100.0	69.0		3.3		1.005	1973							
Susitna R. 2.5 miles south Talkeetna R.	4/4/75	12	100.0	64.2	4.9	2.7	0.6	1.020	1973							

Table 10. Survey of winter conditions in Indian River, Lane Creek, and Gold Creek, Devil's Canyon Winter Project, 1974-1975.

Stream	Survey Site	Date	Time (military)	Temperature (°F) Air	Water	Ice Thickness (inches)	Ice Cover (%)	Snow Depth on ice (inches)	Water Depth (inches)	Flow	Anchor Ice Present
Indian River	3.0	12/6/74	0930	21	34	1.5-3.5	50	4-24	12-14	yes	no
	3.0	1/15/75	1155	18	34	3.0-5.0	100	8-36	12	yes	no
	0.2	2/18/75	0934	27	32	7-12	100	14-40	7	yes	no
	0.3	3/11/75	1030	27	32	9.5	99.5	24-35	12	yes	no
Lane Creek	0.1	12/6/74	1500	28	35.5	0.5-1.0	90	6-24	8-12	7.21 1/	no
	0.1	1/13/75	1405	6	33	1.0-12.0	99	2-36	5	yes	no
	0.1	2/18/75	1538	28	33	6.0-14.0	100	5-36	7	yes	no
	0.1	3/14/75	1300	30	33	0.0-1.0	50	0-36	7	yes	no
Gold Creek	0.3	12/6/74	0830	21	32.5	12.0-14.0	98	24-48	6-9	yes	no
	0.3	1/15/75	1006	21	33	2.0-12.0	100	12-48	7	yes	no
	0.3	2/16/75	1100	15	32.5	1.0-7.0	100	28-36	7.2	yes	no
	0.3	3/13/75	1145	30	33	0.0-36.0	95	0-24	15	yes	no

1/ Cubic feet per second

Table 11. Analysis of water conditions at Chase Creek, Devil's Canyon Project, 1974-1975.

Date	Time (military)	Temperature Air(°F)	Temperature Water(°F)	Sample Size (l.)	Settlable (mg/l)	Non-filterable (mg/l)	Suspended (mg/l)	D.O. (ppm)	pH	Water Depth (inches)	Ice Cover (%)	Snow Depth on Ice (inches)	Anchor Ice Present
12/6/74	1700	28	34	2.0	6	6	12	14.8	6.7	>96	95	1.0-24	no
1/13/75	1145	-9	32	2.0	57	1	58	10.4	5.7	48	75	0.5-12	no
2/18/75	1630	27	32	2.0	8	1	9	9.0	5.8	50	100	24-30	no
3/14/75	1430	30	32	2.0	2	2	4	19.0	5.3	20	100	1-24	yes

Table 12. Analysis of water conditions at Gold Creek, Devil's Canyon Project, 1974-1975.

Date	Temperature Air(°F)	Temperature Water(°F)	Sample Size (l)	Suspended Solids Settlable (mg/l)	Suspended Solids Non-filterable (mg/l)	Suspended Solids Total Suspended (mg/l)	D.O. (ppm)	pH	Water Depth (inches)	Ice Cover (%)	Snow Depth (inches)	Anchor Ice Present
12/5/75	30	33.5	2.0	21	4	25	>6.4	5.6	48	30	0.5-6	no
1/14/75	6	32	2.0	57	1	58	10.4	5.7	48	75	0.5-12	no
2/14/75	14	32	2.0	19	1	20	10.1	5.8	47	95	0.0-18	no
3/16/75	25	32	2.0	2	2	4	17.0	5.5	>50	95	0.0-12	no
3/29/75		32	2.0	5	4	9	15.0	5.4	>50	95	0.0-8	no
7/23/75	68	48	2.0	329	52	381						
8/4/75			2.0	189	16	205			>60			
8/14/75	53	42	2.0	113	10	123			>60			
8/27/75	56	45	2.0	147	20	167			>60			
9/2/75	55	44	2.0	33	1	34			>60			

Table 13. Analysis of water conditions at the Anchorage-Fairbanks Highway Bridge crossing, Devil's Canyon Project, 1974-1975.

Date	Temperature Air (°F)	Temperature Water (°F)	Sample Size (1)	Suspended Solids Settlable (mg/l)	Suspended Solids Non-filterable (mg/l)	Suspended Solids Total Suspended (mg/l)	D.O. (ppm)	pH	Water Depth (inches)	Ice Cover (%)	Snow Depth (inches)	Anchor Ice Present
12/19/74	16	32.5	2.0	2	2	4	14.2	6.8	>96	75	9.7-13	
1/12/75	2	33	2.0	4	224	228	12.8	5.6	42	90	9	no
1/22/75			2.0	2	2	4	12.1	7.8		90		
2/18/75	23	32	2.0	10	2	12	8.8	5.9	50	100	12	no
2/20/75			2.0	6	1	7	9.7					no
3/9/75	25	32	2.0	4	1	5	10.8	5.9	>50	100	1-36	no
3/25/75			2.0	1	1	2	11.0					
4/4/75	22	32.5	2.0	2	1	3	11.0	5.7	>50	99	10.3	no
4/21/75	39	33	2.0	6	4	10	14.5	6.0	>50	99	0-12	no
4/24/75			2.0	3	2	5	13.2	7.8				
5/14/75			2.0	84	2	86						
5/27/75			2.0	264	6	270						
6/9/75	50	45	2.0	155	22	177						
6/20/75			2.0	163	13	177						
7/21/75			2.0	358	74	432						

Table 14. Age and length samples of coho fry collected at Sloughs Numbers 1, 2, 3, 4, 5, 6, 9, 10, 11, 13, 14, 15, 17, 20, 21 and Fishwheel Slough, Susitna River, Devil's Canyon Project, 1975.

Slough No.	Date	Sample Size	0.0 Age Class			1.0 Age Class		
			Percent Composition	Mean Length(mm)	Standard Deviation	Percent Composition	Mean Length(mm)	Standard Deviation
1	8/11	8	100	53.3	6.4			
2	8/5	8	100	58.9	2.3			
	9/24	8	100	60.4	2.0			
3	7/29	4	100	57.3	5.4			
3A	7/29	4	100	55.3	4.4			
	8/5	8	100	55.8	3.1			
3B	8/23	9	100	60.0	6.2			
4	8/2	8	100	49.9	5.1			
6	7/26	8	100	57.9	7.0			
8	9/27	1	100	69.0	---			
9	8/9	8	100	53.5	5.3			
10	8/7	8	100	50.8	7.8			
11	8/7	8	100	55.0	3.2			
13	3/12	7	100	67.4	4.6			
	7/28	7	100	50.1	8.8			
	9/25	2	100	64.0	7.0			
14	7/23	8	100	61.3	4.7			
	9/4	6	100	61.3	1.9			
15	7/29	8	100	59.1	5.7			
	8/14	9	100	52.2	3.0			
17	3/12	3	100	68.0	1.0			
	7/29	8	100	54.9	2.4			
20	8/14	8	100	60.6	3.4			
21	3/12	5	100	65.2	3.8			
Fishwheel	8/2	4	25	65.0		75	99.0	9.5
Fishwheel	8/25	4	100	70.3	6.7			

Table 15. Age and length samples of coho fry collected at Whisker's Creek, Chase, Lane and McKenzie Creeks, Susitna River, Devil's Canyon Project, 1975.

Slough No.	Date	Sample Size	0.0 Age Class Percent Composition	0.0 Age Class Mean Length(mm)	0.0 Age Class Standard Deviation	1.0 Age Class Percent Composition	1.0 Age Class Mean Length(mm)	1.0 Age Class Standard Deviation
Whiskers Creek	7/28	8	100	49.8	4.6			
Chase Creek	7/17	8	100	50.0	5.0			
Lane Creek	7/26	8	100	61.3	5.7			
McKenzie Creek	8/6	8	100	51.0	3.9			

Table 16. Age and length samples of king salmon fry in Slough Number 15, Susitna River, Devil's Canyon Project, 1975.

Slough	Date	Sample Size	0.0 Age Class Percent Composition	0.0 Age Class Mean Length(mm)	0.0 Age Class Standard Deviation	Mean Weight	Standard Deviation	Condition Factor
15	8/14	6	100	50.7	3.7	1.3	0.23	1.013

King salmon fry (O. tshawytscha) were collected in Slough Number 15. The mean length and mean weight were 50.7 mm and 1.3 gm, respectively (Table 16). No sockeye salmon fry were observed in the sloughs by survey crews in 1975.

Resident fish species were found in sloughs containing salmon fry. Grayling fry (Thymallus arcticus) were observed in Sloughs Numbers 2, 10, 11, 13, 20 and 21. Whitefish fry (Coregonidae) were found in Slough Numbers 8, 10, 13, 20 and 21. Juvenile rainbow trout (Salmo gairdneri) were observed in Slough Number 20. Sculpins (Cottidae) and suckers (Catostomidae) were observed in many slough areas.

Limited artificial substrate sampling was conducted to determine species composition of the insect population in tributary streams of the Susitna River. Foregut analysis of salmon fry provided comparative data on food availability. The most common insects were stoneflies (Plecoptera: Perlodidae: Isoperla sp.) and "no-see-ums" (Diptera: Ceratopogonidae: Dasyhelea sp.). Also present were:

Simuliidae: Diptera (black-flies)

Heptageniidae: Ephemeroptera (mayflies): Cinygma sp.
Ironodes sp.

Rhyacophilidae: Tricoptera (caddis flies): Rhyacophila sp.
Psychomyiidae: Tricoptera (caddis flies): Psychomyia sp.

The low number of insects captured was due to the late dates of substrate installation. No Plecoptera were found in Waterfall Creek samples. Plecoptera adults were, however, very common after late July. No-see-ums adults were also very common accounting for the low number of larvae in the samples. Large numbers of Psychomia sp. larvae (up to 4 per sq ft) were observed in the silt bottoms of some areas (Sloughs Numbers 4, 14 and McKenzie Creek). Substrates should be installed in early June to provide more detailed data on species composition.

Foregut analysis of coho fry demonstrated the importance of insect larvae in the diets of rearing fish (Table 17). Salmon eggs were also an important food source. A larger variety of insects were present in the Talkeetna River stomach samples. This is probably due to the time of year these fry were collected. More detailed studies on insect populations and their importance in salmon fry diets is required.

Escapement Surveys

Chum salmon spawning occurred in Sloughs Numbers 3, 9, 13, 15, 16, 21, Lane Creek and Indian River. Peak spawning occurred during the last week of August and first three weeks of September (Table 18). Sloughs Numbers 9 and 21 contained the largest numbers of spawning adults.

Spawning sockeye salmon were observed in four sloughs and three streams. Sloughs Number 3-B and 21 contained spawning sockeye and chum salmon. The highest density of spawning occurred in Sloughs Numbers 11 and 21. The peak of spawning occurred between August 26 and September 27 (Table 18).

Table 17. Stomach content analysis of coho salmon fry collected at Sloughs Numbers 9, 11 and 15, Susitna River and Slough Number 2, Talkeetna River, Devil's Canyon Project, 1975.

Slough No.	Date	Length (mm)	Weight (g)	Relative Condition	Contents
Susitna River					
15	8/14/75	50	1.6	full	1 egg, 1 Diptera larvae 5 Trichoptera larvae
		50	1.3	empty	
		50	1.4	1/2	Trichoptera larvae, detritus Diptera larvae
		58	1.8	full	1 egg, detritus, Diptera larvae
		55	1.5	1/2	1 egg
		54	1.4	3/4	Diptera larvae, algae, Trichoptera larvae, detritus
		50	1.3	empty	
		50	1.4	empty	
		53	1.5	1/2	Diptera larvae & pupae, algae, Trichoptera larvae, detritus
9	9/6/74	78	6.1	full	2 eggs
		65	3.6	1/2	Diptera nymphs
		61	3.2	full	2 eggs, Diptera nymphs
		60	2.6	1/2	3 Diptera larvae
		69	4.2	full	2 eggs, 1 Trichoptera larvae
		65	3.3	empty	
		68	3.7	1/3	1 egg
		66	3.4	empty	
		63	3.0	empty	
		54	2.3	1/4	detritus
11	9/6/75	67	4.0	full	2 eggs
		63	2.9	empty	
		60	2.7	full	2 eggs, ? Trichoptera
		57	2.4	1/2	? Trichoptera, detritus, algae
		58	2.5	full	2 eggs, detritus
		55	2.0	full	1 egg, 8 Trichoptera (heads)
Talkeetna River					
2	6/5/75	49	1.4	3/4	8 Trichoptera larvae, blue-green algae, ? Diptera larvae
		49	1.5	full	Diptera larvae & pupae, algae, detritus, Trichoptera, Odonata, Plecoptera, Coleoptera
		56	1.8	3/4	Trichoptera larvae, algae, detritus, Plecoptera, Diptera larvae
		48	1.3	empty	
		47	1.3	1/2	Trichoptera larvae, detritus, algae
		45	1.2	full	Trichoptera larvae, Diptera larvae Odonata (?), detritus
		46	1.3	3/4	1 egg, Trichoptera larvae, algae Diptera larvae

Table 18. Peak adult escapement survey counts for chum, pink, sockeye and king salmon, Susitna River, Devil's Canyon Project, 1975.

Chum Salmon Surveys

Location	Date	Density Live	Density Dead	Density Total
Slough No. 3B	9/3	50	0	50
Lane Creek	8/17	3	0	3
Slough No. 9	9/27	54	127	181
Slough No. 13	9/25	1	0	1
Slough No. 15	9/6	1	0	1
Slough No. 16	8/26	12	0	12
Indian River	8/12	70	0	70
Slough No. 21	9/6	246	4	250
Total		437	131	568

Sockeye Salmon Surveys

Location	Date	Density Live	Density Dead	Density Total
Slough 3B	9/3	14	1	15
4th July Creek	8/17	1	0	1
Slough No. 11	9/4	84	0	84
Slough No. 19	8/26	16	4	20
Slough No. 21	9/25	74	1	75
McKenzie Creek	9/27	45	1	46
Indian River	9/26	1	0	1
Total		235	7	242

Pink Salmon Surveys

Location	Date	Density Live	Density Dead	Density Total
4th July Creek	8/17	143	5	148
Indian River	8/12	312	9	321
Lane Creek	8/17	96	10	106
Total		551	24	575

King Salmon Surveys

Location	Date	Density Live	Density Dead	Density Total
Whisker's Cr.	8/4	19	3	22
4th July Creek	8/9	1	0	1
Indian River	8/12	10	0	10
Portage Creek	7/29	29	0	29
Total		59	3	62

Pink and king salmon were observed spawning only in clearwater streams. The peak in pink spawning was from August 12 through August 17 and the peak of king spawning from July 29 to August 12 (Table 18). The survey counts of the clearwater tributary streams do not reflect the total number of spawning salmon, but only the density within the index areas (Appendix II, Table 7).

Talkeetna and Chulitna River Investigations

Investigations were initiated on the Talkeetna and Chulitna Rivers in June 1975. Surveys located 13 potential spawning and rearing sloughs and two clearwater tributary streams in the Talkeetna River from the confluence with the Susitna River upstream about 16 miles (26 km) to Clear Creek (Figure 3). The mainstem Talkeetna River flowed through some of the potential slough areas making fry counts impossible due to silty water conditions. Only one slough area was accessible by boat on the Chulitna River due to the braided nature of the mouth. One slough was identified on the mainstem Susitna River from the Talkeetna River downstream to the Anchorage-Fairbanks Highway bridge (Appendix I, Figure 41). No fry were observed in this slough.

Rearing coho and chum salmon fry were observed in the Talkeetna River sloughs during June surveys. Chum salmon were collected from Sloughs Numbers 1, 4 and Beaver Pond Slough. Seventeen samples were collected from Slough Number 1 (Table 19). The mean lengths of chum salmon fry from Beaver Pond Slough and Slough Number 4 were 38.4 and 37.6 mm, respectively. No chum salmon fry were observed in the sloughs after the first week of June.

Coho salmon fry were observed in Sloughs Numbers 1, 2, 9 and Beaver Pond Slough during June surveys. The mean lengths ranged from 42.9 mm in Slough Number 2 to 73.6 mm in Slough Number 9. All were 0.0 age fish produced from the 1973 brood year (Table 20). The largest numbers of fry were observed in Slough Number 2. High water conditions in mid-June prevented further boat surveys. An aerial reconnaissance was conducted to observe conditions of the river and note the presence of king salmon adults migrating to spawning areas. No adults were observed. Further sampling was postponed until conditions of the river permitted.

Escapement surveys were initiated the third week of July and continued through mid-September. Rearing coho fry were observed in 8 slough areas and one clearwater tributary stream (Appendix II, Tables 8 and 9). Only one representative of the 1.0 age class coho fry was collected in a Talkeetna River slough. No other salmon fry species were observed. Grayling and whitefish, resident species, were observed in Clear Creek slough on August 19.

Chum salmon were the only adult species observed spawning in the slough areas of the Talkeetna River by the escapement survey crew. Reports from sportfishermen and other department biologists did, however, document sockeye, pink and chum salmon spawning in clearwater tributaries. Tags were recovered from Chunilna Creek, Clear Creek and Stephan Lake (Table 4). Aerial surveys of sloughs upstream from Clear Creek revealed high densities of spawning chum salmon.

Table 19. Age and length samples of chum salmon fry from Slough Number 1, Beaver Pond Slough, and Slough Number 4, Talkeetna River, Devil's Canyon Project, 1975.

Slough Number	Date	Sample Size	0.0 Age Class Mean Length (mm)	0.0 Age Class Standard Deviation
1	6/5	17	35.7	2.2
Beaver Pond	6/5	10	38.4	3.4
4	6/5	20	37.6	3.0

Table 20. Age and length of coho salmon fry from Sloughs Numbers 1, 2, Beaver Pond, Billion, 3A, 5, 6, 7, Whiskey and 9, Talkeetna River, Devil's Canyon Project, 1975.

Slough No.	Date	Sample Size	0.0 Age Class			1.0 Age Class		
			Percent Composition	Mean Length (mm)	Standard Deviation	Percent Composition	Mean Length (mm)	Standard Deviation
1	6/5	5	100	48.6	8.1	0		
	7/25	8	100	54.8	3.0	0		
	9/2	8	100	62.6	5.1	0		
2	6/5	19	100	42.9	7.6	0		
	8/5	8	100	58.9	2.3	0		
Beaver Pond	6/5	2	100	44.5	2.12	0		
Billion	8/11	8	90	65.4	4.7	10	91.0	
3A	8/5	8	100	55.8	3.1	0		
5	7/25	4	100	42.5	5.2	0		
6 & 7	7/25	8	100	54.5	5.0	0		
	9/9	8	100	60.9	8.5	0		
Whiskey	8/5	8	100	58.1	6.5	0		
9	6/7	8	100	73.6	3.7	0		

Three sloughs (Numbers 4, 8 and 9) originally identified in June were flooded by the mainstem Talkeetna River on August 5. These 3 sloughs were flowing through for the remainder of the surveys.

The mouth of Slough Number 6 dried up between August 19 and September 2. Approximately 1,000 coho fry were trapped in the slough. Water levels were sufficient to support the population, but it is not known if this area will freeze completely and result in mortalities during winter months.

Water conditions of the Talkeetna River were monitored monthly at the Alaska Railroad bridge (Table 21). Total suspended solid levels ranged from 4 mg/l in March to a peak of 185 mg/l on July 25. The settleable suspended solids were normally greater than 9 percent of the total dissolved solids. Water temperatures ranged from 33°F in March to 48°F in mid-August. Dissolved oxygen levels were not a limiting factor at this location, being greater than 12 ppm.

The Chulitna River was surveyed weekly from July 22 to August 25. No fry or adults were observed in Slough Number 1, Chulitna River, throughout the season. June surveys noted the presence of unidentifiable adult salmon carcasses, from the 1974 season, in the clearwater stream below the beaver dam (Appendix I, Figure 40).

Climatological Observations

Climatological data was collected daily, at approximately 2000 hours, at the fishwheel camp from July 7 through August 26 (Table 22). The maximum air temperature during this period was 76°F and the minimum was 52°F. The maximum and minimum water temperatures were 62°F and 50°F, respectively. The Susitna River level fluctuated a maximum of 3.1 feet (0.9 m) from July 7 through August 26. The maximum twenty-four hour fluctuation in the river level was an increase of 0.9 feet (0.3 m) which occurred between July 27 and July 28. Atmospheric observations during the 51 day period indicated that 3 days had a cloud cover less than 5 percent of the sky and 13 days were completely overcast.

Water temperature profiles, recorded 24 hours a day with a Ryan thermograph, demonstrate relatively low fluctuations in water temperatures at Gold Creek during winter months (Figure 11). Profiles of water and air temperatures at the fishwheel site suggests a significant daily warming and cooling of water temperatures (Figure 12).

DISCUSSION AND SUMMARY

Gross indications of migrational timing, abundance by species and age-length-sex data was obtained from fishwheel operation in the lower study area. The total catch of salmon during the 1975 season was less than 1974. Chum and pink salmon dominated the fishwheel catches. Population estimates were determined by the Peterson mark and recapture method. The population estimates for 1974 and 1975 were:

Table 21. Analysis of water conditions of the Talkeetna River at the Alaska Railroad bridge, Devil's Canyon Project, 1975.

Date	Temperature Air(°F)	Temperature Water(°F)	Sample Size (l)	Suspended Solids Settlable (mg/l)	Suspended Solids Non-filterable (mg/l)	Suspended Solids Total Suspended (mg/l)	D.O. (ppm)	pH	Water Depth (inches)	Ice Cover (%)	Snow Depth on Ice (inches)	Anchor Ice Present
3/16/75	30	33	3	3	1	4	18	5.6	>50	100	6-12	no
4/3/75	29	33	3	36	1	37	17.9	5.5	32.5	95	10.8	no
4/21/75	40	34	2	23	1	24	18.5	5.6	>60			
6/5/75	50	42	2	69	2	71			>72			
7/25/75	57	48	2	168	17	185						
8/19/75	55	48	2	171	8	179						
9/1/75	56	45	2	24	1	25						

Table 22. Climatological observations at the fishwheel camp, Devil Canyon Project, 1975.

Date	(military)	Air Temp (°F)	Water Temp (°F)	Water Guage (feet)	Cloud Cover (percent)
July					
7	2100	67	58	2.1	10
8	2000	76	62	2.2	5
9	2000	76	62	2.3	80
10	2020	76	62	---	5
11	2200	65	62	2.2	90
12	2000	55	58	2.6	100
13	2000	53	54	3.2	100
14	2000	65	54	3.0	60
15	2000	52	51	2.4	100
16	2000	58	54	2.6	30
17	1945	64	55	2.1	90
18	2000	59	55	1.8	40
19	2000	54	52	2.0	100
20	2000	53	51	2.3	100
21	2000	53	50	2.6	100
22	2000	57	51	2.5	5
23	2000	60	52	1.8	90
24	2000	57	53	1.5	100
25	2130	54	53	1.7	100
26	2000	55	52	1.7	90
27	2000	59	53	1.5	60
28	2020	58	53	2.4	60
29	2000	53	51	2.2	100
30	2000	54	53	1.7	100
31	2000	54	51	1.6	95
August					
1	2130	54	51	1.6	90
2	2000	60	56	1.5	50
3	2000	58	54	1.3	100
4	2000	56	54	1.2	60
5	2000	58	56	0.8	10
6	2000	58	55	0.8	70
7	2000	58	54	1.0	95
8	2000	60	54	0.9	50
9	2000	60	54	1.0	80
10	2000	58	53	0.8	100
11	2000	59	53	0.8	60
12	2000	62	54	0.7	90
13	2000	58	56	0.5	95
14	2000	63	57	0.5	90
15	2000	55	56	0.5	100
16	2000	58	55	0.8	50
17	2000	61	53	1.3	50
18	2000	56	53	0.9	60
19	2000	57	52	0.9	20
20	2000	57	53	0.5	50
21	2000	56	53	0.3	10
22	2000	54	55	0.3	70
23	2000	57	55	0.1	10
24	2000	53	52	0.1	99
25	2000	55	53	0.1	99
26	2000	53	52	0.1	50

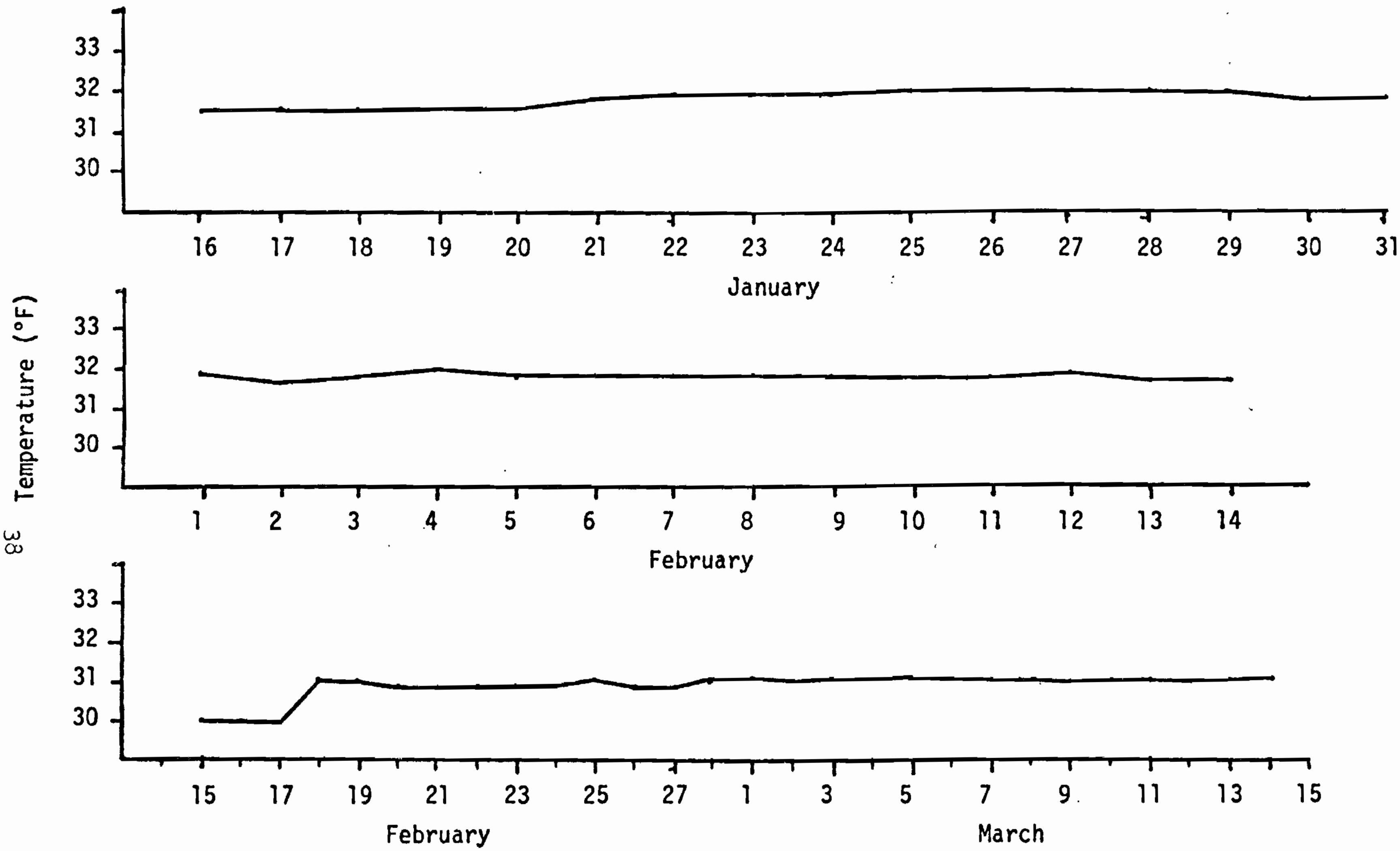

Figure 11. Water temperature profiles recorded daily in the Susitna River at Gold Creek, Devil's Canyon Winter Project, 1975.

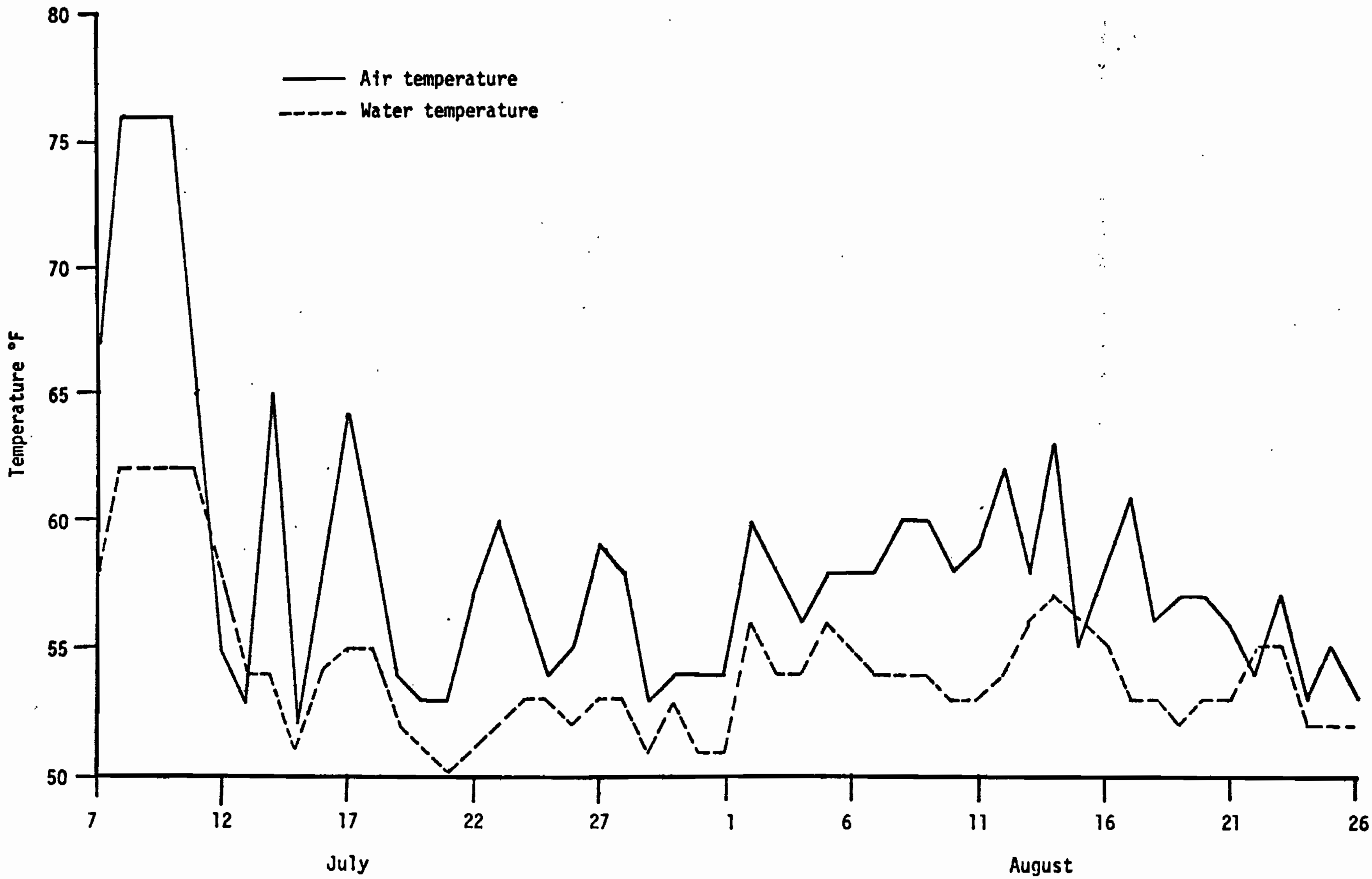

Figure 12. Profile of water and air temperatures recorded daily (2000 hours) at the east bank fishwheel camp, Devil's Canyon Project, 1975.

	1974	1975
chum	24,386 ± 2,602	11,850 ± 4,044
pink	5,252 ± 998	6,257 ± 261
sockeye	1,008 ± 224	1,835 ± 337

Comparative data is not available for king and coho salmon. Tag recoveries from chum, pink, sockeye and coho salmon below the fishwheel sites indicate a significant, but unknown, proportion of the salmon captured were possibly milling and not migrating to spawning grounds above the tagging project.

Twenty-one sloughs were identified and surveyed on the Susitna River during 1974. An additional 7 sloughs were identified during winter and summer 1975. Rearing fry were observed in 22 of the slough areas. Adult salmon were found spawning in 8 of the sloughs. Adult sockeye salmon were observed in 4 sloughs and adult chum salmon were observed in 6 slough areas. Pink, king and coho salmon adults were found exclusively in clearwater tributaries. Chum salmon were observed spawning in Lane Creek and Indian River and sockeye spawned in Fourth of July Creek, McKenzie Creek and Indian River, clearwater tributaries of the Susitna River.

A minimum of 575 pink, 568 chum, 242 sockeye and 62 king salmon spawned in the streams and sloughs of the Susitna River between the confluence of the Chulitna River and Portage Creek as determined from peak slough and stream index escapement counts.

Thirteen sloughs and 2 clearwater streams were identified and surveyed on the Talkeetna River between its confluence with the Susitna River and Clear Creek in 1975. Coho fry were rearing in 8 sloughs and one clearwater stream. Rearing chum salmon fry were observed in 3 sloughs in June. Chum salmon were the only salmon species observed spawning in the slough areas of the Talkeetna River. Pink salmon were, however, observed in Clear Creek by the escapement survey crew. The presence of spawning sockeye, coho and pink salmon was confirmed by sportfishermen's tag returns in Chunilna Creek, Clear Creek and Stephan Lake.

Winter surveys of the slough and mainstem Susitna River established the presence of rearing coho fry (O. kisutch) in both areas. Suspended solid levels of the mainstem river were extremely low during fall and winter months resulting in clear water conditions. The combination of partial slough dewatering and clear water conditions were contributing factors of fry emigration into the mainstem river for rearing.

Artificial substrate sampling and fry foregut analysis was conducted to determine species composition of invertebrates within the study area and the importance of benthic invertebrates as food items to rearing fry. Insects comprised 100 percent of the benthic organisms found in the substrate samples. The number of species of benthic organisms identified was extremely low. The contributing factors are the time of year they were installed and the length of time they remained in the sampling locations. The Plecoptera (stoneflies) and Diptera ("no-see-ums") represented the dominant orders. Simuliidae (black flies), Ephemeroptera (mayflies) and Tricoptera (caddis flies) were also present.

Various environmental changes will occur as a result of dam construction on the Susitna River. The most obvious change produced will be the flooding of about 82 miles (132 km) of river above the Devil Canyon Damsite. Anadromous fishes are not found in this section of the river. Environmental changes will, however, occur downstream as a result of river impoundment. The effects will occur not only on the mainstem Susitna River but also on the Talkeetna and Chulitna Rivers.

Deposition of the Susitna, Talkeetna and Chulitna Rivers will be altered by dam construction. The Chulitna River carries a large bed load and suspended load to its confluence with the Susitna River. The braided nature of the Chulitna at its mouth and the extension of this condition several miles up the Susitna, indicate that this portion of the two rivers has a sediment transporting regime that could readily become depositional. The loss of peak flows in the Susitna River will favor deposition and related flooding in the flats of the Chulitna River above its confluence (Bishop, 1974).

The Talkeetna River does not carry the sediment load of the Chulitna River, but it may also be affected by regulation of the Susitna. The effect would most likely be in response to the Chulitna's deposition of sediments acting to backwater the Talkeetna River. Flooding conditions in the Talkeetna River would most likely be enhanced (Bishop, 1974).

Temperature regimes and velocities in the Talkeetna and Chulitna Rivers are also expected to be altered. Potential changes such as these warrant continued studies of the fish populations in these tributaries.

Descriptions of potential impacts and suggestions for further studies have been compiled by Department of Fish and Game, Sport and Commercial Fisheries biologists. These were compiled jointly, since many areas overlap and would result in unnecessary repetition. These are included in the next section of the report.

There are no present methods of affixing a value on the Susitna River salmon production. Total escapement data by species by year is not available for the Susitna River drainage due to the glacial water conditions of this system which prohibits visual observation and total escapement counts. Test fishing and fishwheel tag-recovery programs have been and are still being conducted in the lower Susitna River and its tributaries (Yentna and Talachulitna Rivers and Susitna River at Susitna Station), but have been unsuccessful in providing total escapement figures to date. The utilization of sonar to provide escapement data for the Susitna River has not been explored fully. An experimental program may be initiated by Department of Fish and Game in 1976. We can only estimate the monetary values of the Susitna River salmon stocks at this time. Department of Fish and Game Commercial Fisheries biologists have derived a method of determining the monetary values, but it must be emphasized that these figures are at best "guesstimates" (Appendix IV).

POTENTIAL IMPACTS AND RECOMMENDATIONS

Impoundment of the Susitna River, from Devil Canyon upstream 84 miles, by the Devil Canyon and Watana Dams will inundate some 50,500 acres of land. Environmental impacts will occur both up and downstream from the dams. Two phases of development of the hydroelectric facilities will occur:

(1) the construction period projected to extend over a 12-year period and

(2) the operation of the facilities which will provide hydroelectric power to the Southcentral Railbelt area. Environmental impacts of this project can be divided into two phases: (1) those occurring during the construction period and; (2) those occurring during the post-construction period which will encompass the entire life of the project.

Construction Period Impacts

Construction of the dams will necessitate the diversion of the Susitna River from its natural course. The major effect during this period is expected to be an increase in silt load due to construction activities. This decrease in water quality may cause the following impacts:

1. Disorientation of adult salmon returning to their home streams, resulting in a decrease or lack of production in the upper areas of the river.

2. Change in substrate composition in sloughs resulting in decreased spawning area. Chum (*Oncorhynchus keta*) and sockeye salmon (*O. nerka*) are known to utilize these areas for spawning.

3. Lack of clearwater conditions during fall and winter months preventing fry from utilizing the mainstem Susitna River for rearing.

4. Degradation of water quality resulting in possible alterations in the aquatic food chain. Some orders of insects, important food items for salmon fry, may be unable to adapt to the changed water quality and the entire food chain will be altered.

5. Reduction of flow during construction years and initial filling of dam would remove much spawning habitat and could eventually change fish distribution below dam. During the low flow construction period a substantial risk of water pollution from concrete pouring, oil spillage, etc., could occur.

6. Reduction in run of salmon would follow reduction of flow (Penn, 1975). Reducing flows could result in access restrictions to salmon utilizing the upper regions.

Post-Construction Impacts

1. Turbidity

The Susitna River currently carries a heavy load of glacial silt in spring and summer. The river's water is clear during fall and winter months. Impoundment will result in a milky color of the water year-round. Turbidity may also be increased if there is permafrost in the area (Afton, 1975). This condition may result in:

a. Inability of fry to utilize the mainstem for rearing.

b. Erosion of gills of adults and fry due to the silty condition of the mainstem Susitna River.

c. Increased light penetration due to decreased summer turbidity would encourage more primary production. Rate of zooplankton development may not necessarily be increased due to possible lower temperature in the April-May period. Rearing salmon depend on zooplankton stock at this time.

d. Influence of bedrock on impoundment water quality may affect fisheries. (Duthie and Ostrofsky, 1975).

e. Increased mortality due to decreased summer turbidity and increased predation success might occur (Geen, 1975).

f. Decreased spring and summer turbidity would likely limit downstream migration to the darker hours, thereby extending the downstream migration periods even further than at present since some migration occurs in the turbid water during daylight. There is evidence suggesting that increased time to migrate would increase young salmon mortality (Geen, 1975).

2. Temperature

Normal temperature regimes will be altered by impoundment. Various effects may be seen.

a. Any increases in downstream fall temperatures could affect spawning success of salmon. There is evidence that relatively high temperatures are associated with poor returning runs (Geen, 1975).

b. Increases in temperatures could result in change in the incubation period of salmon eggs and incubation conditions.

c. Increases in temperature could result in premature fry emergence and seaward migration due to increased rate of development. Increased mortality could occur because the migration may occur prior to development of estuarine and marine zooplankton.

d. Alteration of the normal thermal regime would change the overall productivity of the river, which could add extreme stress to fry populations.

e. A decrease in summer temperature could effect upstream migrational time for adult salmon, but its critical nature is unknown.

f. Changes in the aquatic food chain would be expected due to the inability of some organisms to adapt to even slight thermal alterations. The elimination of even one invertebrate species could affect the remainder of the food chain.

3. Chemical and Physical Parameters

a. Reservoir supersaturation of both dissolved oxygen and nitrogen resulting from stratification and spillage can be expected, impacting downstream fishes for an unknown distance (Geen, 1975).

b. Increases in dissolved nitrogen gas could also result from air vented into turbines to reduce negative pressures during weekend periods of sustained low generating levels (Ruggles and Watt, 1975).

c. Dams slow down water transport which gives more time for the biochemical oxygen demand to consume available oxygen, thus reducing dissolved oxygen content.

d. Conductivity, alkalinity, and pH can increase after impoundment construction (Geen, 1975).

e. Dissolved oxygen levels will probably be altered due to changes in river conditions. Levels below 5 ppm would preclude the survival of fish in slough areas.

4. Organic Debris

a. Debris has a time frame of 100-200 years. This time frame would be reduced with time as a result of forest drowning.

b. Population explosions of fish, benthos, and plankton may result from the addition of organic nutrients.

5. Water Flow

a. Altered lake levels may result in flooding, slumping, erosion and general shoreline degradation. Littoral zone changes affect fisheries.

b. Changed ice regimes can also affect river and lake shorelines. A change in water quality can be expected due to erosion and sediment processes from altered water levels, flows and ice regimes (Dickson, 1975).

c. Changes in substrate composition of spawning areas due to lack of natural scouring could affect winter survival of eggs.

d. Decreases in water levels during June and July could affect adult access to spawning areas.

e. Reduced discharge during summer could delay the migration of adult salmon upstream.

f. Reduction of discharge could affect survival of young salmonids moving to saline water during April-May. Seaward migration is directly related to river velocity and therefore could extend this period (Geen, 1975).

g. Reduction of normal spring and summer flows could result in a decrease of fry rearing habitat.

Recommendations

Before the full effects of this project are identified as related to fish and wildlife, considerable studies are necessary which are going to be both lengthy in time and costly in money. A brief resume of biological studies and investigational goals required prior to final definition of fish losses and/or gains resulting from impoundment of the Susitna River at Devil Canyon and Watana are:

I A thorough literature review of hydroelectric facilities is needed. This would provide information on pre and post-construction studies and indicate areas of potential concern.

II A thorough hydrologic study is essential. This study may have to be conducted in close coordination with a private engineering firm. The following is a partial list of necessary information.

1. Current unregulated flows and projected regulated flows.

2. Temperature regimes.

3. Turbidity and sediment data.

4. Anticipated physical changes to the natural stream course as a result of flow alterations.

III A comprehensive fishery study to address adult and juvenile salmonid abundance, distribution, migrational patterns, and age composition by species for areas both upstream and downstream of the proposed Devil Canyon Dam.

The Cook Inlet fishery is of mixed stock and presents many problems for its proper management. Total escapement data by species is not available for the Susitna River drainage. Until we are able to determine total escapement into the drainage we will not be able to determine the value of the salmon stocks in the upper Susitna River. Spawning ground surveys do, however, demonstrate the importance of this area to chum and pink salmon.

Data collected since July 1974 provides us with baseline information only. Generalizations may be made, but sufficient information is not available to determine exact impacts of dam construction and operation upon the fishery. Intense investigational projects should be initiated in the study area to provide pre-construction data to adequately evaluate possible impacts.

IV A study of affected habitat areas will be conducted in conjunction with the fisheries program. Productivity and limiting factors can be defined by a thorough limnological study. Physical, chemical and biological conditions of the Susitna River and its tributaries should be examined. A few specific concerns are:

1. Changes in quality and quantity of spawning habitat both upstream and downstream of the proposed dam sites as a result of a) flow and releases, b) innundation of upstream areas and c) effects of periodic pool fill and drawdown.

2. Effects upon the habitat and fisheries resource directly as a result of construction activities.

3. Effects of increased human use resulting from improved air and road access upon both the Susitna River drainage and adjacent fisheries.

These studies can be conducted in conjunction with the fisheries studies. Before ADF&G can completely outline the objectives of hydrological biological and environmental studies, the Corps of Engineers will also need to supply the following data:

1. Finalized plans on locations, design criteria, and features of dams.

2. Year-around data on current projections of regulated flows. The flow regimes are of utmost importance in determining what is required to protect fishery values.

3. Frequency and timing regarding spilling of excess water. Seasonal time and amount of reservoir drawdown is also required.

4. Description of access routes and distances and their status, i.e., private or public.

A means for advising this department of design or operational changes which may necessitate alterations in investigational programs is critical.

Project Time Span & Costs

Estimates from private engineer consultants indicate adequate and comprehensive hydrologic studies will require a minimum of one year to complete, but ideally should continue for a three year period.

Including the required personal services, equipment, and operational costs, etc., a total figure of $4-500,000 will be required annually.

The fisheries investigations required for both the upstream (above Devil Canyon) and the downstream area will require four to five years to complete due to the life cycles of the salmon species involved and the length of time required to assess habitat and environmental changes.

Costs for all fisheries studies, including resident and anadromous, for areas both upstream and downstream of Devil Canyon Dam are estimated at $300-350,000 annually. These figures include necessary personal services, operational costs, equipment, materials, etc. Included in this sum are monies for fulltime professional biologists to act as project leaders and direct the investigational programs. It can be anticipated that as the above mentioned projects are conducted the estimated budget figures stated may require modification.

ACKNOWLEDGEMENTS

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Ward Knous, Project Leader
Mike Stratton

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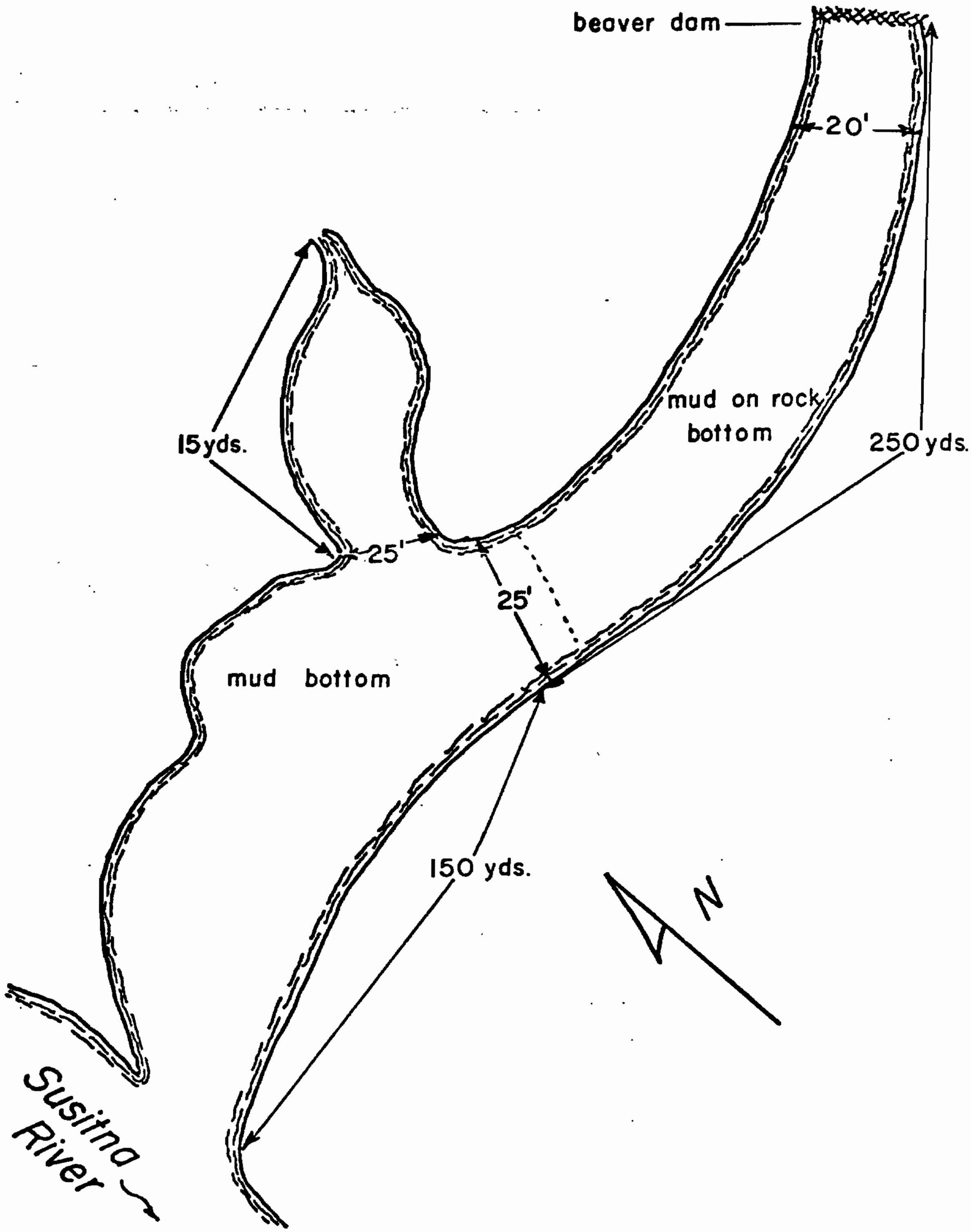
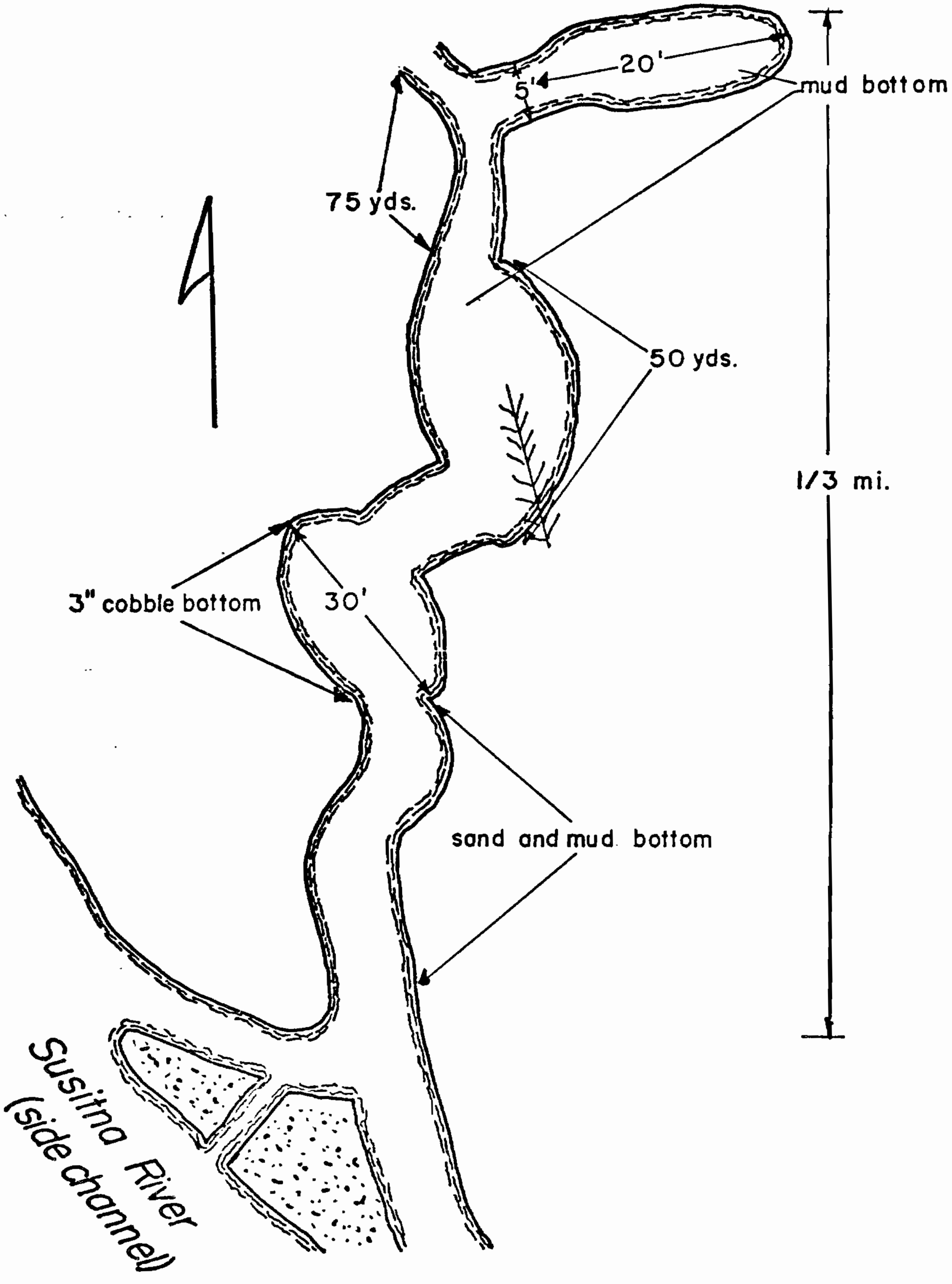
APPENDIX I

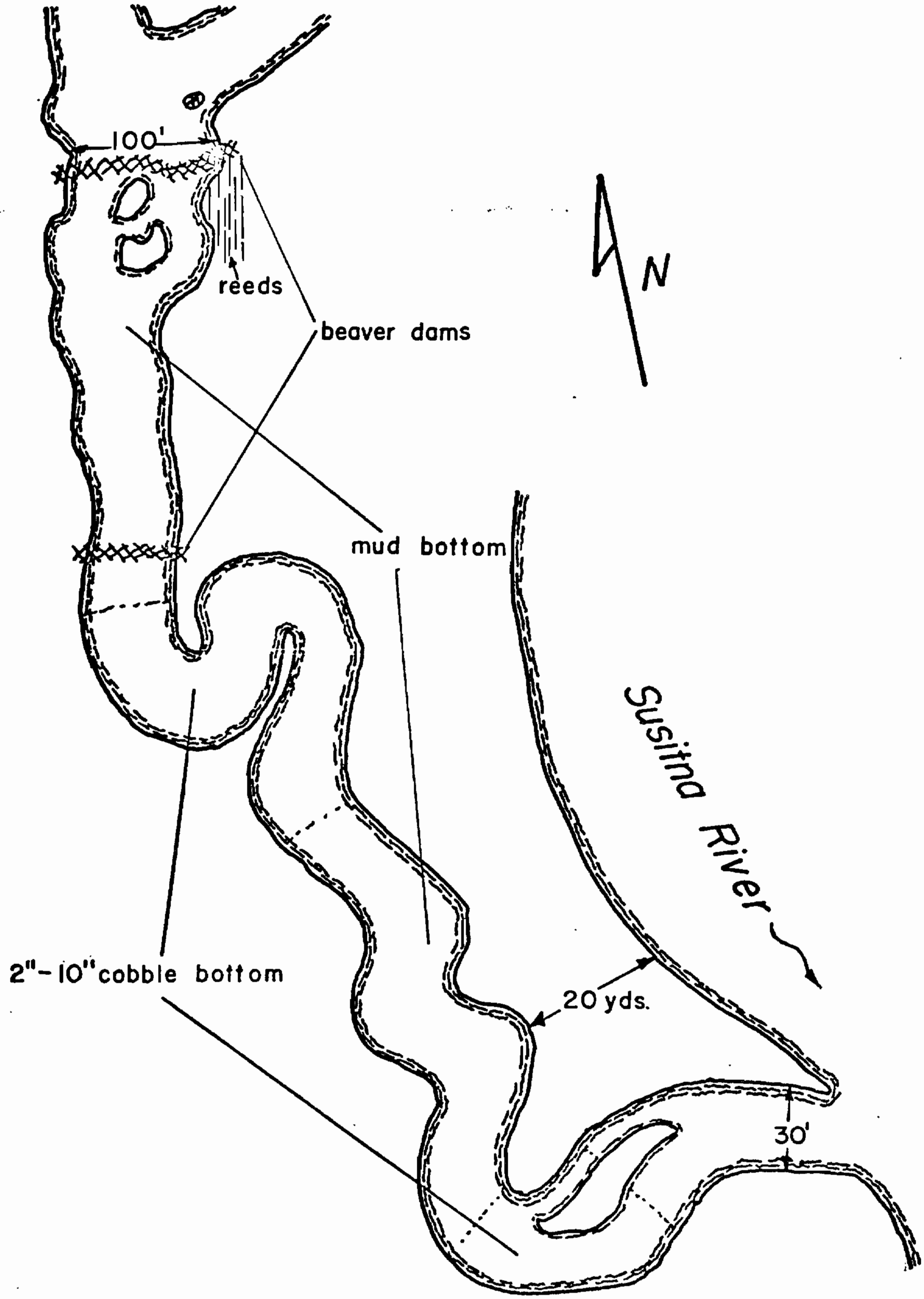
The slough areas of the Susitna, Talkeetna, and Chulitna Rivers have been referred to throughout the text. A diagrammatic sketch of each slough and some clearwater streams follows. The drawings are not to scale and are intended to define the slough area, its relative size, substrate composition, and sampling sites.



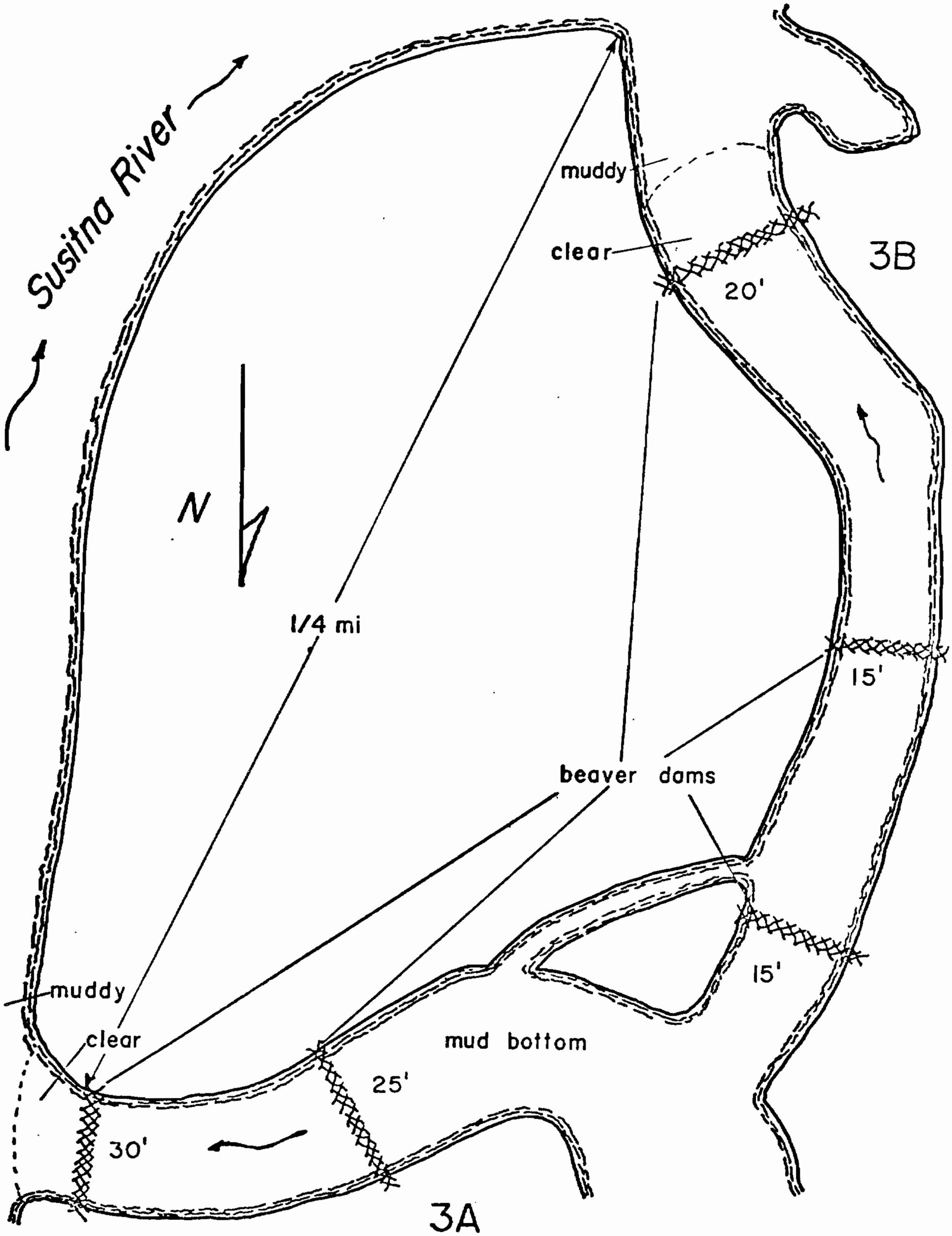
Appendix Figure 1. Map of Slough Number 1, Susitna River, as composed on September 3, Devil's Canyon Project, 1975.



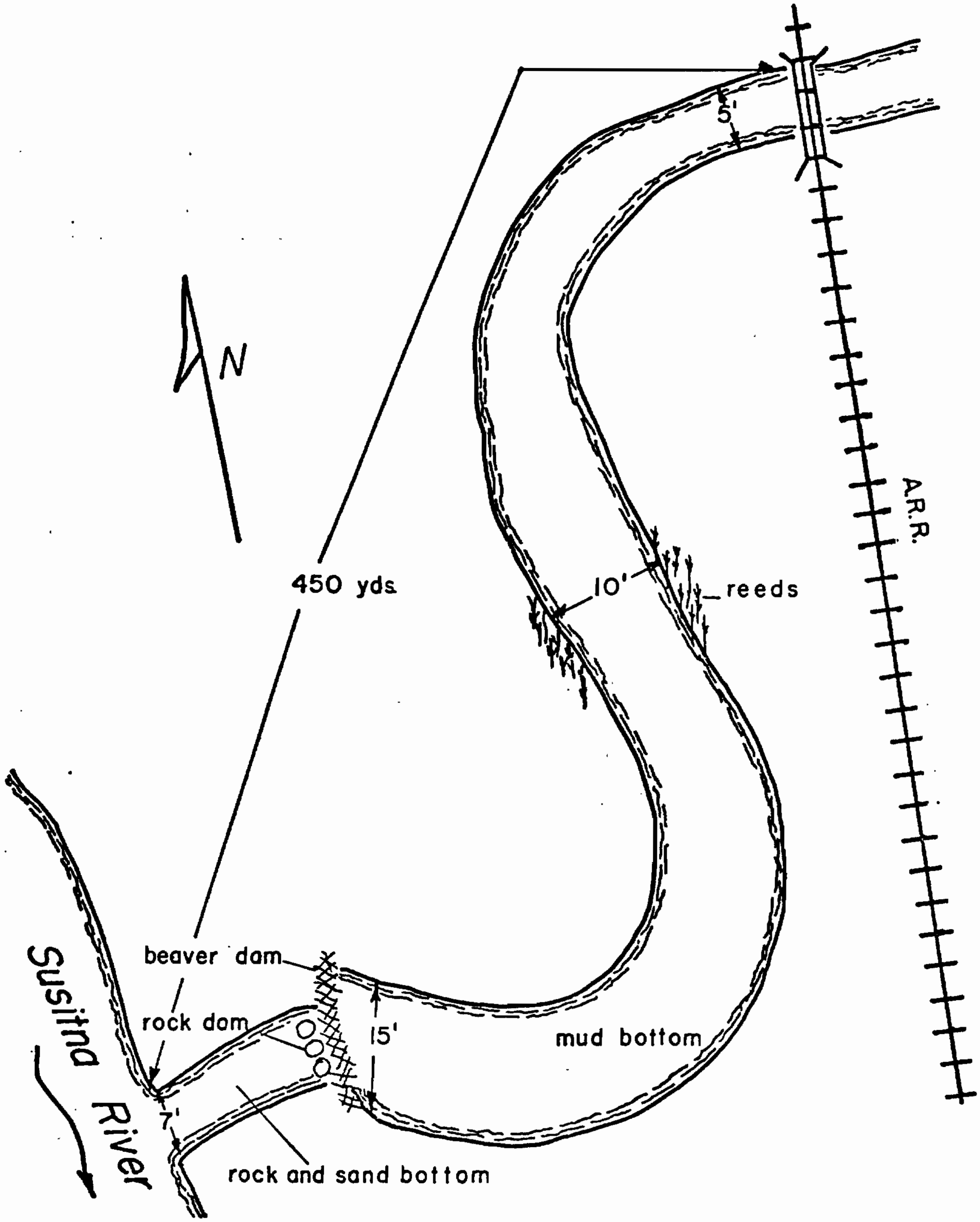
Appendix Figure 2. Map of Slough Number 2, Susitna River, as composed on September 3, Devil's Canyon Project, 1975.



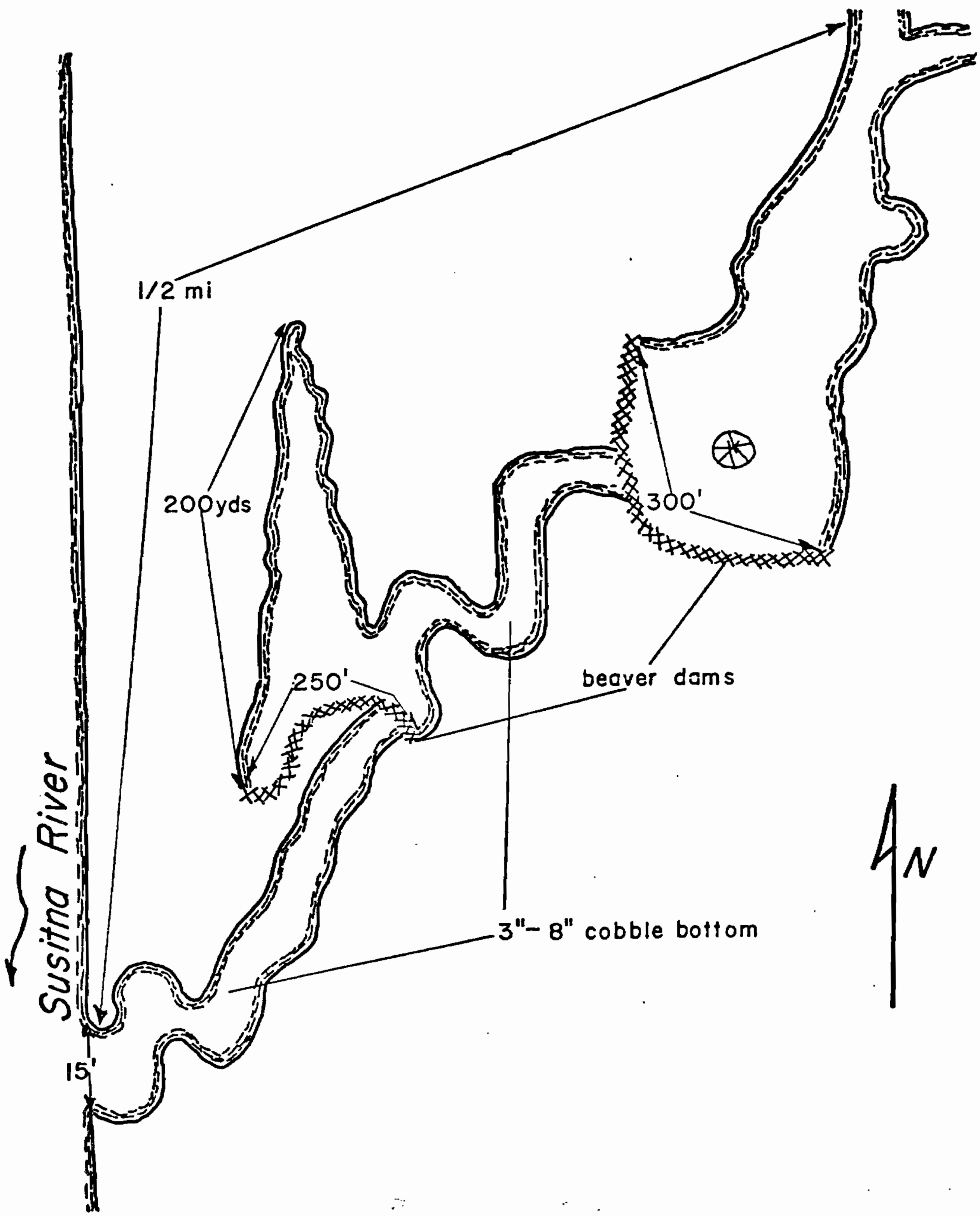
Appendix Figure 3. Map of Whiskers Creek, Susitna River, as composed on September 3, Devil's Canyon Project, 1975.



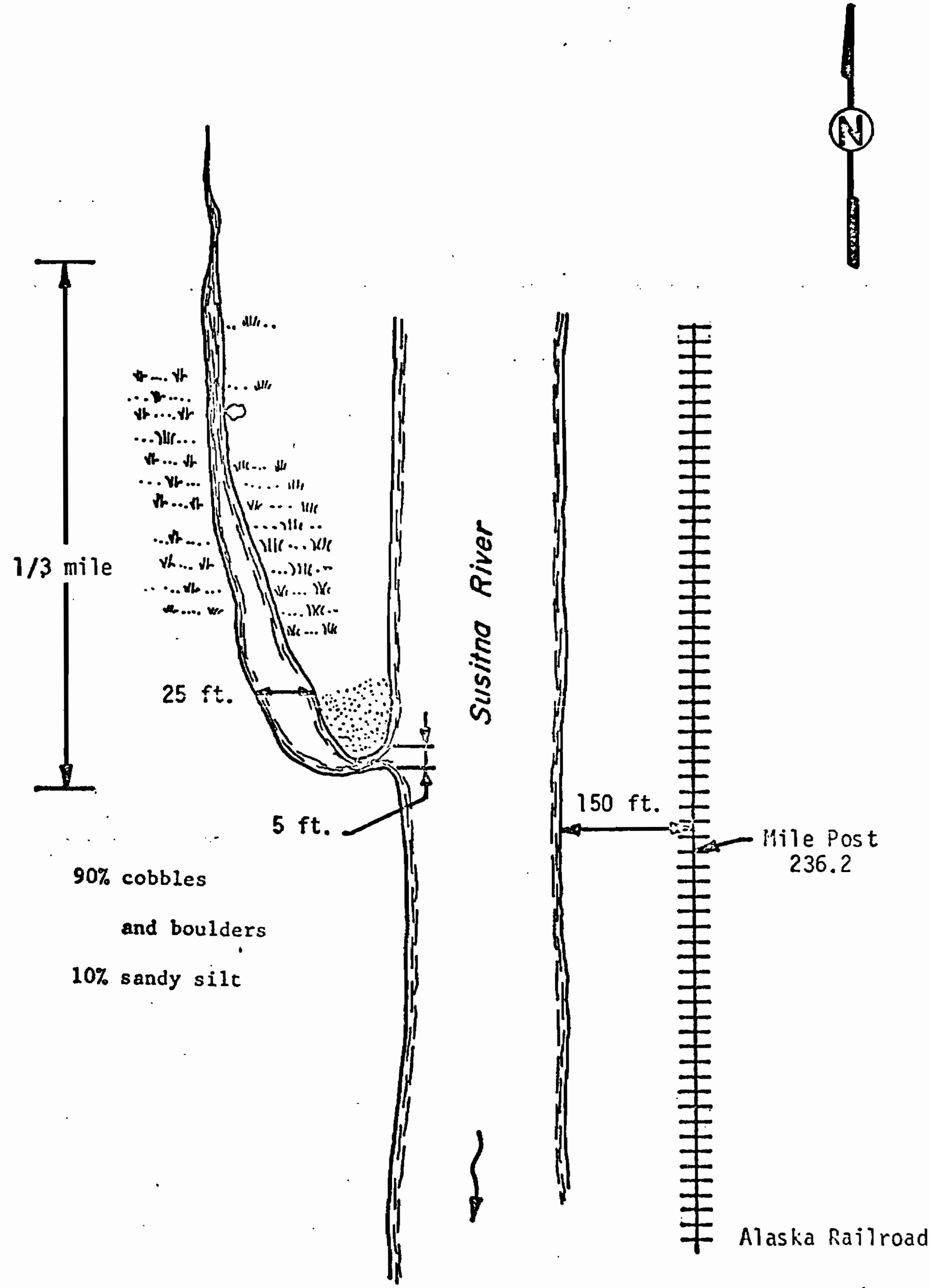
Appendix Figure 4. Map of Slough Number 3-A and Number 3-B, Susitna River, as composed on September 4, Devil's Canyon Project, 1975.



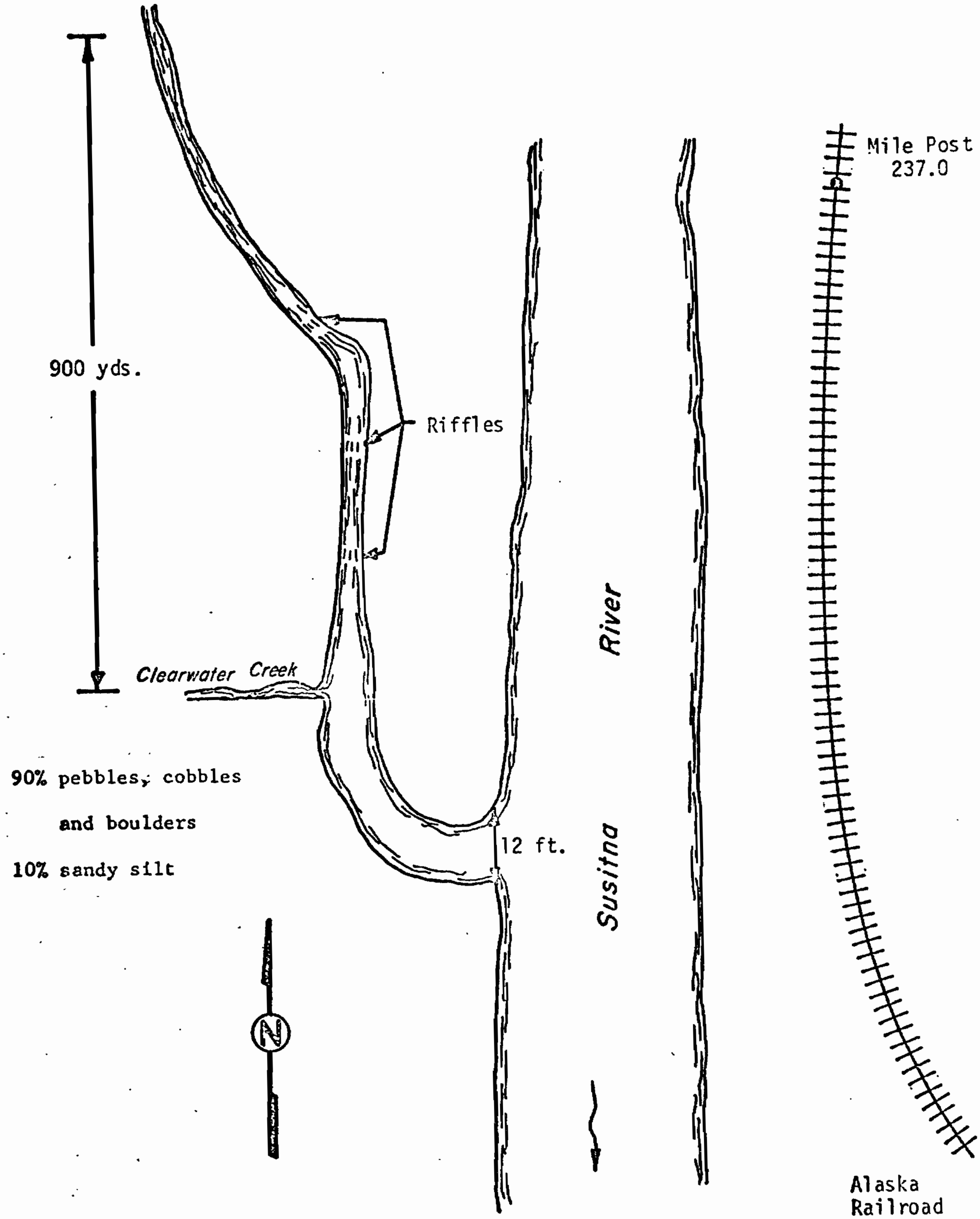
Appendix Figure 5. Map of Slough Number 4, Susitna River, as composed on September 4, Devil's Canyon Project, 1975.



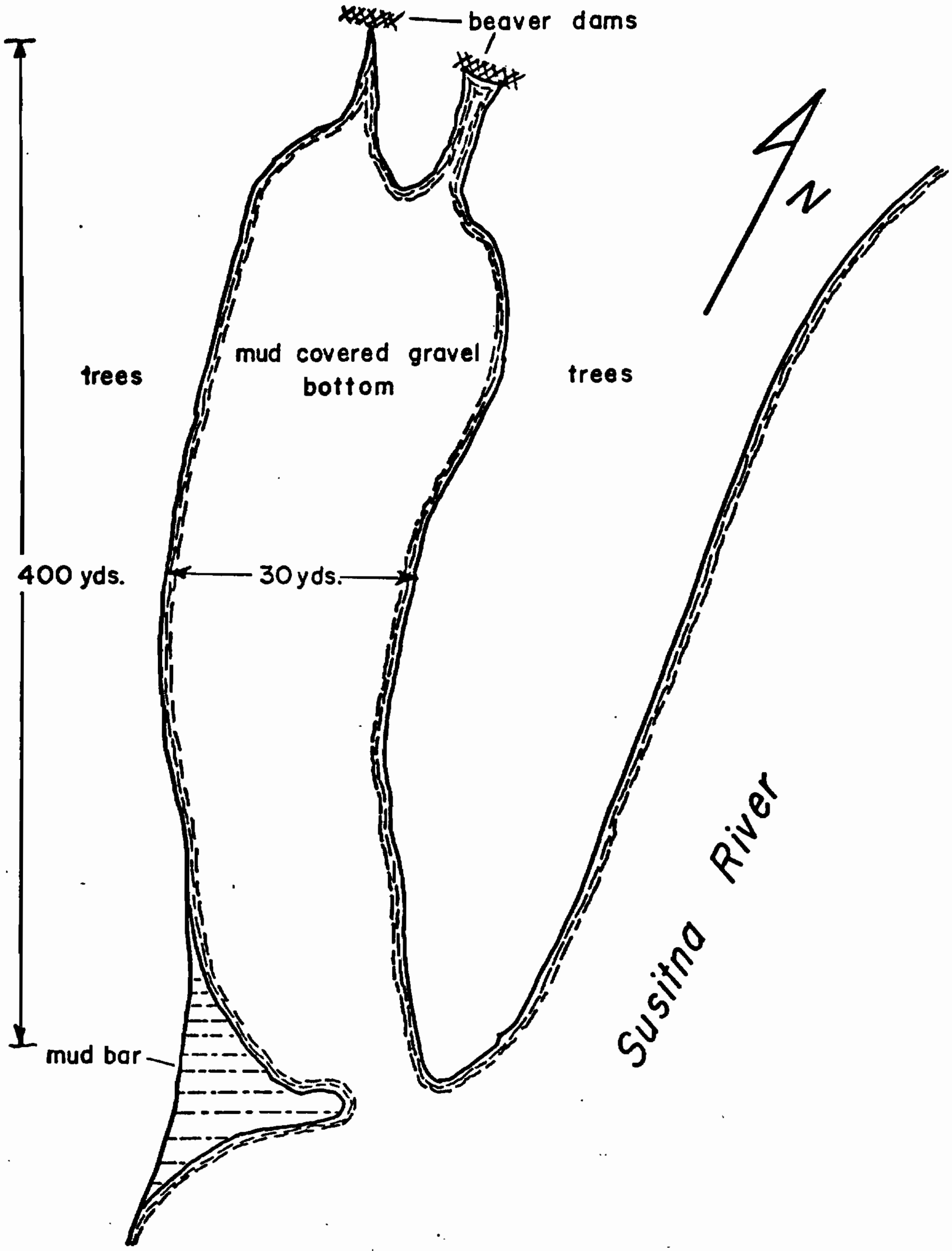
Appendix Figure 6. Map of Chase Creek, Susitna River, as composed on September 4, Devil's Canyon Project, 1975.



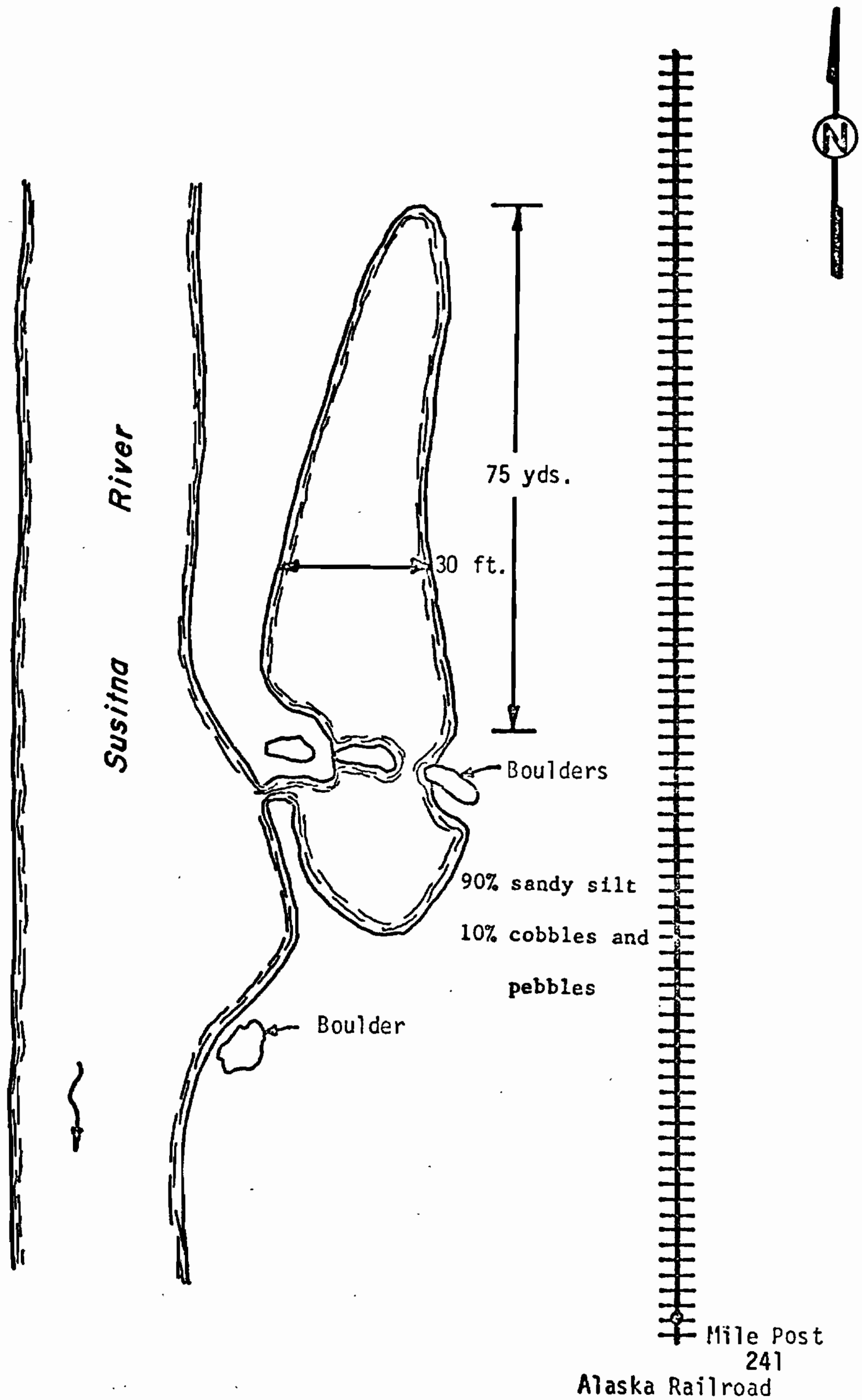
Appendix Figure 7. Map of Slough Number 5, Susitna River, as composed on August 16, Devil's Canyon Project, 1974.



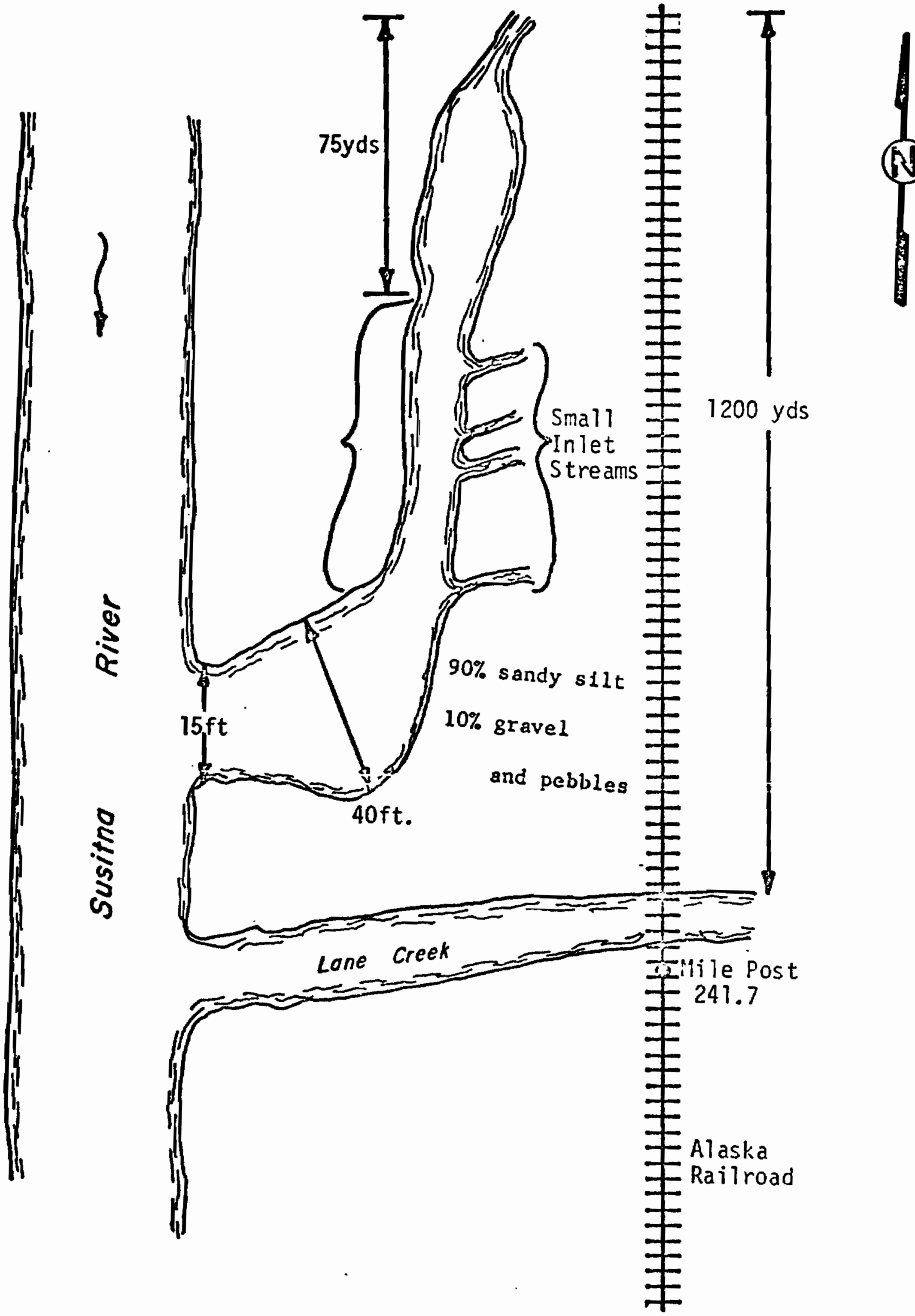
Appendix Figure 8. Map of Slough Number 6, Susitna River, as composed on August 16, Devil's Canyon Project, 1974.



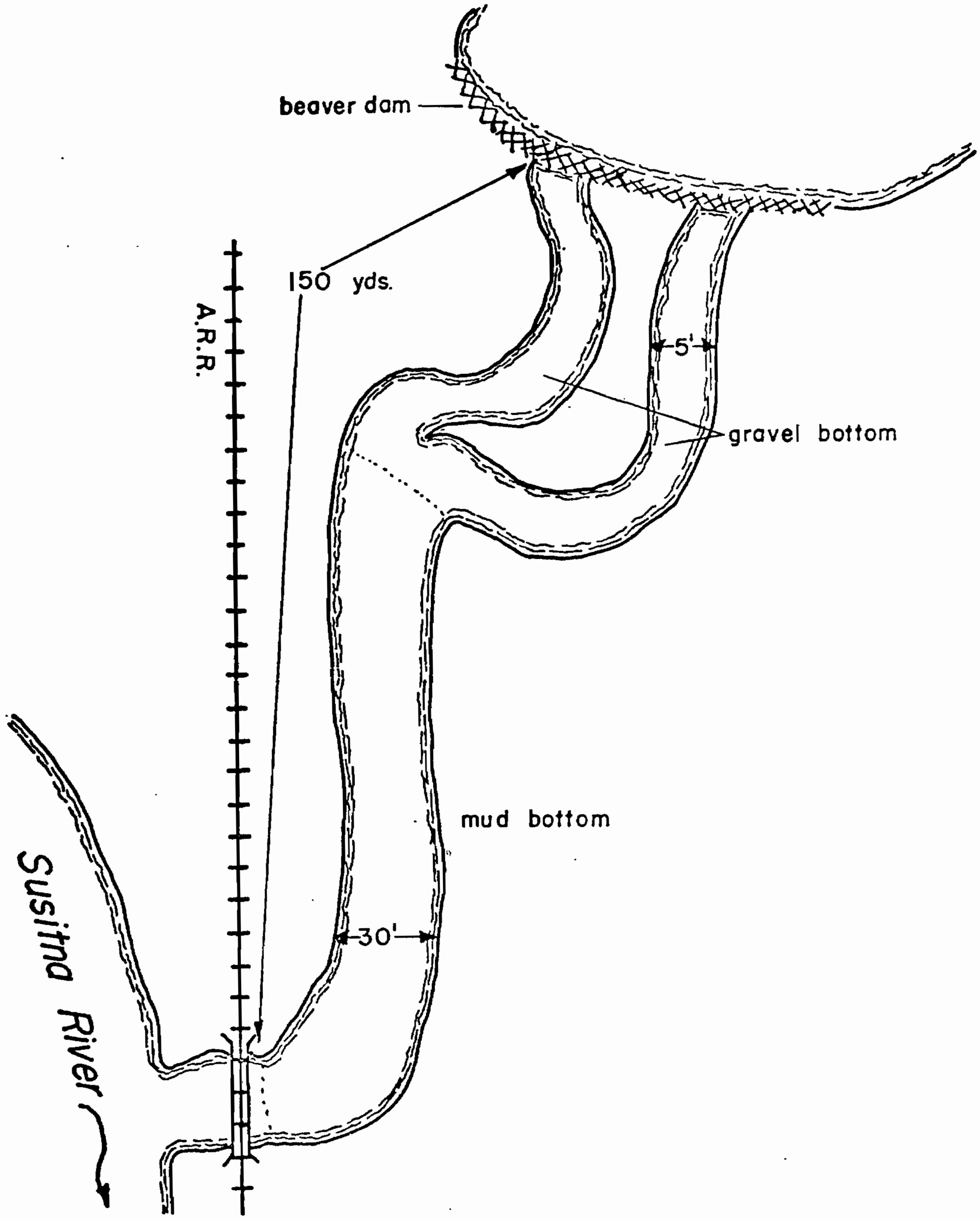
Appendix Figure 9. Map of Slough Number 6-A, Susitna River, as composed on September 5, Devil's Canyon Project, 1975.



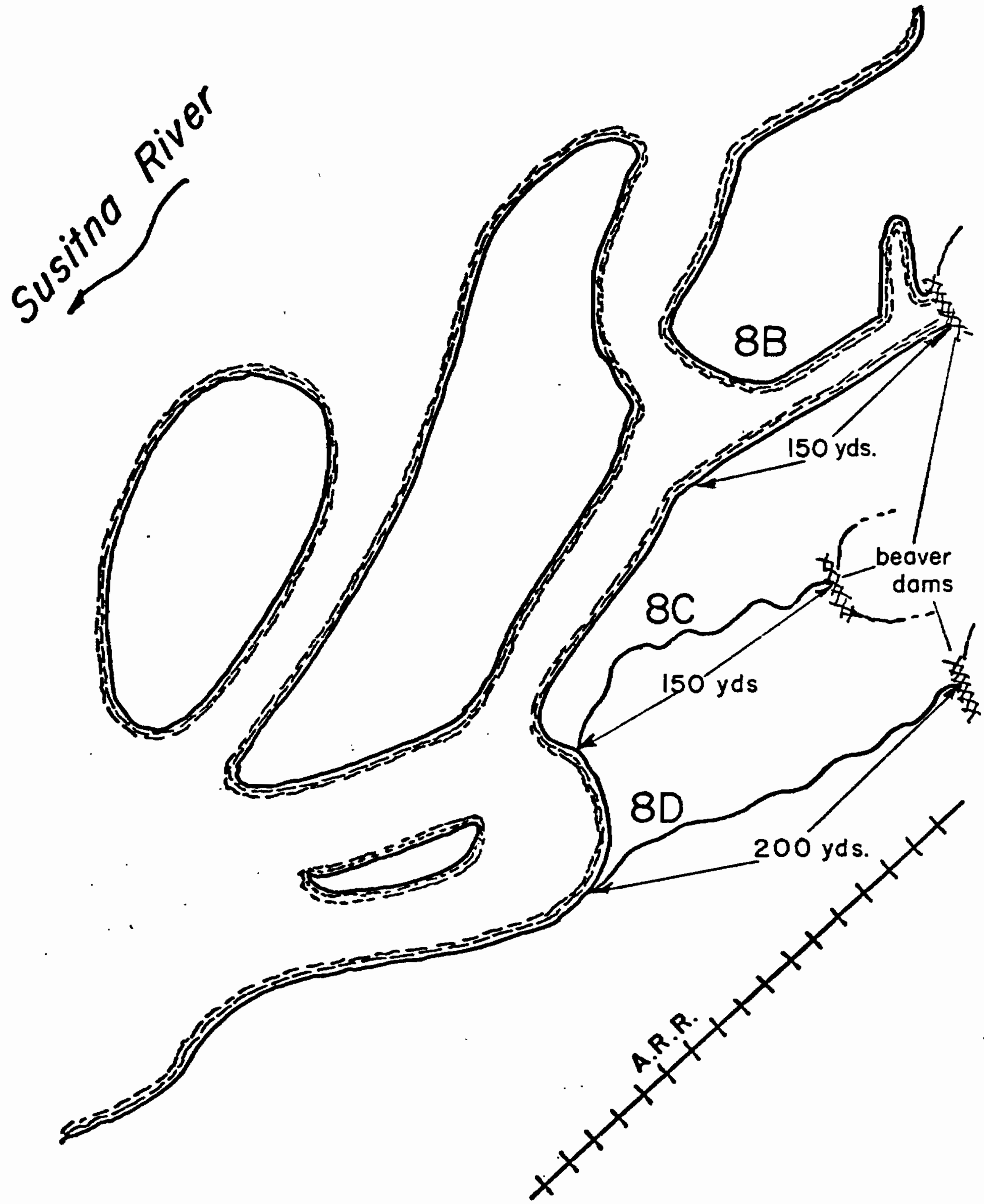
Appendix Figure 10. Map of Slough Number 7, Susitna River, as composed on August 16, Devil's Canyon Project, 1974.



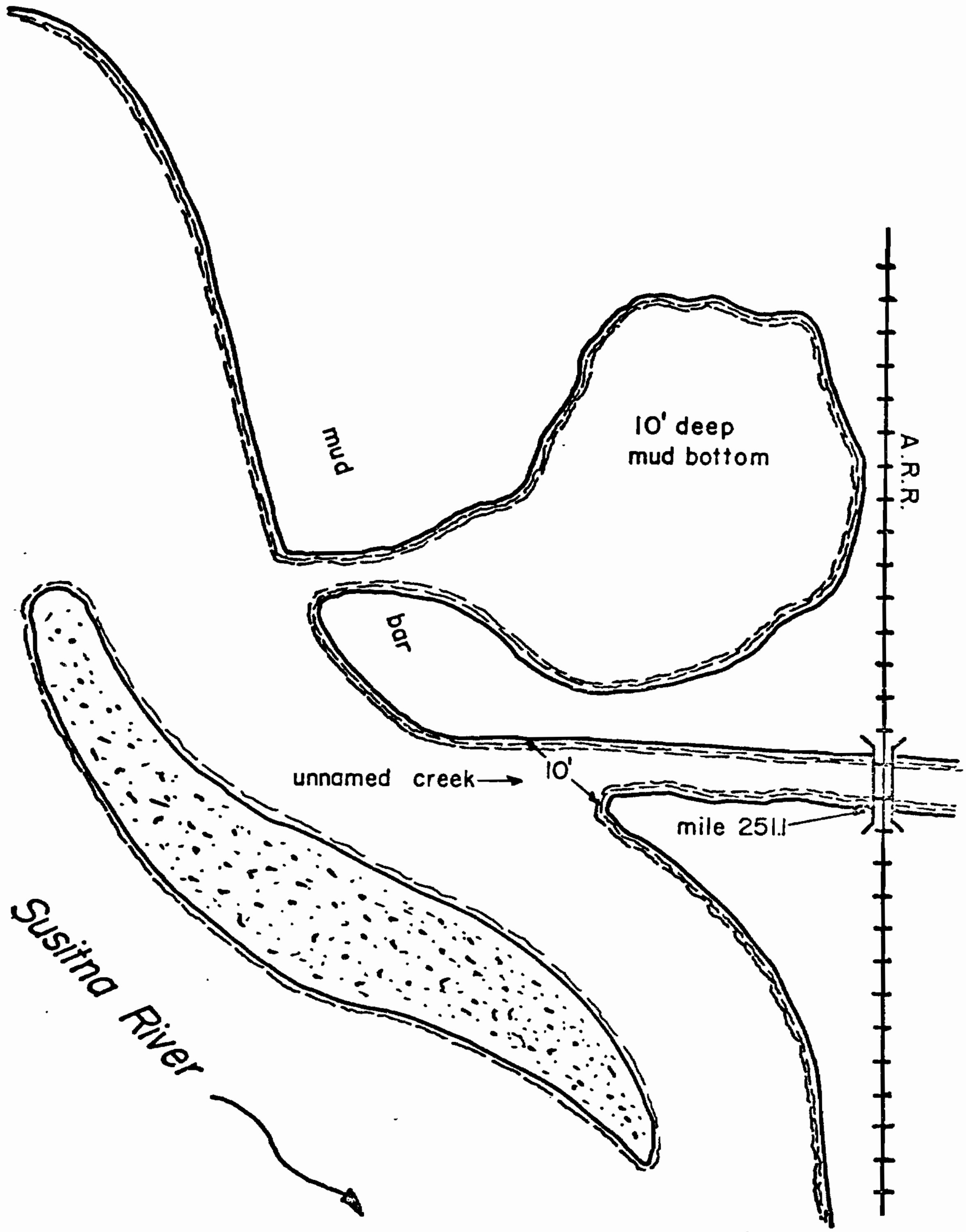
Appendix Figure 11. Map of Slough Number 8, Susitna River, as composed on August 28, Devil's Canyon Project, 1974.



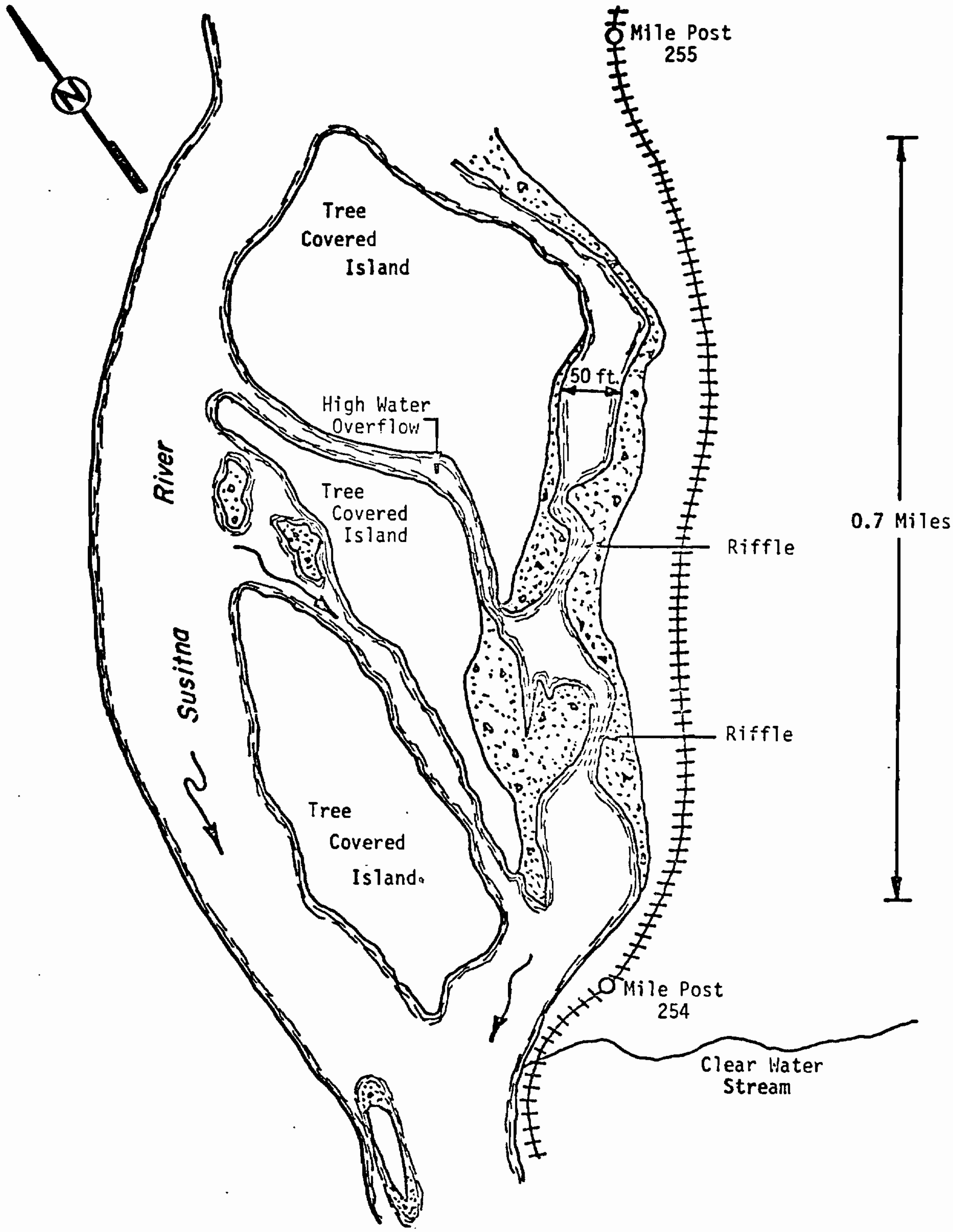
Appendix Figure 12. Map of McKenzie Creek, Susitna River, as composed on September 26, Devil's Canyon Project, 1975.



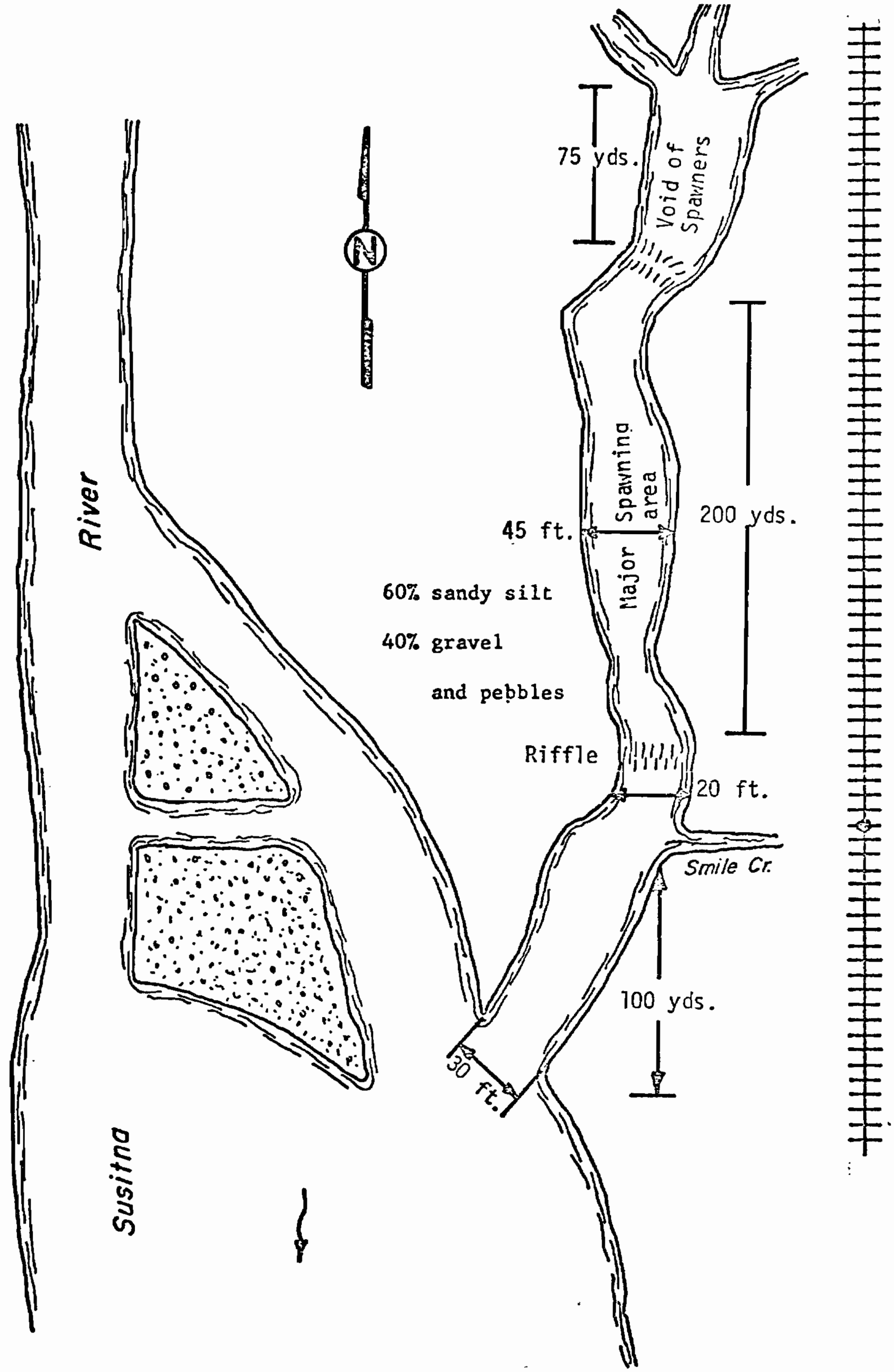
Appendix Figure 13. Map of Slough Number 8B, 8C, and 8D, Susitna River, as composed on September 8, Devil's Canyon Project, 1975.



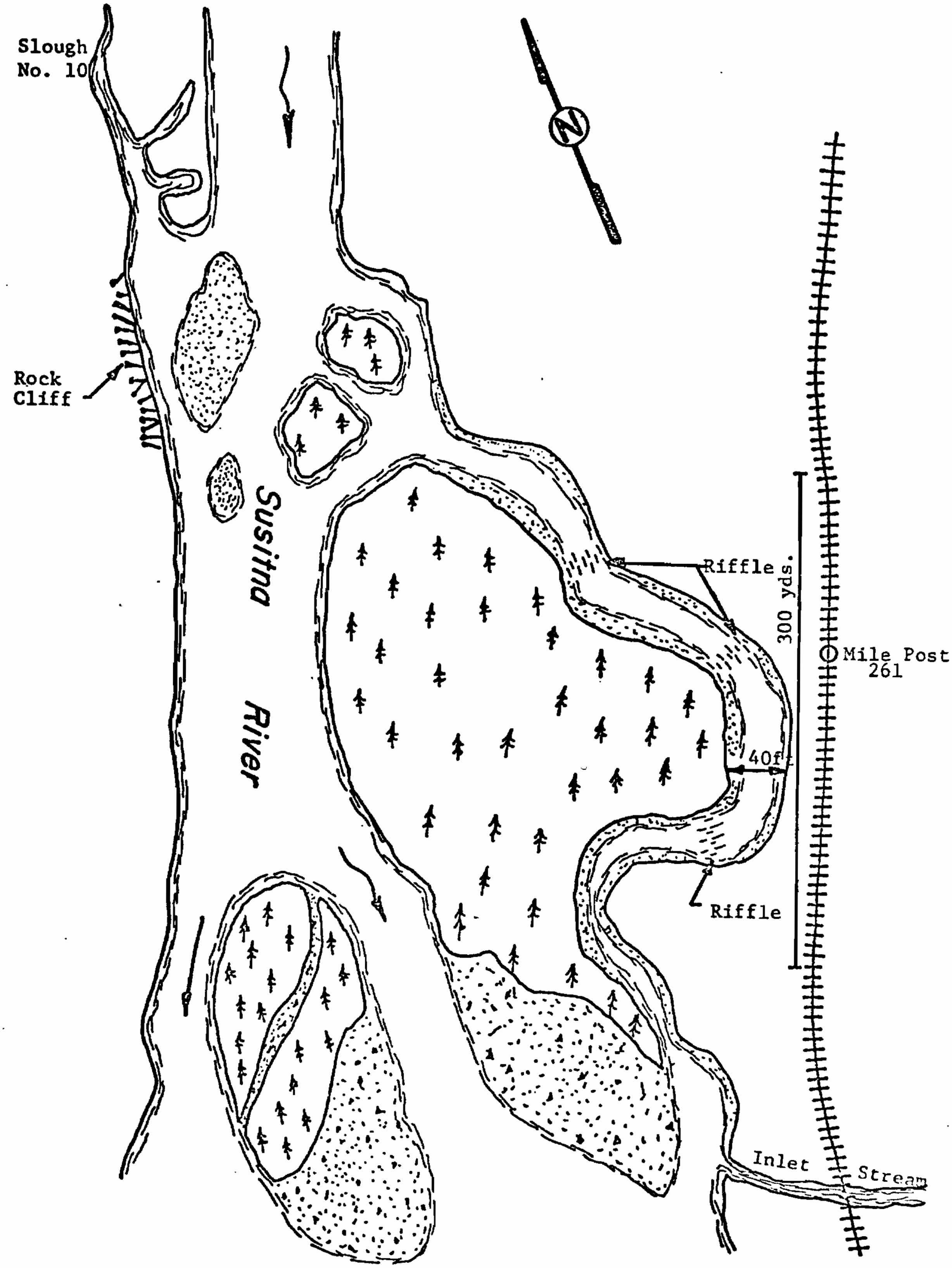
Appendix Figure 14. Map of Slough Number "A", Susitna River, as composed on Septmeber 26, Devil's Canyon Project, 1975.



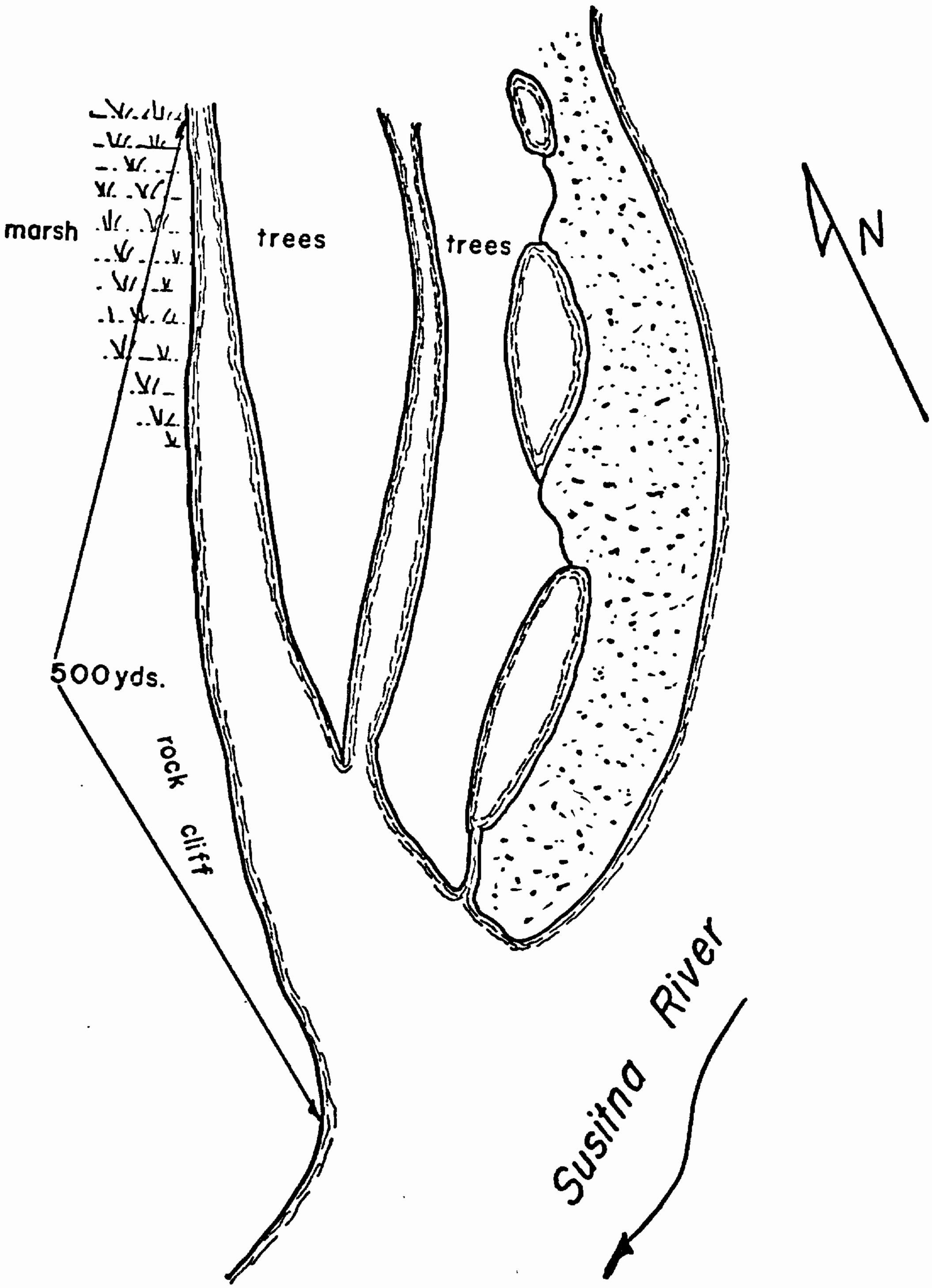
Appendix Figure 15. Map of Slough, Number 8A, Susitna River, as composed on December 6, Devil's Canyon Winter Project, 1974.



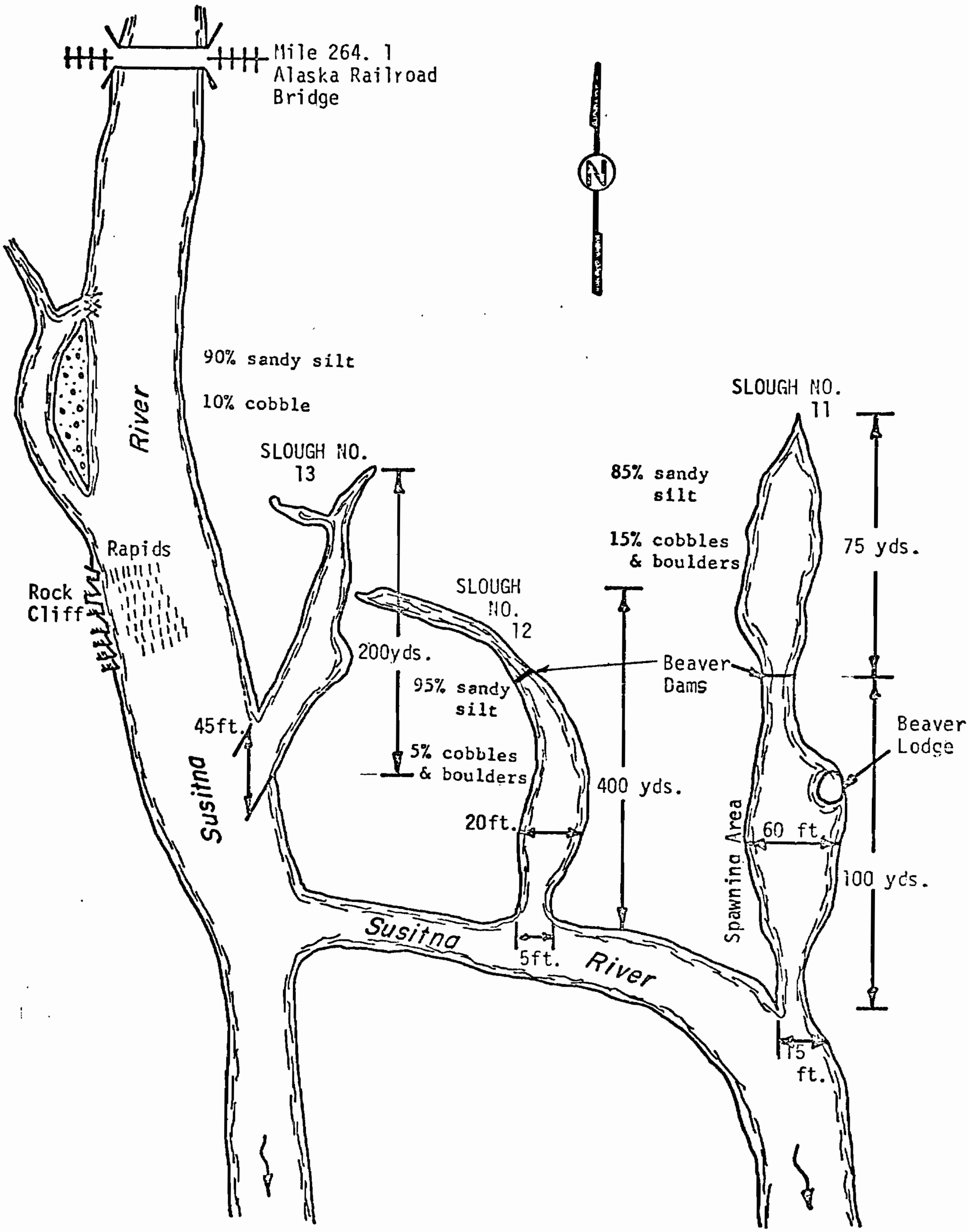
Appendix Figure 16. Map of Slough Number 9, Susitna River, as composed on August 16, Devil's Canyon Project, 1974.



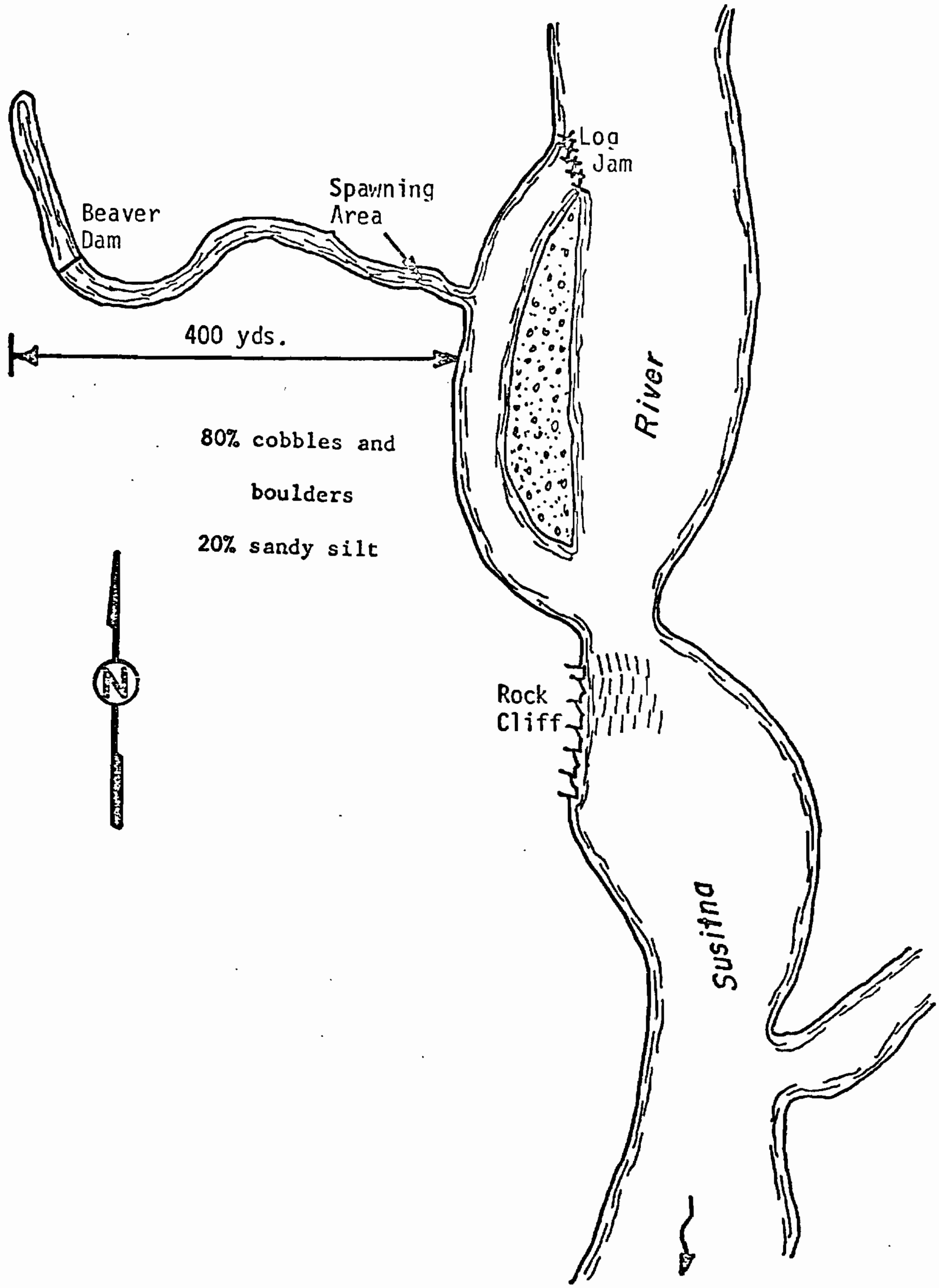
Appendix Figure 17. Map of Slough Number 9A, Susitna River, as composed on February 17, Devil's Canyon Winter Project, 1975.



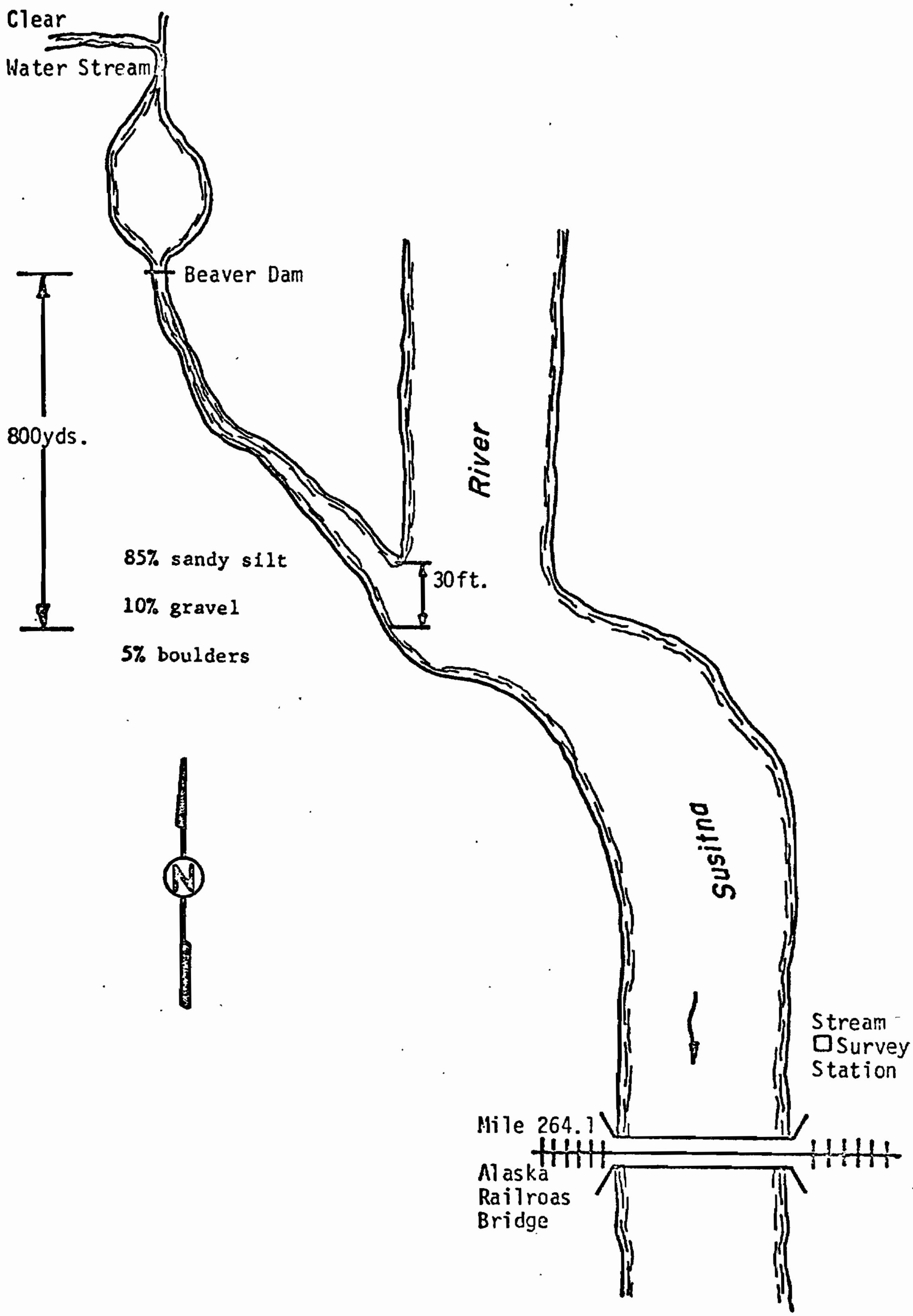
Appendix Figure 18. Map of Slough Number 10, Susitna River, as composed on September 8, Devil's Canyon Project, 1975.



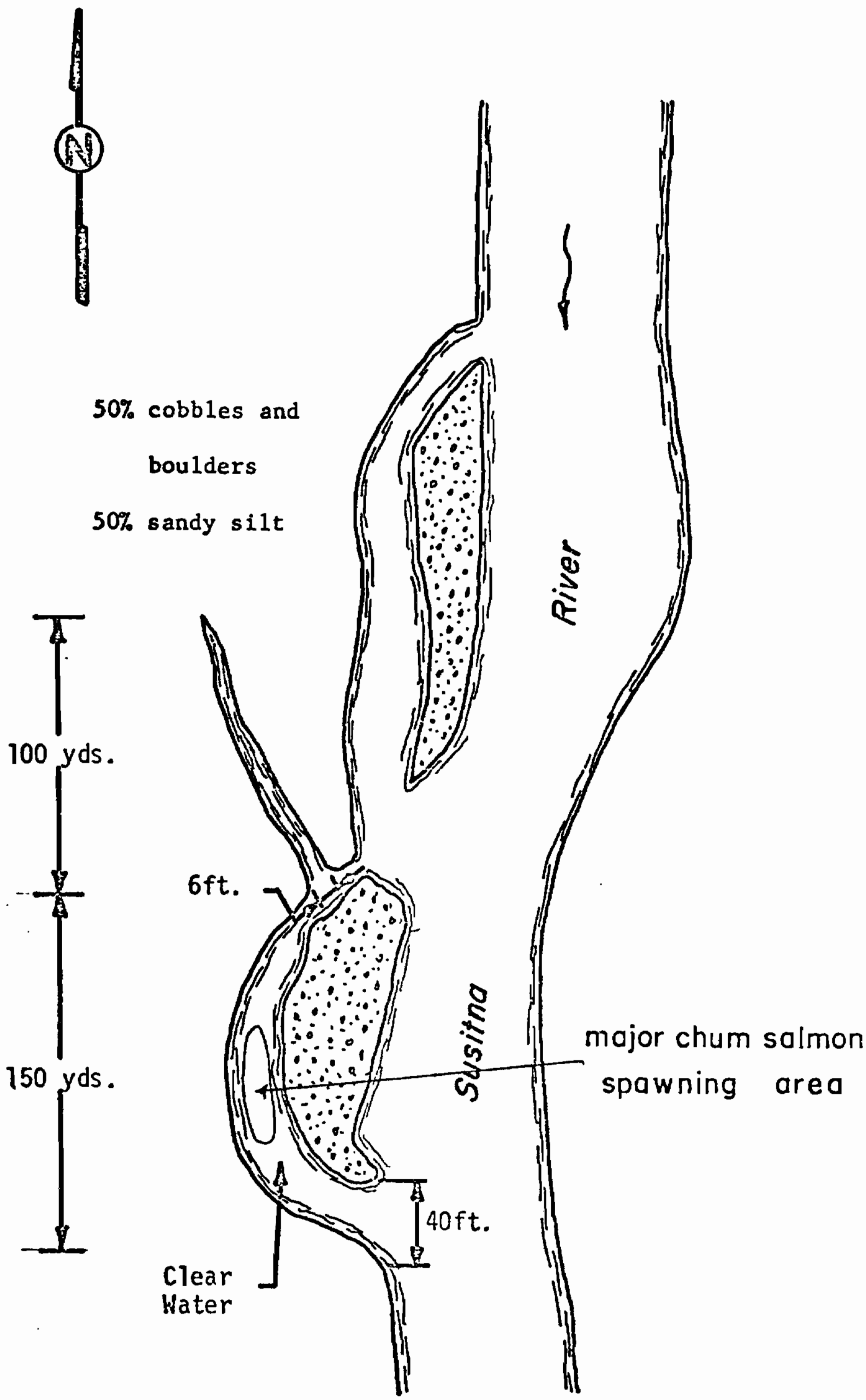
Appendix Figure 19. Map of Sloughs Numbers 11, 12, and 13, Susitna River as composed on August 9, Devil Canyon Project, 1974.



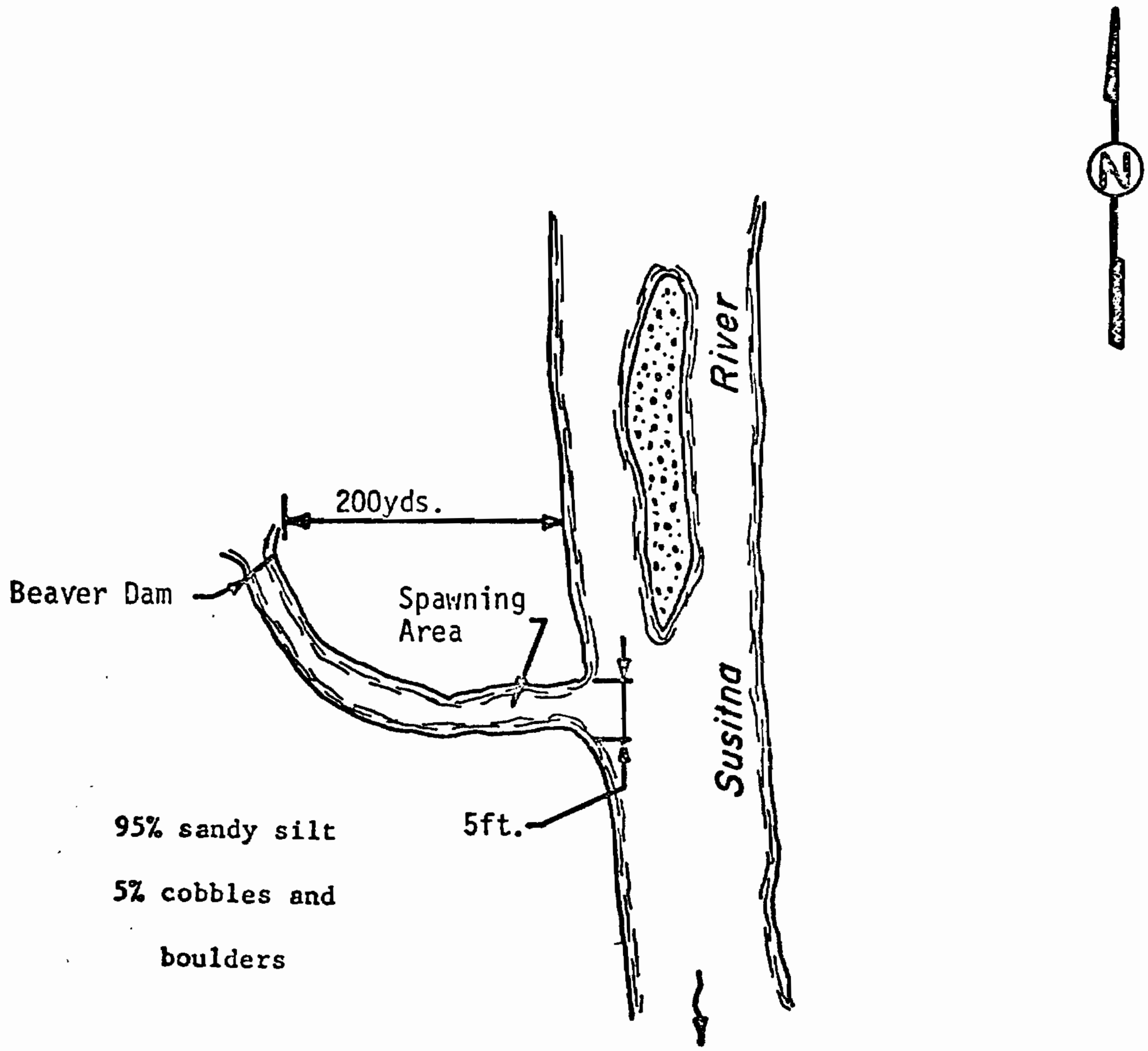
Appendix Figure 20. Map of Slough Number 14, Susitna River, as composed on August 30, Devil's Canyon Project, 1974.



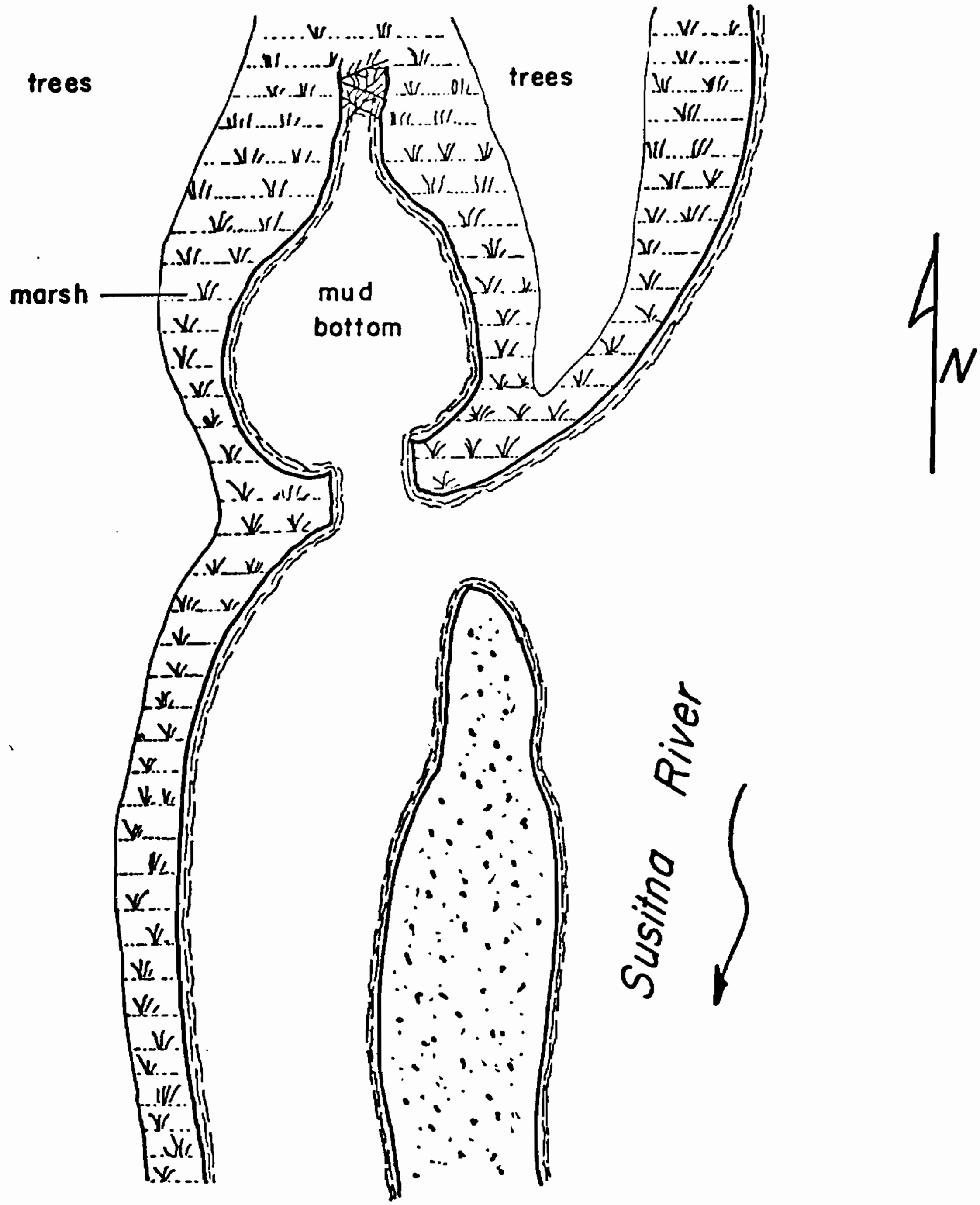
Appendix Figure 21. Map of Slough Number 15, Susitna River, as composed on August 5, Devil's Canyon Project, 1974.



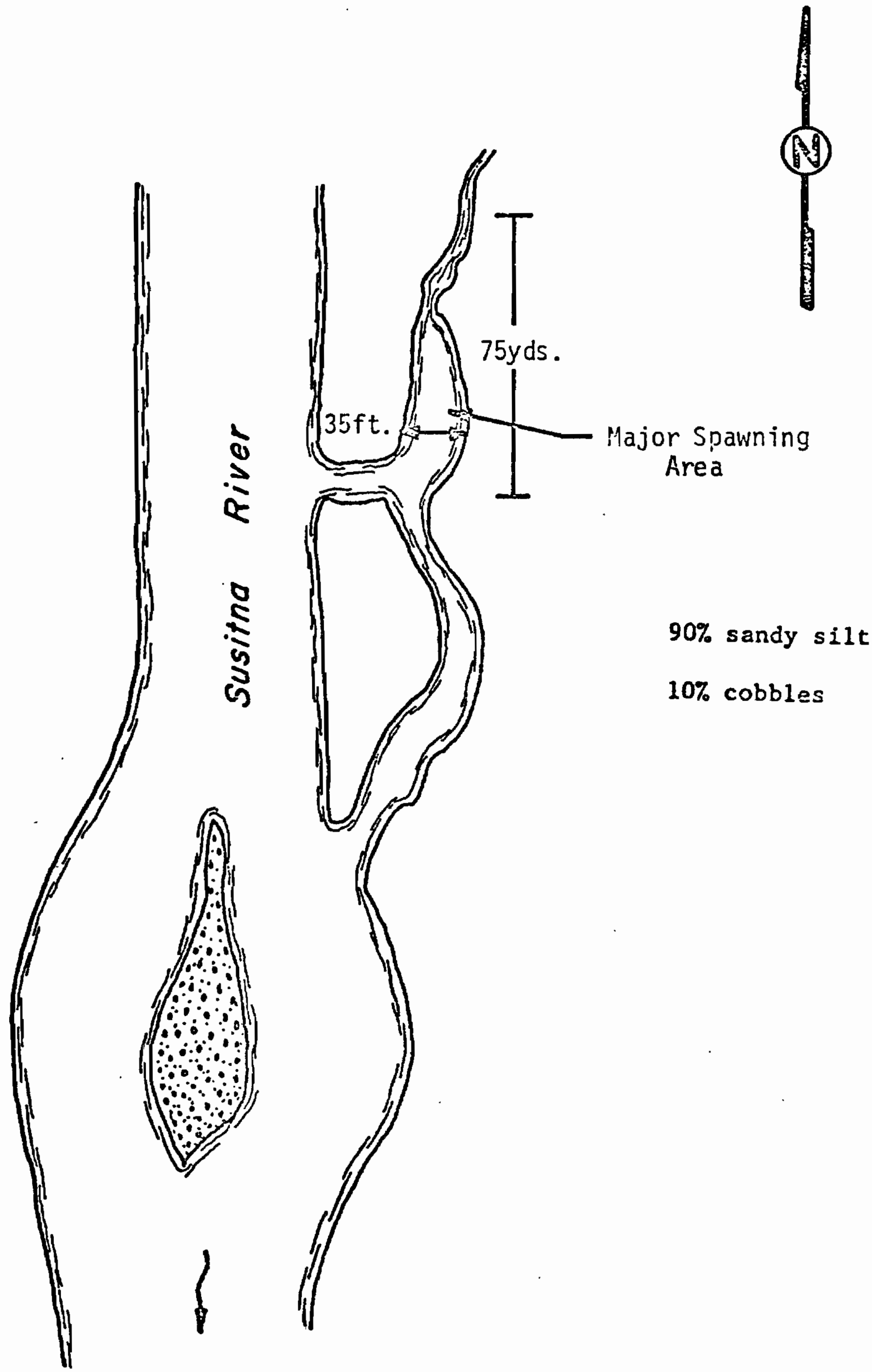
Appendix Figure 22. Map of Slough Number 16, Susitna River, as composed on August 3, Devil's Canyon Project, 1974.



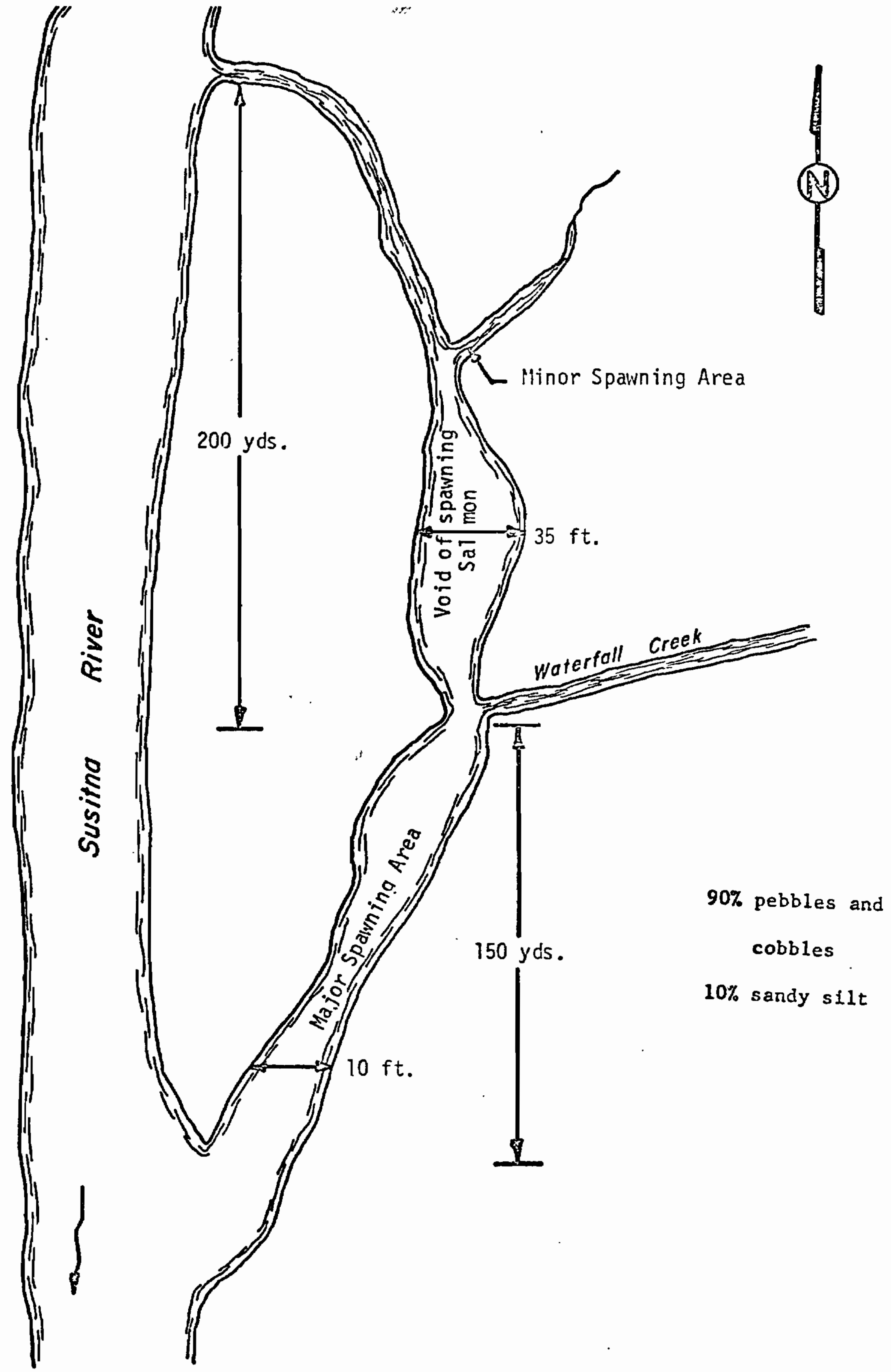
Appendix Figure 23. Map of Slough Number 17, Susitna River, as composed on August 3, Devil's Canyon Project, 1974.



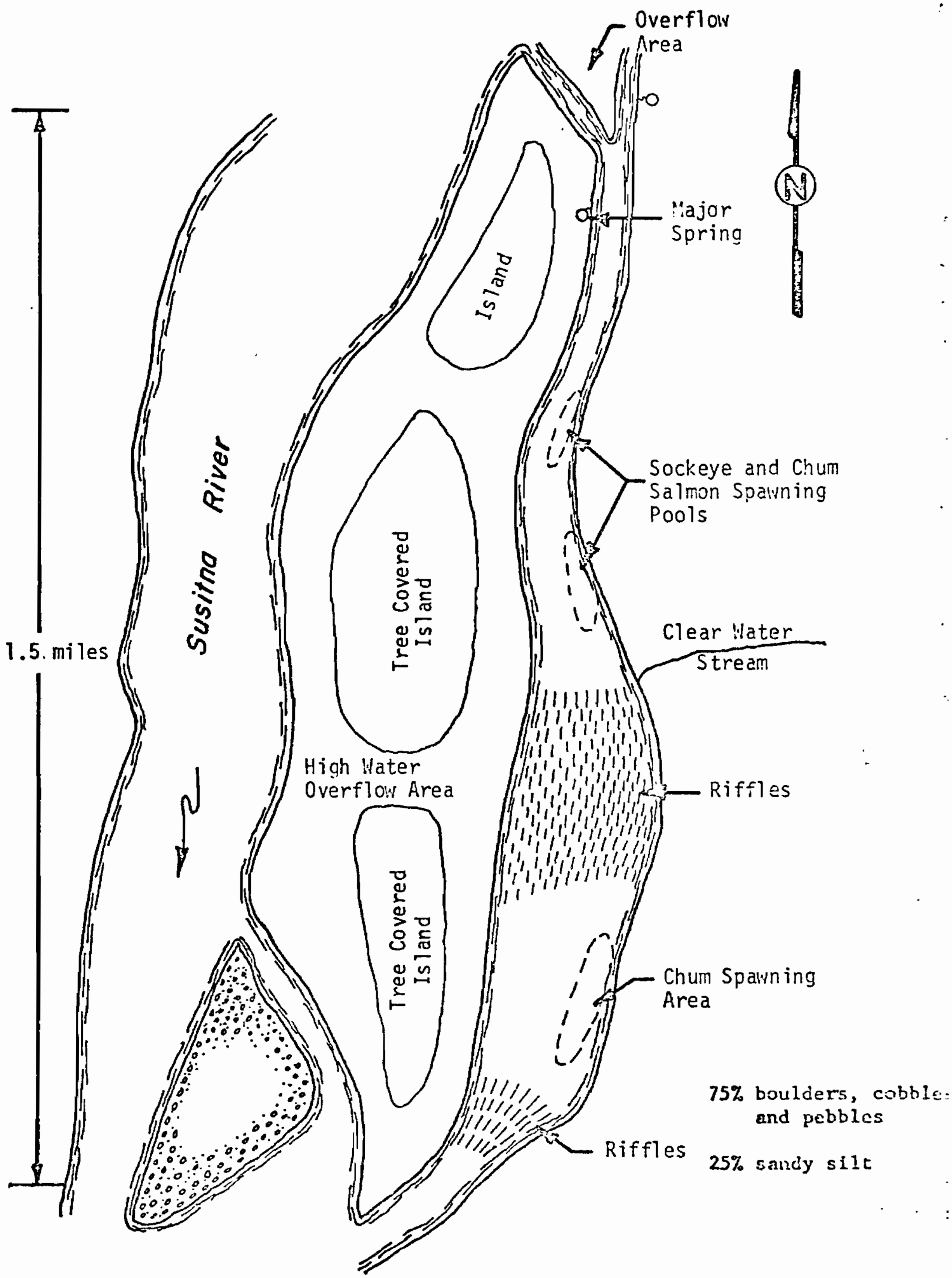
Appendix Figure 24. Map of Slough Number 18, Susitna River as composed on September 8, Devil's Canyon Project, 1975.



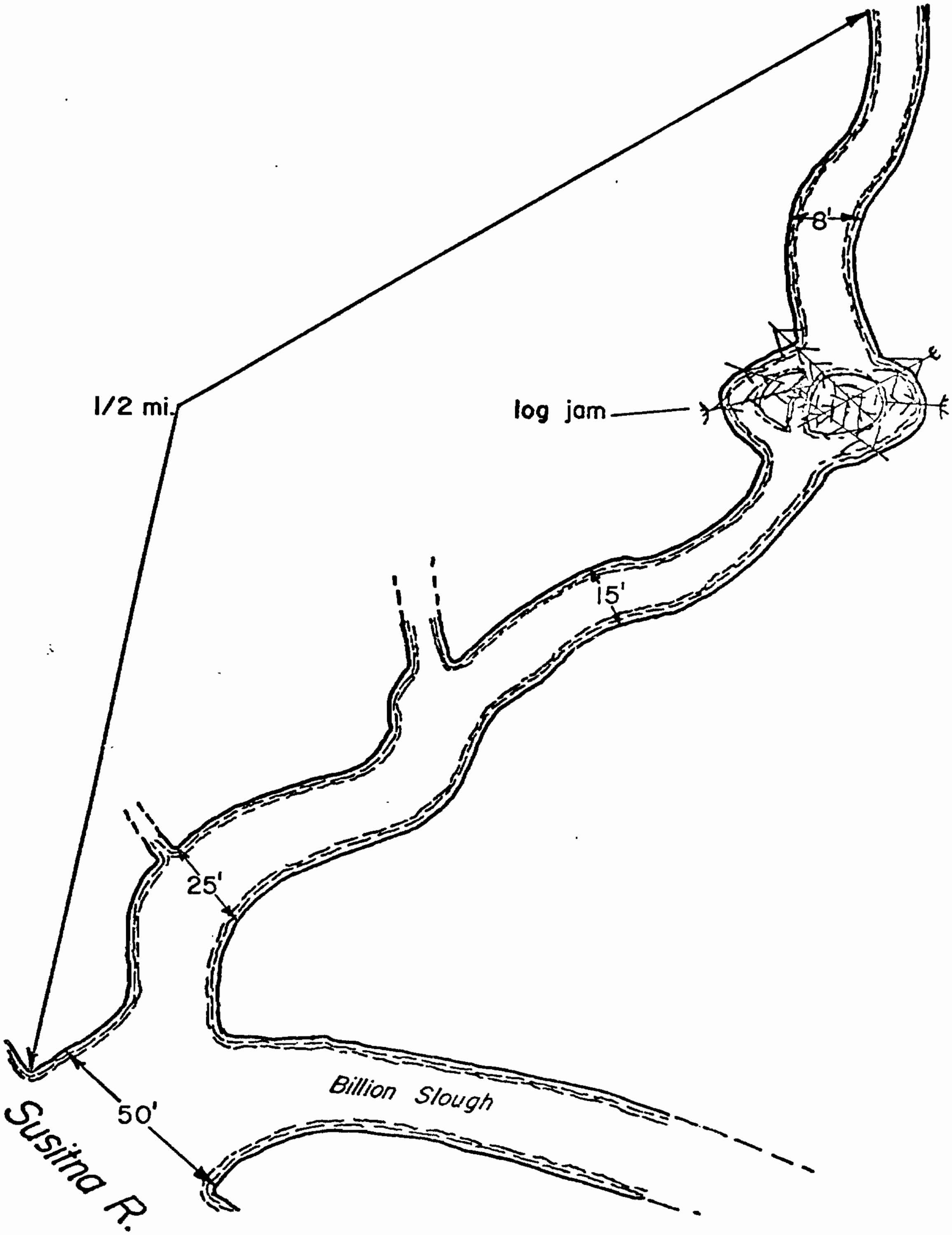
Appendix Figure 25. Map of Slough Number 19, Susitna River, as composed on August 21, Devil's Canyon Project, 1974.



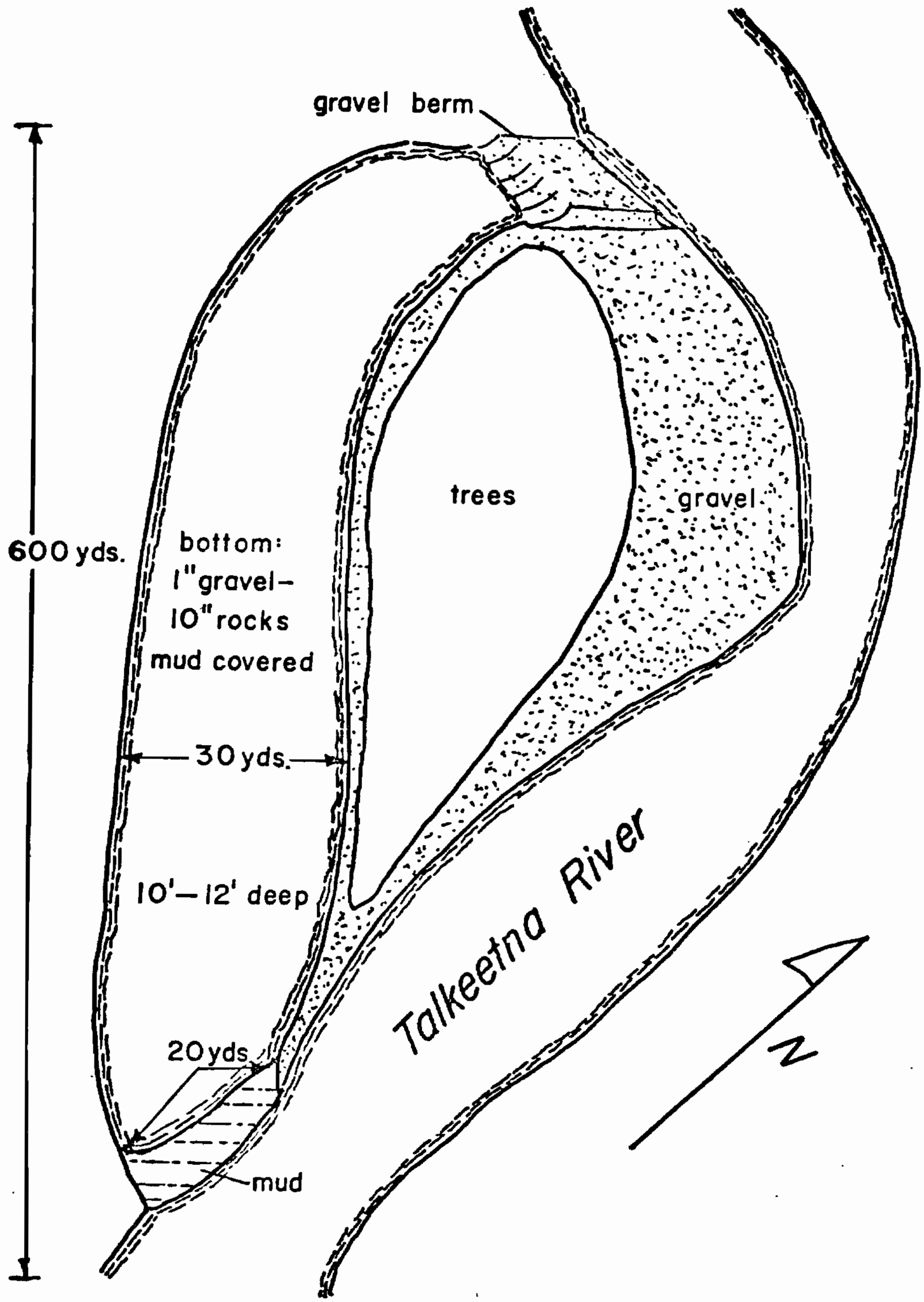
Appendix Figure 26. Map of Slough Number 20, Susitna River, as composed on August 16, Devil's Canyon Project, 1974.



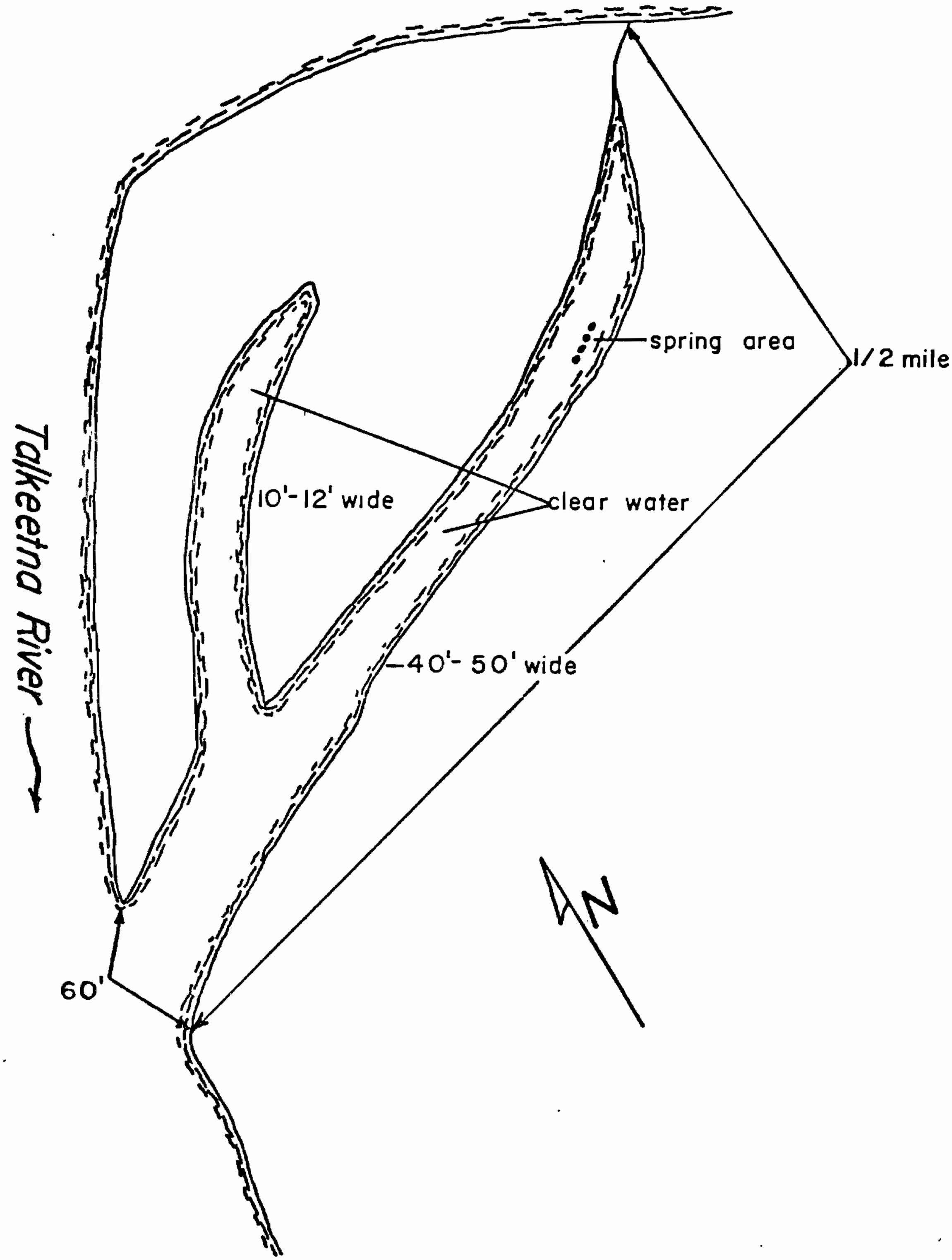
Appendix Figure 27. Map of Slough Number 21, Susitna River, as composed on September 24, Devil's Canyon Project, 1974.



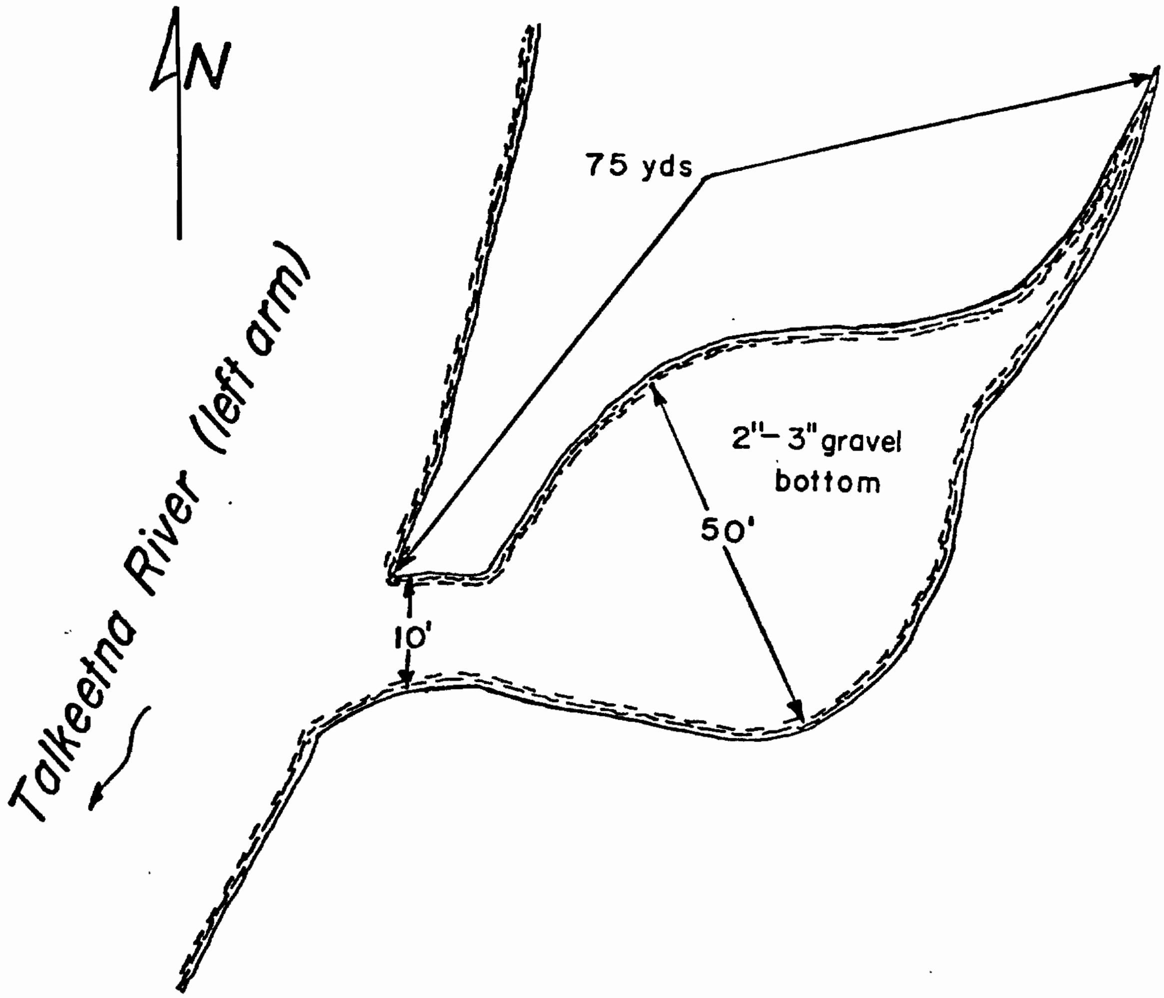
Appendix Figure 28. Map of Billion Slough, Susitna River, as composed on June 9, Devil's Canyon Project, 1975.



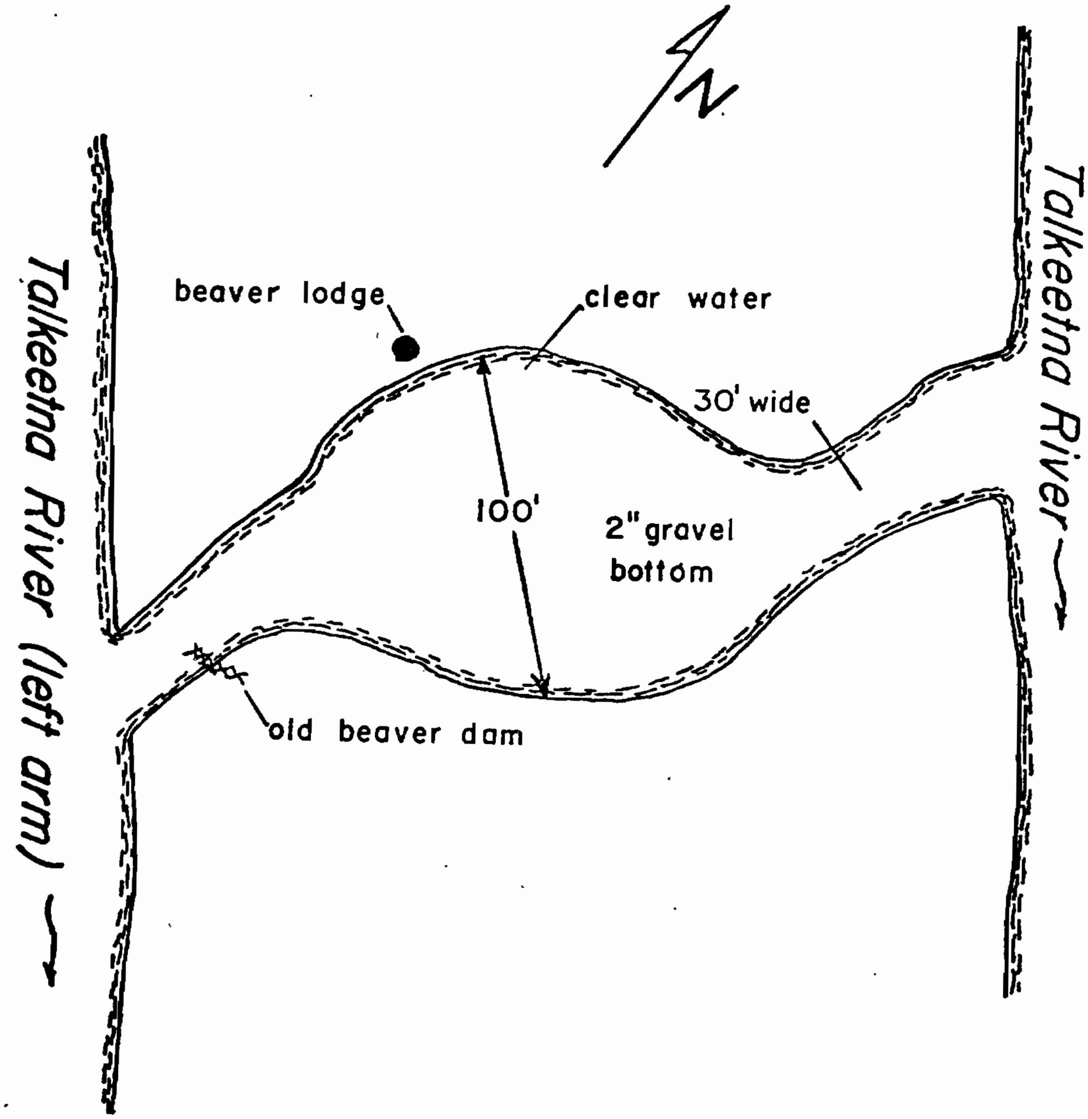
Appendix Figure 29. Map of Railroad Slough, Talkeetna River, as composed June 9, Devil's Canyon Project, 1975.



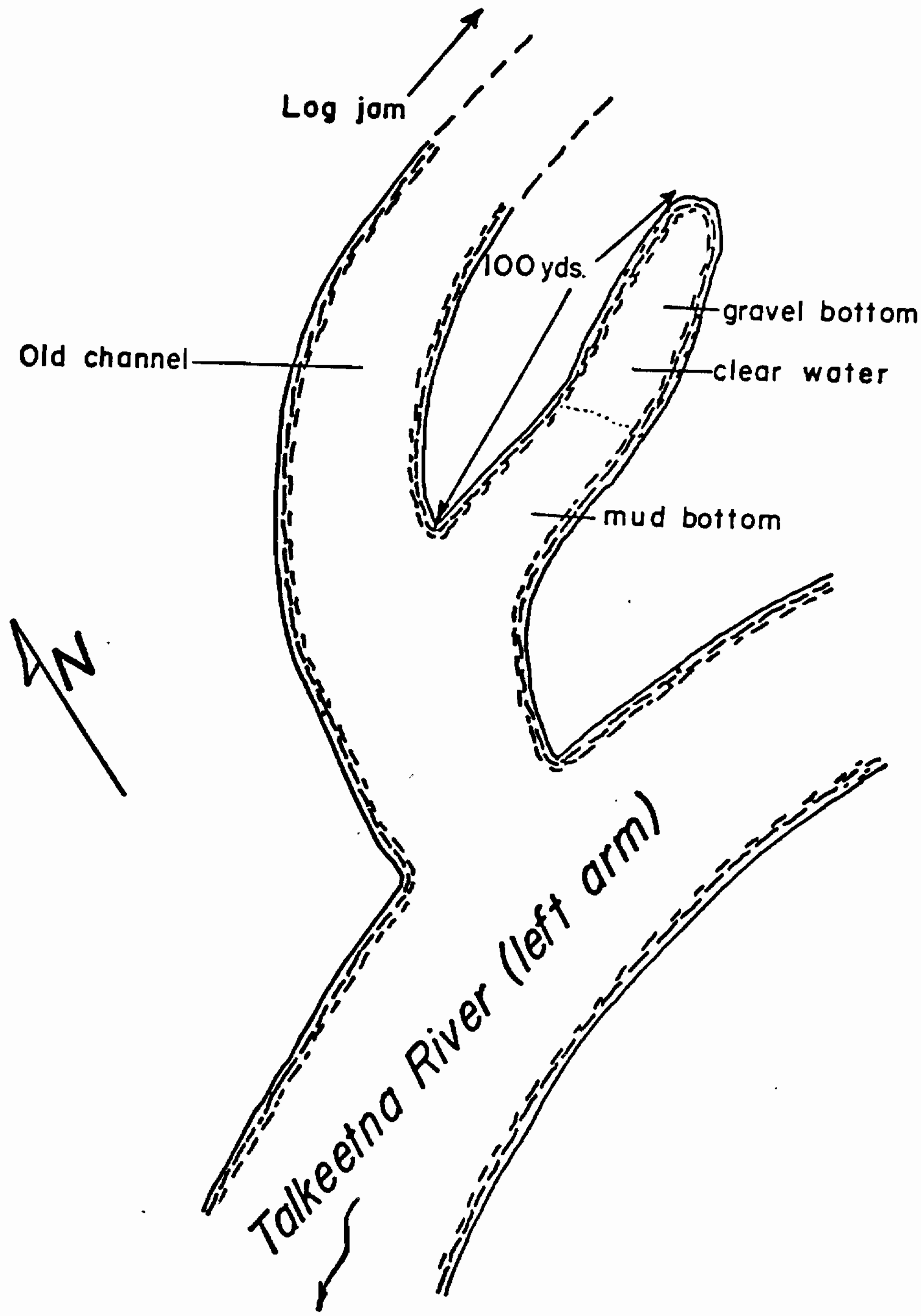
Appendix Figure 30. Map of Slough Number 1, Talkeetna River as composed on June 9, 1975.



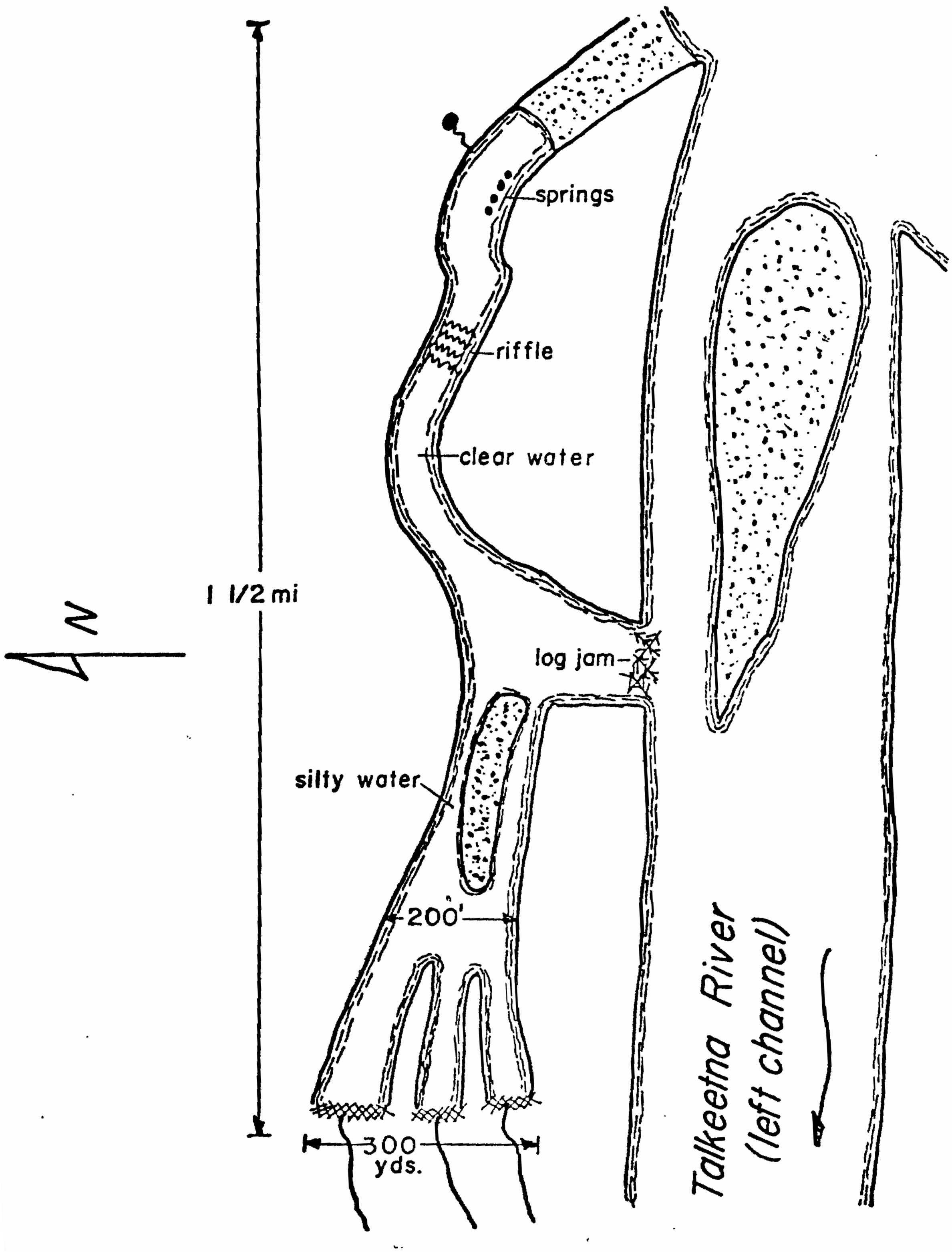
Appendix Figure 31. Map of Slough Number 4, Talkeetna River, as composed on June 9, Devil's Canyon Project, 1975.



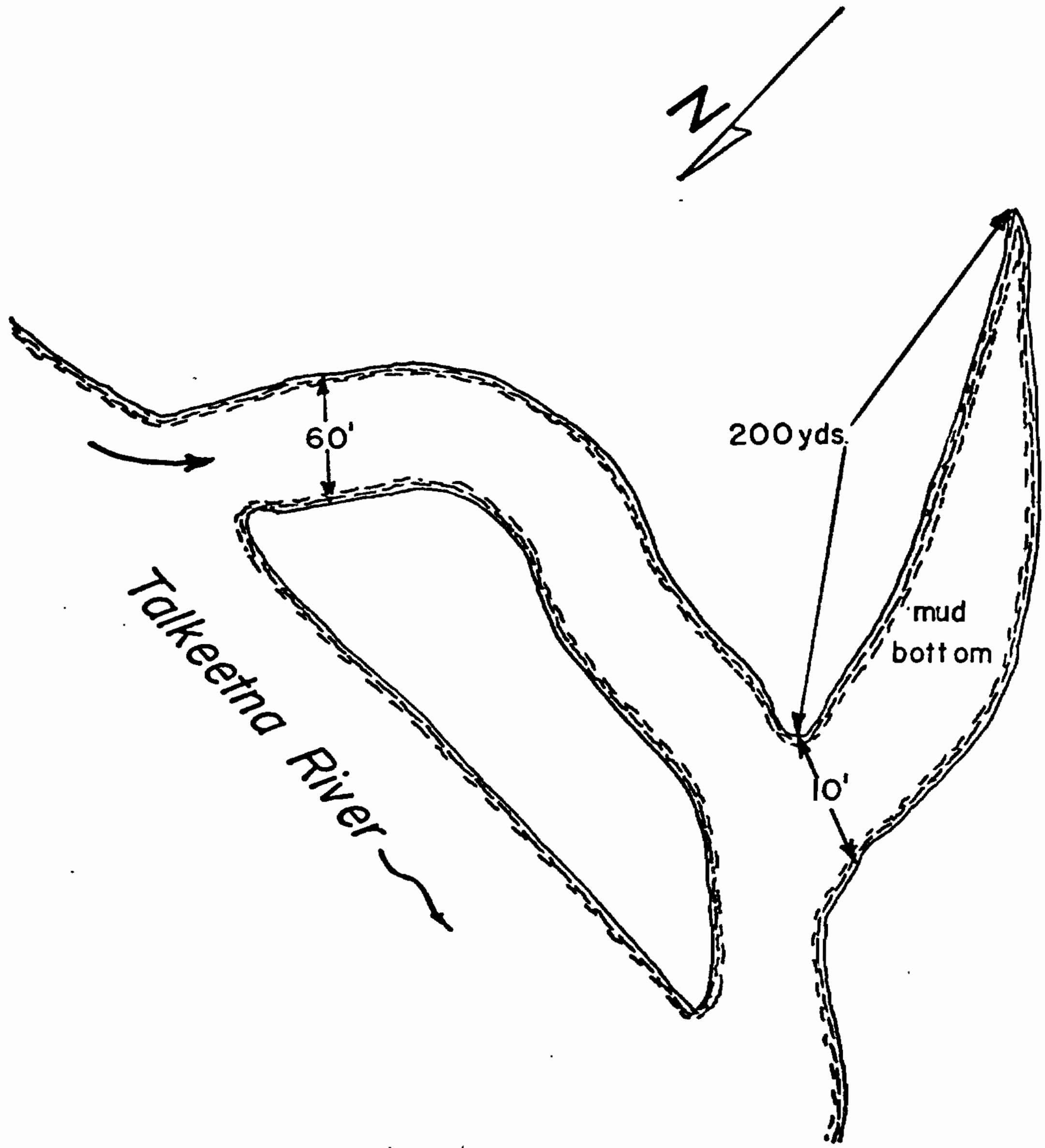
Appendix Figure 32. Map of Beaver Pond Slough, Talkeetna River, as composed on June 9, Devil's Canyon Project, 1975.



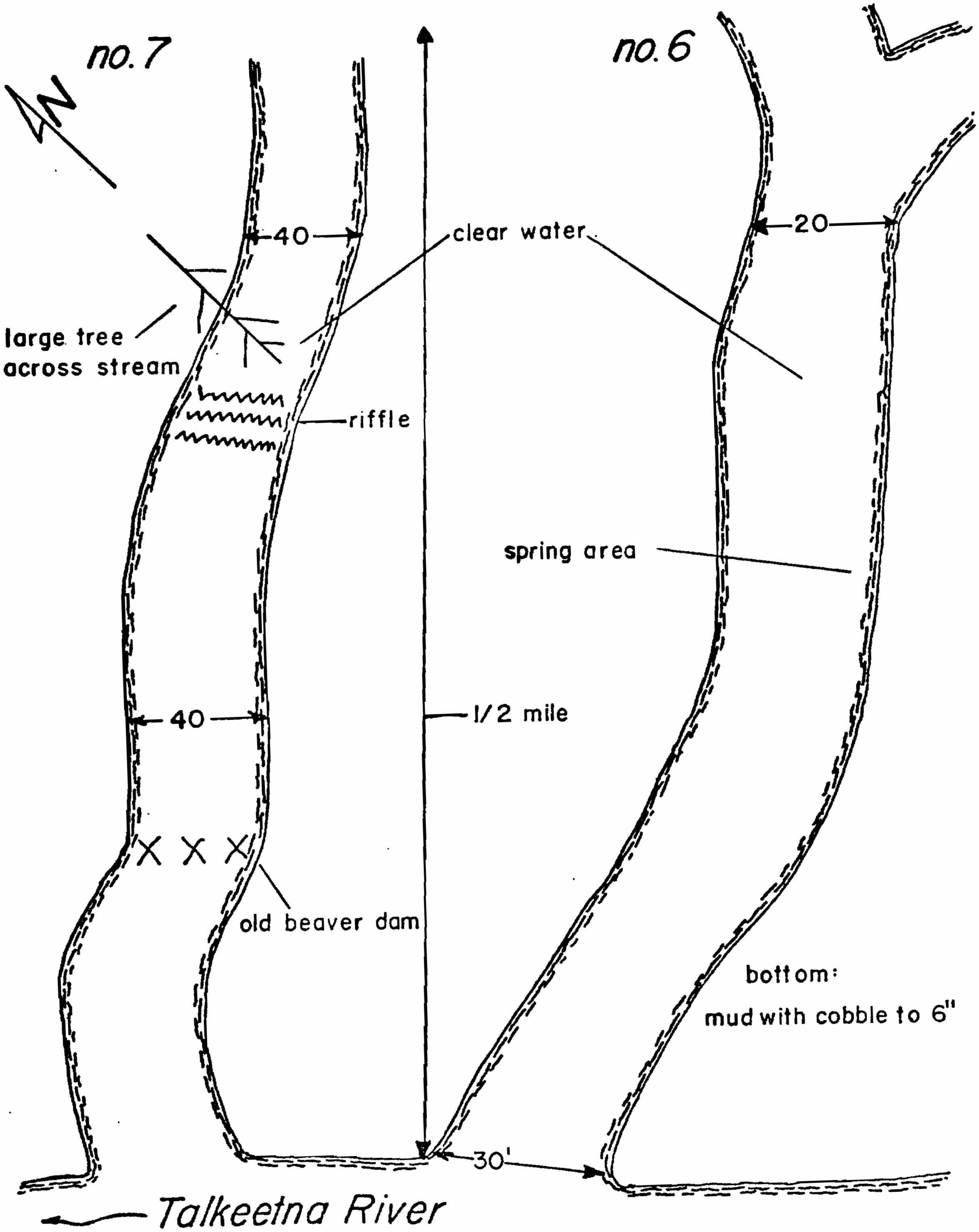
Appendix Figure 33. Map of Slough Number 3, Talkeetna River, as composed on June 9, Devil's Canyon Project, 1975.



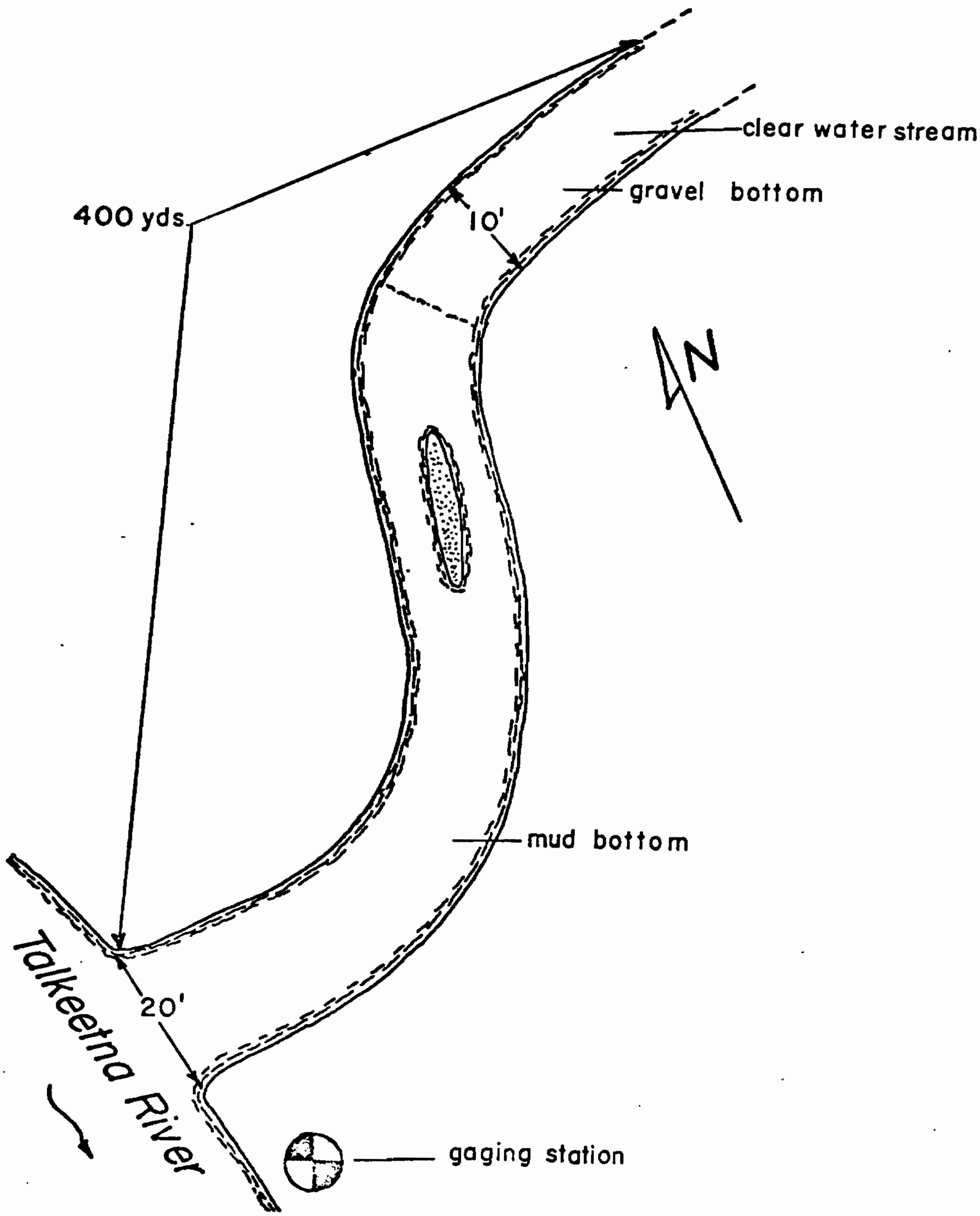
Appendix Figure 34. Map of Slough Number 2, Talkeetna River, as composed on June 9, Devil's Canyon Project, 1975.



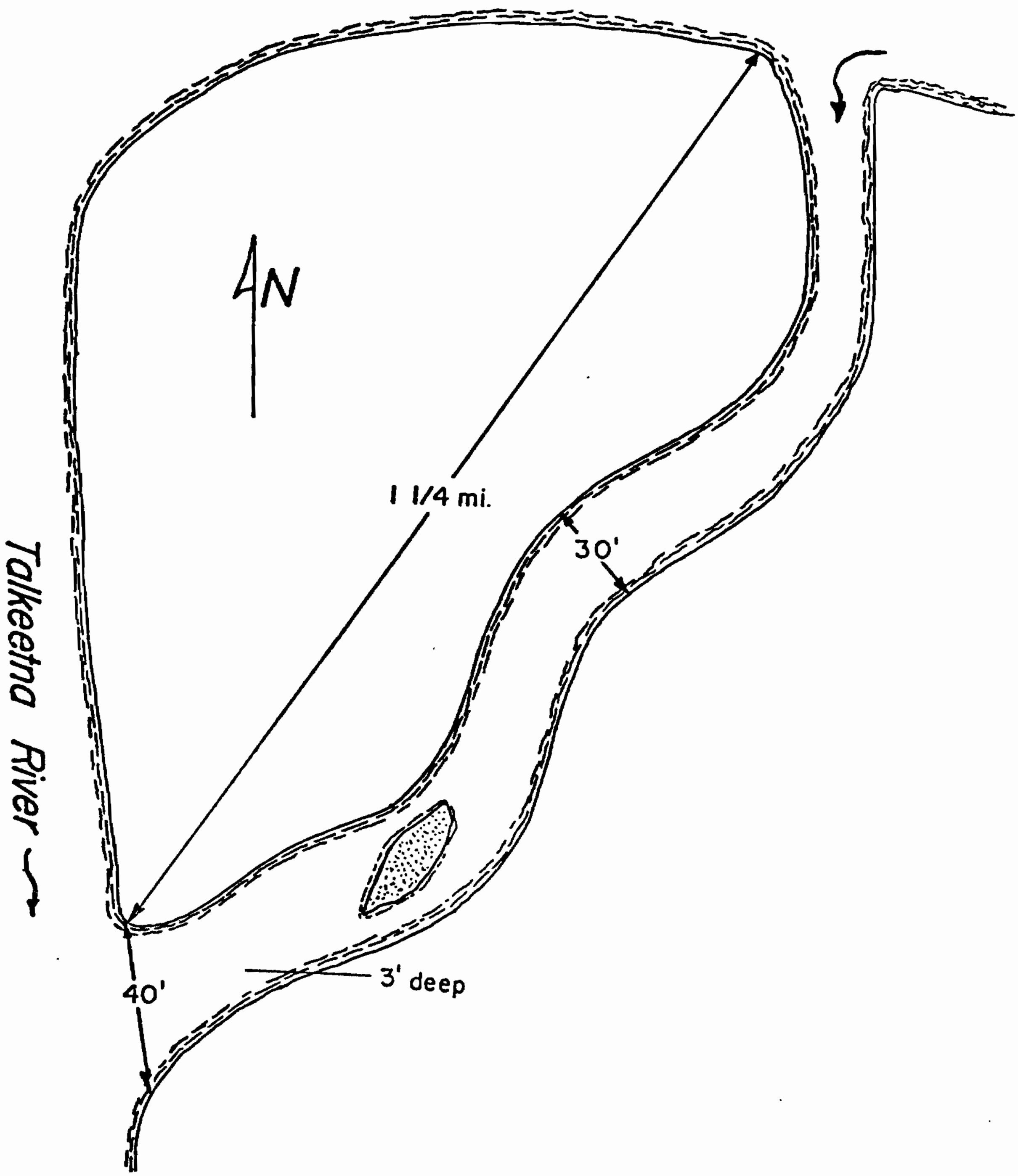
Appendix Figure 35. Map of Slough Number 5, Talkeetna River, as composed on June 9, Devil's Canyon Project, 1975.



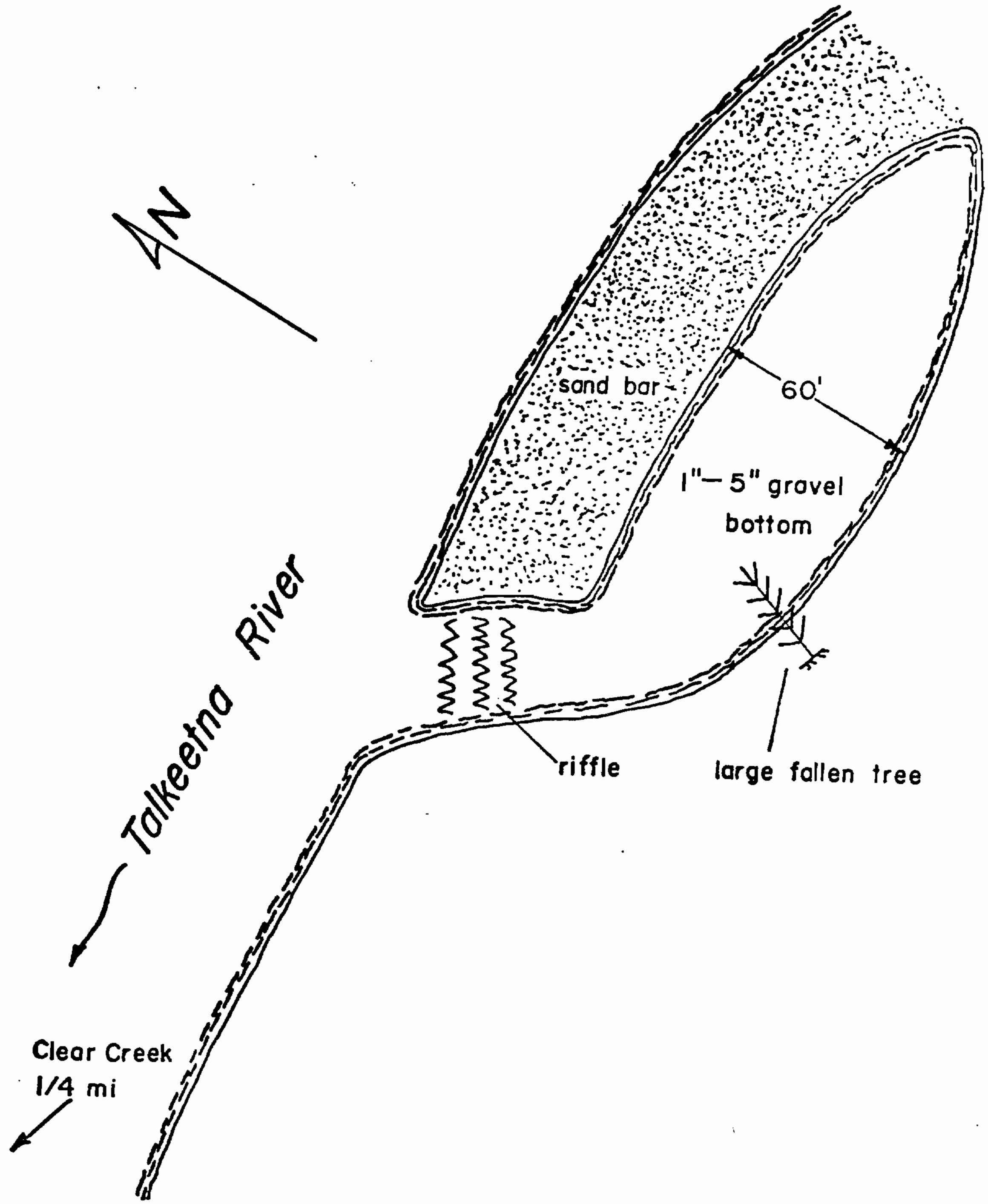
Appendix Figure 36. Map of Sloughs Numbers 6 and 7, Talkeetna River, as composed on June 9, Devil's Canyon Project, 1975.



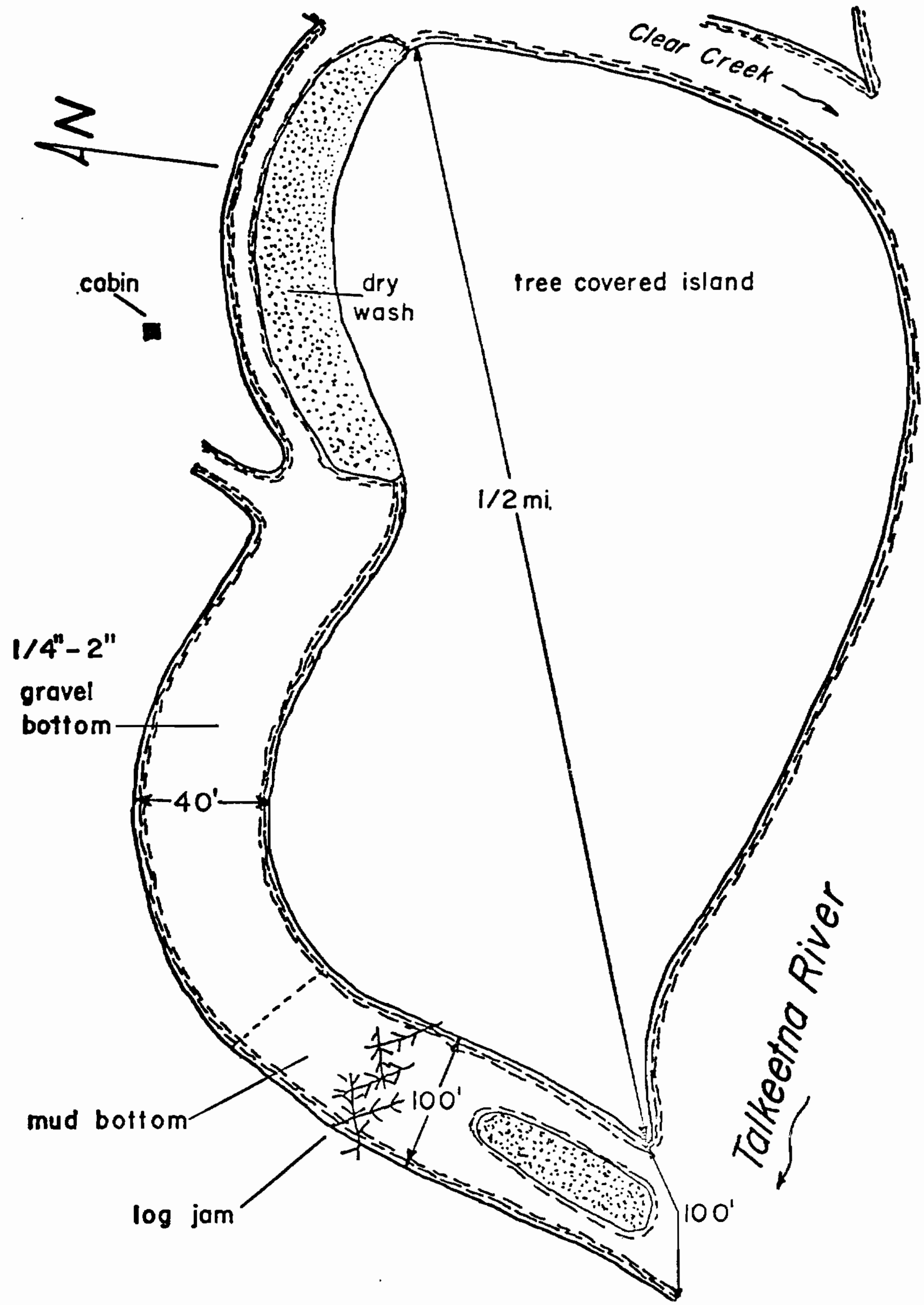
Appendix Figure 37. Map of Whiskey Slough, Talkeetna River, as composed on June 9, Devil's Canyon Project, 1975.



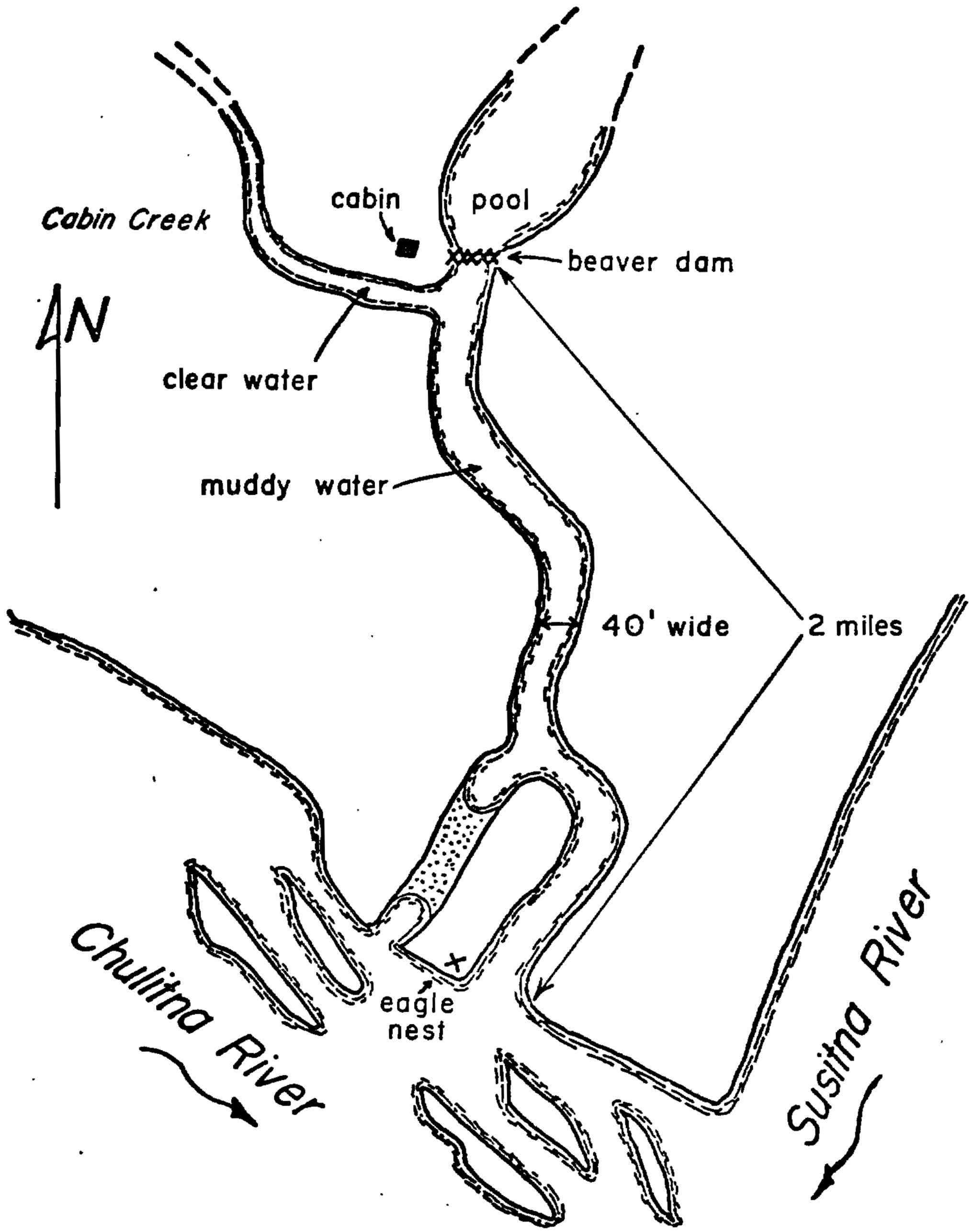
Appendix Figure 38. Map of Slough Number 8, Talkeetna River, as composed on June 9, Devil's Canyon Project, 1975.



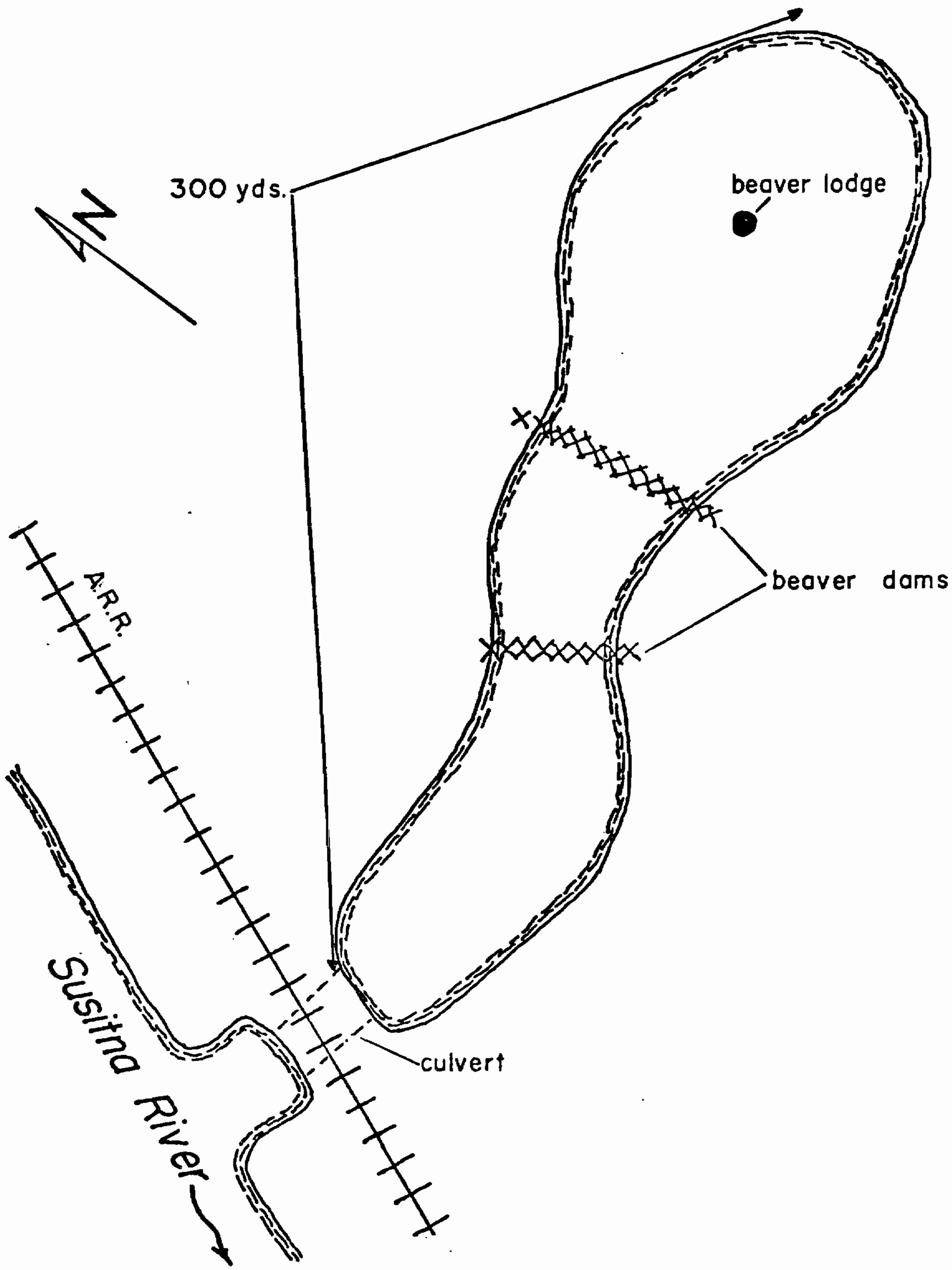
Appendix Figure 39. Map of Slough Number 9, Talkeetna River, as composed on June 9, Devil's Canyon Project, 1975.



Appendix Figure 40. Map of Clear Creek Slough, Talkeetna River, as composed on June 9, Devil's Canyon Project, 1975.



Appendix Figure 41. Map of Slough Number 1, Chulitna River, as composed June 9, Devil Canyon Project, 1975.



Appendix Figure 42. Map of Slough No. 1, Susitna River below the Talkeetna River confluence, as composed on June 6, Devil's Canyon Project, 1975.

APPENDIX II

Escapement surveys of sloughs and tributary streams of the Susitna and Talkeetna Rivers are presented in this Appendix. Included are counts of live tagged and untagged adult salmon in the Susitna River.

Appendix Table 1. Number of live tagged and untagged salmon by species observed during adult escapement surveys, Susitna River, Devil's Canyon Project, 1975.

Chum Salmon Surveys

Location	Date	Survey Conditions	Number Fish Sampled (live) Untagged	Tagged (r)	Total (c)	Ratio (c/r)
Slough 3B	8/27	good	1	1	2	2.0
	9/3	good	50	0	50	0.0
Lane Creek	8/17	excellent	3	0	3	0.0
	8/27	excellent	1	0	1	0.0
Slough 9	8/17	excellent	15	0	15	0.0
	8/25	good	64	0	64	0.0
	9/8	good	63	0	63	0.0
	9/27	excellent	54	0	54	0.0
Slough 13	9/25	good	1	0	1	0.0
Slough 15	9/6	good	1	0	1	0.0
Slough 16	8/26	good	12	0	12	0.0
Indian River	8/8	good	0	2	2	1.0
	8/9	good	0	1	1	1.0
	8/12	excellent	70	0	70	0.0
	9/26	fair	1	0	1	0.0
Slough 21	9/6	good	246	4	250	52.5
	9/25	excellent	92	0	92	0.0
Total			674	8	682	85.3

Pink Salmon Surveys

Location	Date	Survey Conditions	Number Fish Sampled (live) Untagged	Tagged (r)	Total (c)	Ratio (c/r)
4th July Creek	7/28	excellent	40	0	40	0.0
	8/9	excellent	85	2	87	43.5
	8/13	excellent	50	3	53	17.7
	8/17	excellent	143	5	148	29.6
	8/25	excellent	95	6	101	16.8
	9/8	poor	---	---	---	----
Indian River	8/7	-----	0	1	1	1.0
	8/9	-----	0	4	4	1.0
	8/12	-----	312	9	321	35.7
Lane Creek	7/26	excellent	20	0	20	0.0
	8/6	excellent	78	3	81	27.0
	8/17	excellent	96	10	106	10.6
	8/27	excellent	22	3	25	8.3
	9/3	excellent	2	0	2	0.0
Total			943	46	989	21.5

Appendix Table 1. Number of live tagged and untagged salmon by species observed during adult escapement surveys, Susitna River, Devil's Canyon Project, 1975.

Location	Date	Survey Conditions	Number Fish Sampled (live) Untagged	Tagged (r)	Total (c)	Ratio (c/r)
Sockeye Salmon Surveys						
Slough 3B	8/23	excellent	12	1	13	13.0
	9/3	good	14	1	15	15.0
4th July	8/17	excellent	1	0	1	0.0
Slough 11	8/25	excellent	24	1	25	25.0
	9/4	good	78	6	84	14.0
	9/25	good	72	5	77	15.4
Slough 19	8/10	fair	0	1	1	1.0
	8/26	excellent	18	2	20	10.0
	9/6	good	10	2	12	6.0
	9/24	good	10	0	10	0.0
Slough 21	9/6	good	34	2	36	18.0
	9/25	excellent	48	1	49	49.0
McKenzie Creek	9/8	good	3	0	3	0.0
	9/27	excellent	45	0	45	0.0
Indian River	9/26	fair	1	0	1	0.0
Total			370	22	392	17.8

Location	Date	Survey Conditions	Number Fish Sampled (live) Untagged	Tagged (r)	Total (c)	Ratio (c/r)
King Salmon Surveys						
Whiskers Creek	7/23	poor	2	1	3	3.0
	7/28	poor	1	0	1	0.0
	8/4	poor	19	3	22	7.3
	8/14		3	0	3	0.0
4th July Creek	8/9	excellent	1	0	1	0.0
Indian River	8/12	excellent	10	0	10	0.0
Portage Creek	7/23	excellent	2	0	2	0.0
	7/29	excellent	29	0	29	0.0
	8/10	excellent	3	0	3	0.0
Total			70	4	74	18.5

Appendix
Table 2. Escapement survey counts conducted on the Susitna River in Sloughs Numbers 1, 2, 3A, 4, Devil's Canyon Project, 1975.

Slough No.	Date	Time (military)	Temperature (°F) Air	Temperature (°F) Water	Survey Conditions	No. Fry Observed	Fry Species Identified: King	Coho	Chum	Grayling	Whitefish	Adult Salmon Density: Chum Live	Chum Dead	Chum Total	Sockeye Live	Sockeye Dead	Sockeye Total
1	7/22	1320	54	58	poor	0						0	0	0	0	0	0
	7/27	1420	61	55	poor	0						0	0	0	0	0	0
	8/4	1810	66	54	poor	0						0	0	0	0	0	0
	8/11	1510	59	51	good	200		X				0	0	0	0	0	0
	8/22	1555	58	48	good	200		X				0	0	0	0	0	0
	9/3	1030	54	48	good	0						0	0	0	0	0	0
	9/23	1110	54	45	good	2		X				0	0	0	0	0	0
2	7/22	1440	59	50	poor	0						0	0	0	0	0	0
	7/28	1205	57	45	poor	0						0	0	0	0	0	0
	8/4	1740	67	48	excellent	0						0	0	0	0	0	0
	8/11	1545	61	55	excellent	0						0	0	0	0	0	0
	8/25	1235	57	45	excellent	0						0	0	0	0	0	0
	9/23	1200	54	45	excellent	100		X		X		0	0	0	0	0	0
3A	7/15	1245	52	44	excellent	0						0	0	0	0	0	0
3B		1310	51	44	poor	0						0	0	0	0	0	0
A	7/23	1640	66	47	excellent	0						0	0	0	0	0	0
B		1610	64	49	excellent	0						0	0	0	0	0	0
A	7/28	1410	58	45	excellent	40		X				0	0	0	0	0	0
B		1435	57	50	excellent	200		X				0	0	0	0	0	0
A	8/4	1435	65	53	excellent	40		X				0	0	0	0	0	0
B		1510	68	53	excellent	200		X				0	0	0	0	0	0
A	8/14	1220	65	53	excellent	30		X				0	0	0	0	0	0
B		1245	68	44	excellent	150		X				0	0	0	0	0	0
A	8/23	1400	62	49	excellent	150		X				0	0	0	1	0	1
B		1420	58	45	excellent	50		X				0	0	0	12	0	12
B	8/27	1315	--	--	excellent	0						2	0	2	0	0	0
A	9/2	1210	55	45	poor	0						0	0	0	0	0	0
B		1130	52	45	good	0						50	0	50	15	0	15
4	7/25	1355	59	56	poor	0						0	0	0	0	0	0
	8/2	1240	59	57	poor	50		X				0	0	0	0	0	0
	8/9	1255	60	55	poor	0						0	0	0	0	0	0
	8/21	1400	58	55	poor	0						0	0	0	0	0	0

Appendix
Table 3. Escapement survey counts conducted on the Susitna River in Sloughs Numbers 5, 6, 7, 8, 8A, 8B, Devil's Canyon Project, 1975.

Slough No.	Date	Time (military)	Temperature (°F) Air	Water	Survey Conditions	No. Fry Observed	Fry Species Identified King	Coho	Chum	Grayling	Whitefish	Adult Salmon Density Chum Live	Chum Dead	Chum Total	Sockeye Live	Sockeye Dead	Sockeye Total
5	7/21	1200	70	56	poor	0						0	0	0	0	0	0
	7/26	1405	58	54	fair	200		X				0	0	0	0	0	0
	8/6	1045	56	54	good	0						0	0	0	0	0	0
	8/21	1215	56	55	fair	0						0	0	0	0	0	0
	9/3	1230	--	--	poor 1/	0						0	0	0	0	0	0
6	7/21	1220	70	56	fair	+		X				0	0	0	0	0	0
	7/26	1405	58	53	fair	200		X				0	0	0	0	0	0
	8/6	1100	56	56	good	0						0	0	0	0	0	0
	8/21	1230	56	57	fair	0						0	0	0	0	0	0
	9/3	----	--	--	poor	0						0	0	0	0	0	0
	9/27	1445	--	47	good	0						0	0	0	0	0	0
7	7/21	----	--	--	---------	---						-	-	-	-	-	-
	7/26	1450	59	48	excellent	0						0	0	0	0	0	0
	8/6	1220	56	53	excellent	0						0	0	0	0	0	0
	8/21	----	--	--	poor 1/	---						-	-	-	-	-	-
	9/3	----	--	--	poor 1/	---						-	-	-	-	-	-
8	7/21	1315	70	50	poor	0						0	0	0	0	0	0
	7/26	1530	56	49	excellent	500		X				0	0	0	0	0	0
	8/6	1230	55	47	excellent	400		X				0	0	0	0	0	0
	8/17	1745	59	54	excellent	350		X				0	0	0	0	0	0
	8/27	1315	60	47	good	500		X				0	0	0	0	0	0
	9/3	1750	55	45	excellent	1000		X				0	0	0	0	0	0
	9/27	1400	55	48	excellent	60		X			X	0	0	0	0	0	0
8A	7/26	1800	59	48	excellent	2						0	0	0	0	0	0
	8/9	1500	59	54	good	0						0	0	0	0	0	0
8B	8/6	1600	55	48	excellent	300		X				0	0	0	0	0	0
	9/8	1310	51	44	good	0						0	0	0	0	0	0

1/ Slough area dried up.

Appendix
Table 4. Escapement survey counts conducted on the Susitna River in Sloughs Numbers A, 9, 9A, 10, 11, 12, Devil's Canyon Project, 1975.

							Fry Species Identified					Adult Salmon Density					
			Temperature (°F)									Chum			Sockeye		
Slough No.	Date	Time (military)	Air	Water	Survey Conditions	No. Fry Observed	King	Coho	Chum	Grayling	Whitefish	Live	Dead	Total	Live	Dead	Total
A	7/21	1520	65	45	excellent	0						0	0	0	0	0	0
	8/6	1700	64	51	excellent	0						0	0	0	0	0	0
	8/17	1430	60	50	excellent	0						0	0	0	0	0	0
9	7/21	1545	65	50	poor	0						0	0	0	0	0	0
	7/26	1930	60	48	fair	200		X				0	0	0	0	0	0
	8/9	1300	56	49	excellent	400		X				0	0	0	0	0	0
	8/17	1400	65	52	excellent	0						15	0	15	0	0	0
	8/25	1600	56	51	good	0						64	2	66	0	0	0
	9/8	1200	48	49	good	0						63	14	77	0	0	0
	9/27	1100	50	45	excellent	0						54	127	181	0	0	0
9A	8/7	----	--	--	poor 1/	---						-	-	-	-	-	-
10	7/28	1400	55	46	poor	0						0	0	0	0	0	0
	8/7	1050	63	43	excellent	1500		X		X	X	0	0	0	0	0	0
	8/25	1300	57	44	excellent	600				X		0	0	0	0	0	0
	9/4	1915	50	41	good	1000				X		0	0	0	0	0	0
	9/25	1705	59	43	good	10		X				0	0	0	0	0	0
11	7/22	1000	75	44	good	0						0	0	0	0	0	0
	7/28	1325	55	44	excellent	30		X				0	0	0	0	0	0
	8/7	1020	60	47	excellent	4000		X		X		0	0	0	0	0	0
	8/13	1710	59	47	excellent	4500		X				0	0	0	0	0	0
	8/25	1200	54	44	excellent	3000		X				0	0	0	25	0	25
	9/4	1800	50	44	good	300		X				0	0	0	84	0	84
	9/25	1640	51	45	good	0						0	0	0	77	5	82
12	7/28	1300	53	42	good	0						0	0	0	0	0	0
	8/7	0940	57	43	excellent	0						0	0	0	0	0	0
	8/13	1650	58	43	excellent	0						0	0	0	0	0	0
	8/25	1145	52	47	good	0						0	0	0	0	0	0
	9/4	1740	57	45	good	0						0	0	0	0	0	0
	9/25	1620	55	45	good	30						0	0	0	0	0	0

1/ Slough area dried up.

Appendix
Table 5. Escapement survey counts conducted on the Susitna River in Sloughs Numbers 13, 14, 15, 16, 17, Devil's Canyon Project, 1975.

Slough No.	Date	Time (military)	Temperature (°F) Air	Temperature (°F) Water	Survey Conditions	No. Fry Observed	Fry Species Identified: King	Coho	Chum	Grayling	Whitefish	Adult Salmon Density: Chum Live	Chum Dead	Chum Total	Sockeye Live	Sockeye Dead	Sockeye Total
13	7/23	1750	62	50	poor	0						0	0	0	0	0	0
	7/28	1215	54	49	poor	100		X				0	0	0	0	0	0
	8/13	1620	63	58	excellent	200		X		X		0	0	0	0	0	0
	8/25	1115	52	44	good	300		X				0	0	0	0	0	0
	9/4	1715	53	44	good	50				X		0	0	0	0	0	0
	9/25	1600	55	48	good	100				X	X	1	0	1	0	0	0
14	7/23	1735	68	51	excellent	100		X				0	0	0	0	0	0
	7/30	1600	63	51	excellent	600		X				0	0	0	0	0	0
	8/7	1230	62	49	excellent	1000		X				0	0	0	0	0	0
	8/13	1600	59	47	excellent	500		X				0	0	0	0	0	0
	8/25	1100	55	45	good	200		X				0	0	0	0	0	0
	9/4	1630	60	47	good	1000		X				0	0	0	0	0	0
	9/25	1530	57	46	excellent	200		X				0	0	0	0	0	0
15	7/23	1700	68	51	excellent	0						0	0	0	0	0	0
	7/29	1300	66	52	excellent	3500		X				0	0	0	0	0	0
	8/8	1205	62	56	excellent	3000		X				0	0	0	0	0	0
	8/14	0745	50	47	good	500	X					0	0	0	0	0	0
	9/6	1030	44	45	good	0						1	0	1	0	0	0
	9/24	1030	48	46	good	7		X				0	0	0	0	0	0
16	7/23	1645	68	56	fair	0						0	0	0	0	0	0
	7/29	1330	66	49	poor	0						0	0	0	0	0	0
	8/8	1320	61	45	excellent	10		X				0	0	0	0	0	0
	8/14	0815	53	43	good	10		X				0	0	0	0	0	0
	8/26	1615	54	48	good	0						12	0	12	0	0	0
	9/6	1110	47	47	good	0						0	0	0	0	0	0
	9/24	1110	52	45	good	1						0	0	0	0	0	0
17	7/23	1630	76	52	excellent	0						0	0	0	0	0	0
	7/29	1340	64	57	good	1500		X				0	0	0	0	0	0
	8/14	0845	53	40	good	0						0	0	0	0	0	0
	8/26	1630	56	43	good	0						0	0	0	0	0	0
	9/6	----	--	--	poor 1/	0						-	-	-	-	-	-
	9/24	1115	50	46	good	25						0	0	0	0	0	0

Appendix
Table 6. Escapement survey counts conducted on the Susitna River in Sloughs Numbers 18, 19, 20, 21, Devil's Canyon Project 1975.

Slough No.	Date	Time (military)	Temperature (°F) Air	Temperature (°F) Water	Survey Conditions	No. Fry Observed	Fry Species Identified: King	Coho	Chum	Grayling	Whitefish	Adult Salmon Density: Chum Live	Chum Dead	Chum Total	Sockeye Live	Sockeye Dead	Sockeye Total
18	7/29	1400	62	53	poor	0						0	0	0	0	0	0
	8/14	0920	56	46	good	0						0	0	0	0	0	0
	8/26	1645	56	47	good	0						0	0	0	0	0	0
	9/6	----	--	--	poor 1/	---						-	-	-	-	-	-
	9/24	1145	54	45	good	10						0	0	0	0	0	0
19	7/23	0900	59	44	poor	0						0	0	0	0	0	0
	7/29	1415	62	48	poor	0						0	0	0	0	0	0
	8/10	1125	56	49	fair	0						0	0	0	1	0	1
	8/14	0950	58	42	excellent	0						0	0	0	0	0	0
	8/26	1700	54	43	good	0						0	0	0	20	0	20
	9/6	1135	45	42	good	0						0	0	0	12	0	12
	9/24	1200	52	45	good	20						0	0	0	10	3	13
20	7/23	0915	59	44	poor	0						0	0	0	0	0	0
	7/29	1425	62	49	poor	0						0	0	0	0	0	0
	8/10	1220	54	43	excellent	500		X		X	X	0	0	0	0	0	0
	8/14	1020	60	43	excellent	300		X		X		0	0	0	0	0	0
	8/26	1800	54	44	excellent	200		X		X		0	0	0	0	0	0
	9/6	1220	47	44	good	200		X		X		0	0	0	0	0	0
21	7/23	0940	62	50	poor	0						0	0	0	0	0	0
	7/29	1440	62	48	poor	0						0	0	0	0	0	0
	8/10	1330	61	44	fair	500				X	X	0	0	0	0	0	0
	8/14	1120	60	48	good	500				X	X	0	0	0	0	0	0
	8/26	1830	54	46	poor	150				X		0	0	0	0	0	0
	9/6	1300	46	45	good	300				X		250	146	396	36	0	36
	9/25	1400	54	48	excellent	0						92	34	126	49	26	75

1/ Slough area dried up.

Appendix Table 7. Escapement survey counts conducted on the Susitna River in Whisker's Creek, Chase Creek, Lane Creek, McKenzie Creek, Fourth of July Creek, Indian River and Portage Creek, Devil's Canyon Project, 1975.

Location	Date	Time (military)	Temperature (°F) Air	Temperature (°F) Water	Survey Conditions	No. Fry Observed[1/]	Adult Salmon Density: Chum Live	Chum Dead	Chum Total	Sockeye Live	Sockeye Dead	Sockeye Total	King Live	King Dead	King Total	Pink Live	Pink Dead	Pink Total
Whisker's Creek	7/23	1430	65	55	poor	1500	0	0	0	0	0	0	3	2	5	0	0	0
	7/28	1245	60	50	poor	1500	0	0	0	0	0	0	1	0	1	0	0	0
	8/4	1710	68	56	poor	1500	0	0	0	0	0	0	22	1	23	0	0	0
	8/14	1320	66	55	poor	1500	0	0	0	0	0	0	3	1	4	0	0	0
	8/23	1650	60	54	poor	1500	0	0	0	0	0	0	0	0	0	0	0	0
	9/3	1230	56	49	good	0	0	0	0	0	0	0	0	0	0	0	0	0
Chase Creek	7/17	1235	59	58	poor	1500	0	0	0	0	0	0	0	0	0	0	0	0
	7/25	1445	58	57	poor	1500	0	0	0	0	0	0	0	0	0	0	0	0
	8/2	1310	60	58	poor	1500	0	0	0	0	0	0	0	0	0	0	0	0
	8/9	1315	58	57	poor	1500	0	0	0	0	0	0	0	0	0	0	0	0
	8/22	1725	61	57	poor	1500	0	0	0	0	0	0	0	0	0	0	0	0
	9/3	1515	60	54	good	0	1	1	0	0	0	0	0	0	0	0	0	0
Lane Creek	7/21	1330	70	47	excellent	0	0	0	0	0	0	0	0	0	0	0	0	0
	7/26	1545	56	49	excellent	0	0	0	0	0	0	0	0	0	0	20	0	20
	8/6	1245	55	47	excellent	100	0	0	0	0	0	0	1	0	1	81	0	81
	8/17	1700	59	49	excellent	0	3	0	3	0	0	0	0	0	0	106	2	108
	8/27	1220	57	48	excellent	0	1	0	1	0	0	0	0	0	0	25	21	46
	9/3	1700	55	46	excellent	0	0	0	0	0	0	0	0	0	0	2	41	43
	9/27	1415	55	45	poor	0	0	0	0	0	0	0	0	0	0	0	0	0
McKenzie Creek	8/6	1410	60	49	excellent	250	0	0	0	0	0	0	0	0	0	0	0	0
	8/17	1630	59	53	excellent	250	0	0	0	0	0	0	0	0	0	0	0	0
	8/27	1200	54	49	excellent	0	0	0	0	0	0	0	0	0	0	0	0	0
	9/8	1400	51	48	good	200	0	0	0	3	0	3	0	0	0	0	0	0
	9/27	1300	54	46	excellent	0	0	0	0	45	1	46	0	0	0	0	0	0
Fourth of July Creek	7/28	1620	63	46	excellent	0	0	0	0	0	0	0	0	0	0	40	0	40
	8/9	1600	66	56	excellent	0	0	0	0	0	0	0	1	0	1	87	0	87
	8/17	1130	65	53	excellent	0	0	0	0	1	0	1	0	0	0	148	3	151
	8/25	1500	60	55	excellent	0	0	0	0	0	0	0	0	0	0	101	70	171
	9/8	0945	43	45	poor[2/]	----	-	-	-	-	-	-	-	-	-	-	-	-
	9/27	1030	50	46	fair	0	0	0	0	0	0	0	0	0	0	0	0	0
Indian River	8/9	1800	--	--	good	0	1	0	1	0	0	0	0	0	0	4	0	4
	8/12	1415	76	57	excellent	0	70	0	70	0	0	0	10	8	18	321	0	321
	9/6	1400	--	--	poor[2/]	-	-	-	-	-	-	-	-	-	-	-	-	-
	9/26	1030	57	45	fair	0	1	6	7	1	0	1	0	0	0	0	0	0
Portage Creek	7/23	1030	78	48	excellent	0	0	0	0	0	0	0	2	0	2	0	0	0
	7/29	1700	54	47	excellent	0	0	0	0	0	0	0	25	0	25	0	0	0
	8/10	1400	58	50	good	0	0	0	0	0	0	0	3	0	3	0	0	0
	8/24	1200	52	47	excellent	0	0	0	0	0	0	0	0	0	0	0	0	0
	9/6	1330	--	--	poor[2/]	-	-	-	-	-	-	-	-	-	-	-	-	-

1/ All fry present were coho salmon.

2/ White water conditions prevented surveys.

Appendix Table 8. Escapement survey counts conducted on the Talkeetna River in Sloughs Numbers 1, 2, 3, 4, 5, and 6, Devil's Canyon Project, 1975.

Slough No.	Date	Time (military)	Temperature (°F) Air	Temperature (°F) Water	Survey Conditions	No. Fry Observed	Fry Species Identified: King	Coho	Chum	Grayling	Whitefish	Adult Salmon Density: Chum Live	Chum Dead	Chum Total	Sockeye Live	Sockeye Dead	Sockeye Total
1	7/25	1300	63	49	excellent	3500		X				0	0	0	0	0	0
	8/5	1030	69	47	excellent	1500		X				0	0	0	0	0	0
	8/19	1015	55	49	excellent	3000		X				0	0	0	0	0	0
	9/2	0945	54	46	good	3000		X				0	0	0	0	0	0
	9/9	1200	50	45	good	2000		X				0	0	0	0	0	0
2	7/25	1735	57	48	excellent	300		X				0	0	0	0	0	0
	8/5	1400	77	55	excellent	1500		X				0	0	0	0	0	0
	8/19	1350	64	55	excellent	0						0	0	0	0	0	0
	9/2	1205	58	47	good	4		X				15	0	15	0	0	0
3	7/25	1750	57	52	poor	0						0	0	0	0	0	0
	8/5	1505	75	50	excellent	1400		X				0	0	0	0	0	0
	8/19	1530	63	54	poor	0						0	0	0	0	0	0
	9/2	1235	54	49	excellent	0						6	0	6	0	0	0
4	7/25	1830	60	48	poor	0						0	0	0	0	0	0
	8/5	1550	--	--	poor [1/]	0						0	0	0	0	0	0
5	7/25	1410	58	49	excellent	300		X				0	0	0	0	0	0
	8/5	1715	59	54	excellent	20						0	0	0	0	0	0
	8/19	1050	57	55	good	0						0	0	0	0	0	0
	9/2	1020	--	--	poor [2/]	-						-	-	-	-	-	-
6	7/25	1500	57	46	excellent	3000		X				0	0	0	0	0	0
	8/5	1730	69	48	excellent	500		X				0	0	0	0	0	0
	8/19	1105	59	47	good	1500		X				0	0	0	0	0	0
	9/2	1040	56	46	good [3/]	300		X				0	0	0	0	0	0
	9/9	1225	48	47	good [3/]	1000		X				0	0	0	0	0	0

Appendix Table 8. Escapement survey counts conducted on the Talkeetna River in Sloughs Numbers 7, 8, and 9, Devil's Canyon Project, 1975 (cont.).

Slough No.	Date	Time (military)	Temperature (°F)		Survey Conditions	No. Fry Observed	Fry Species Identified					Adult Salmon Density					
												Chum			Sockeye		
			Air	Water			King	Coho	Chum	Grayling	Whitefish	Live	Dead	Total	Live	Dead	Total
7	7/25	1500	57	46	excellent	1000		X				0	0	0	0	0	0
	8/5	1745	69	47	excellent	50		X				0	0	0	0	0	0
	8/19	1130	57	48	good	2000		X				0	0	0	0	0	0
	9/2	1145	57	49	good[3/]	400		X				0	0	0	0	0	0
	9/9	1325	48	47	good[3/]	500		X				0	0	0	0	0	0
8	8/5	1220	--	--	poor[1/]	----						-	-	-	-	-	-
9	7/25	1700	58	49	poor[1/]	----						-	-	-	-	-	-
	8/5	1240	--	--	poor[1/]	----						-	-	-	-	-	-

1/ The mainstem Talkeetna River flowing through the slough area.

2/ The slough area completely dried up.

3/ The mouth and sections of the slough area dried up.

Appendix Table 9. Escapement survey counts conducted on the Talkeetna River in Beaver Pond, Railroad, Old Channel, Whiskey, Clear Creek Sloughs, and Wiggle Creek, Devil's Canyon Project, 1975.

Slough	Date	Time (military)	Temperature (°F)		Survey Conditions	No. Fry Observed	Fry Species Identified					Adult Salmon Density					
												Chum			Sockeye		
			Air	Water			King	Coho	Chum	Grayling	Whitefish	Live	Dead	Total	Live	Dead	Total
Wiggle Creek	7/25	1800	59	57	excellent	0						0	0	0	0	0	0
	8/5	1530	76	59	excellent	1000		X				0	0	0	0	0	0
	8/19	1535	66	57	good	1500		X				0	0	0	0	0	0
	9/2	1300	55	49	good	0						0	0	0	0	0	0
Beaver Pond Slough	7/25	1820	60	48	poor 1/	----						-	-	-	-	-	-
	8/5	1540	75	48	poor 1/	----						-	-	-	-	-	-
	9/2	1350	57	49	good	0						0	0	0	0	0	0
Railroad Slough	8/19	1545	65	58	poor	0						0	0	0	0	0	0
	9/2	1330	55	55	good	0						0	0	0	0	0	0
Old Channel	8/5	1600	72	59	fair	0						0	0	0	0	0	0
Whiskey Slough	7/25	1600	57	52	excellent	3000		X				0	0	0	0	0	0
	8/5	1200	64	52	excellent	3000		X				0	0	0	0	0	0
	8/19	1220	65	55	good	4000		X				50	0	50	0	0	0
	9/2	1100	57	51	good	2000		X				0	0	0	0	0	0
	9/9	1415	50	48	good	200		X				8	0	8	3	0	3
Clear Creek Slough	8/5	1300	75	54	excellent	600						0	0	0	0	0	0
	8/19	1245	63	52	excellent	2000		X		X	X	0	0	0	0	0	0
	9/2	1130	54	47	good	0						-	-	-	-	-	-
	9/9	1500	48	45	good	0						139	21	160	0	0	0

1/ The mainstem Talkeetna River flowing through the slough area.

APPENDIX III

NOTES ON THE MORE COMMON BENTHIC INVERTEBRATES FOUND IN THE SUSITNA RIVER TRIBUTARIES

Insecta

All of the insects collected in the Susitna River sampling sites were larval or pupal forms of insects that are terrestrial in the adult stage. The major portion of the life history usually occurs in the aquatic environment. The adult stages often emerge and live as a terrestrial insect for only a few days. In some instances the adult has no mouth parts (Ephemeroptera). It emerges, carries out the reproductive functions, and dies in two or three days. The juveniles stages of an aquatic insect may last from several months to three years, as with Plecoptera. It is during this developmental stage that all growth or increase in biomass occurs.

Plecoptera (stoneflies)

Stonefly nymphs are strictly aquatic and are found in debris, masses of leaves and algae, and under stones in every kind of lotic environment where there is an abundance of dissolved oxygen. They form an important portion of the diet of fish, especially for members of the trout family, and are commonly found in clear, cool, streams where little organic enrichment occurs (Reid, 1961; Pennak, 1953).

Ephemeroptera (mayflies)

This order of insects is found in all types of fresh water where there is an abundance of dissolved oxygen. The nature of the substrate and the rate of water movements largely determines the species composition. They are all herbivores, very sensitive to temperature changes, and one of the most important sources of fish food (Pennak, 1953). They will not survive even a short-term oxygen depletion (Beeton, 1961).

Tricoptera (caddis flies)

Larval and pupal forms of caddis flies are aquatic and are found in all types of freshwater habitats. Most species of this order build a case of rocks or organic debris. These cases may or may not be attached to the substrate. The larvae and pupa are an important source of fish food and require an adequate supply of dissolved oxygen. The species composition is affected by rate of flow and the nature of the substrate (Pennak, 1953). In swift flowing streams most large concentrations of caddis fly larvae are associated with gravel or cobble bottoms (Hickin, 1968).

Diptera

The Diptera are highly specialized two-winged flies and include common insects such as the horsefly, mosquitoes and midges. Many families have aquatic immature stages, although adults are never found in the aquatic environment. Representatives of two families, Simuliidae and Ceratopoqonidae, were identified in the Susitna River tributary streams.

Simuliidae (black flies)

Black fly larvae are usually abundant in shallow, swift streams where an abundance of oxygen occurs. They are always attached and feed on plankton and detritus (Pennak, 1953).

Ceratopogonidae (biting midges)

This family of insects is commonly referred to as "no-see-ums." The larvae are most commonly found in floating masses of algae, but also occur in springs, streams, and wet mud along shores (Pennak, 1953).

APPENDIX IV

The Alaska Department of Fish and Game has been requested to assign monetary values to the Susitna River salmon stocks by the Corps of Engineers. These figures will provide a basis for mitigation actions. Total escapement figures are not available for this system and it is therefore difficult to assign a value to the salmon populations. The following has been compiled by Commercial Fisheries staff biologists to partially fulfill the request. It must be emphasized that final figures are only estimates based on feelings of biologists familiar with the Susitna Basin area and do not represent fact.

The estimated maximum sustained yields (MSY) for salmon produced in the Cook Inlet gill net districts, i.e., that area north of the latitude of Anchor Point, based on historical catch trends are:

sockeye	1,700,000
king	66,000
pink	1,800,000
chum	700,000
coho	300,000

The percentage of salmon produced from the Susitna River basin is estimated to be:

sockeye	.50 x 1,700,000 = 850,000
king	.90 x 66,000 = 59,400
pink	.85 x 1,800,000 = 1,530,000
chum	.90 x 700,000 = 630,000
coho	.70 x 300,000 = 210,000

If we assume the above is relatively correct and we relate this to:

1. The average weights of adult salmon by species, i.e., sockeye 6.1 lbs.; king 25.0 lbs.; pink 3.5 lbs.; chum 7.4 lbs.; and coho 6.1 lbs.

2. The average 1975 prices paid to fishermen per pound by species, i.e., sockeye \$0.63, king .62, pink .36, chum .43, and coho .47.

Then:

Susitna Production		x	Average Weight	x	Average Price/lb.	Value to Fishermen
Sockeye	850,000		6.1		.63	\$3,266,550
King	59,400		25.0		.62	920,700
Pink	1,530,000		3.5		.36	1,927,800
Chum	630,000		7.4		.43	2,004,660
Coho	210,000		6.1		.47	602,070

The estimated average annual value to fishermen is therefore approximately \$8,721,780.

This value does not include the value of salmon it takes to produce the estimated catch produced in the Susitna basin. This may be calculated by using estimated return by spawner by species using the 1975 price per pound paid to fishermen:

Species	Return/Spawner	Spawners/MSY
Sockeye	3.0:1	283,333
King	1.0:1	59,400
Pink	3.8:1	402,632
Chum	2.2:1	286,364
Coho	2.2:1	95,455

Value of Spawners

Species	Average Weight	Average Price	Spawners	Value
Sockeye	6.1	.63	283,333	$1,088,849
King	25.0	.62	59,400	920,700
Pink	3.5	.36	402,632	507,316
Chum	7.4	.43	286,364	911,210
Coho	6.1	.47	95,455	273,670
Average annual value of spawners				$3,701,745

The 1973 average estimated market values of drift gill net vessels and gear were $12,843 and $2,411, respectively. The maximum number of drift gill net units participating in the Cook Inlet fisheries is 625. With a potential loss of a portion or all of the above Susitna River production this investment will constitute a potential loss.

Based on the same 1973 estimates, set gill net gear and sites were valued at $8,223 and $21,563 respectively, or a total of $29,786 per set net fisherman. The maximum number of set gill net units participating in the fishery is 525. As with the drift gill net fishery a portion or all of this investment represents a potential loss.

Other areas of interest would obviously be affected should a drastic decline in salmon production occur. These include, but are not limited to: (1) sport fishermen and supporting services; (2) salmon processing facilities and seasonal employment; (3) State tax of the commercial cannery salmon pack of Cook Inlet; (4) licensing revenues; (5) a variety of commercial fishermen and industry supporting services; and (6) cutback in the numbers of fishermen participating in the fishery by the Commercial Fisheries Entry Commission accomplished through the "buy-back program" costing the State funds.

PRE-AUTHORIZATION ASSESSMENT

OF THE

SUSITNA RIVER HYDROELECTRIC PROJECTS:

PRELIMINARY INVESTIGATIONS OF WATER QUALITY AND AQUATIC SPECIES COMPOSITION

SPORT FISH SECTION

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Pre-authorization Assessment of the Susitna River Hydroelectric Projects: Preliminary Investigations of Water Quality and Fish Species Composition.

ABSTRACT

Biological investigations of the Susitna River and selected tributaries were conducted from February 10, 1975 to September 30, 1975 to obtain baseline data regarding indigenous fish populations, available aquatic habitat, and water quality which will aid in the definition of biological areas of concern requiring additional study prior to authorization of hydroelectric development by the U. S. Army Corps of Engineers.

INTRODUCTION

Anadromous fish stocks of Cook Inlet and the Susitna River drainage, the largest fresh water system in Cook Inlet, have historically been of great value to the economy of Southcentral Alaska.

Commercial fishing has been the principle use of the anadromous fish resource, but in recent years, both anadromous and resident fresh water fish species indigenous to Upper Cook Inlet and the Susitna River system have become increasingly important to the recreational user.

The direct cumulative value to recreational and commercial fishermen, and indirect values to the many and varied supportive services and communities deriving benefit, makes the fishery resources of the Susitna River an extremely valuable resource.

The salmon stocks utilizing the Susitna River drainage, particularly the chinook (Oncorhynchus tshawytscha), and coho salmon, (O. kisutch), are currently at depressed levels. Chinook salmon stocks have been the target of extensive commercial and recreational fishing closures since the early 1960's. Management of these stocks is currently at a most important, if not critical, stage. The proposed hydroelectric development of the Susitna River basin will have a number of identifiable, and currently undefined, effects upon the existing quality of water and aquatic habitat necessary for perpetuation of the anadromous and resident fish species.

The U. S. Army Corps of Engineers has stated downstream Susitna River flows will be significantly altered by regulation, existing seasonal patterns of silt and sediment transport will be different, stream temperatures and water quality parameters may be affected, and 50,500 acres, including 82 river miles, of natural stream will be impounded by the Devil-Watana dam impoundments.

The United States Fish and Wildlife Service, pursuant to provisions in the Fish and Wildlife Coordination Act and the "Cooperative Agreement between the Service and the State of Alaska, Department of Fish and Game" provided funding to the Sport Fish Division (Alaska Department of Fish and Game) in the amount of $8,000 during the period July 1, 1974 to June 30, 1975, and $16,000 during the period July 1, 1975 and June 30, 1976 for biological surveys and studies of the Susitna River basin.

With the available funds study objectives were to: 1) determine resident and anadromous sport fish species present and their distribution in the mainstem Susitna River, its tributaries, and peripheral slough areas; 2) measure chemical, physical, and biological parameters associated with the mainstem and important tributaries; 3) determine the most acceptable sampling techniques for the highly variable conditions existing in the Susitna River; and 4) define future studies required to fully identify the impacts and effects of hydroelectric development upon the Susitna River fishery resource. Study results are discussed in the following text, conclusions presented where possible, and recommendations made for further definitive biological investigations.

STUDY AREA

The hydroelectric project under study will have major effects upon the Susitna River which drains an area of approximately 20,000 square miles. That portion of the river above the proposed Devil Canyon dam site drains approximately 6,000 square miles. The Susitna River basin is bounded on the east by the Copper River plateau and the Talkeetna Mountains, on the west and north by the mountains of the Alaska Range, and on the south by the Talkeetna Mountains and Cook Inlet.

The Maclaren, the Oshetna, and the Tyone rivers are the largest tributaries of the Susitna River above Devil Canyon. The Tyone River is the only one of the three which is non-glacial. There are numerous smaller tributaries which fluctuate greatly in seasonal rate of flow, but remain silt free or clear throughout the year.

The Susitna River tributaries below Devil Canyon, for the most part, originate in the surrounding mountains. The Chulitna, Talkeetna, and Yentna are the major tributaries, all of which are glacial. Clear water tributaries below Devil Canyon collectively exert considerable influence and are the major fish producing waters in this system. The major non-glacial tributaries include: Portage Creek, Indian River, Montana Creek, Goose Creek, Sheep Creek, Little Willow and Willow Creeks, Deshka River, and Alexander Creek.

The work described in this report was conducted on the Susitna River primarily from Portage Creek (located approximately three miles below Devil Canyon) downstream to the mouth of the Yentna River.

One field trip into the upstream impoundment area during late winter was accomplished to attempt the capture of mainstem residing fish. Time and budgetary restraints precluded additional field studies in the upstream impoundment area during the 1975 summer field season.

MATERIALS AND METHODS

Travel to and from sampling sites during the winter was accomplished via a fixed wing aircraft on skis. A 20-foot riverboat, powered by an 85 horsepower outboard, was used to travel on the Susitna River during the ice-free months. Chinook salmon escapement counts were made with the use of fixed wing aircraft (supercub), Bell-47 helicopter, and ground surveys.

Adult and rearing salmonids were collected with gill nets, minnow traps, set lines, seines, dip nets, rod and reel, and electroshocker.

Benthic invertebrates were collected with artificial substrates which consisted of wire vegetable baskets lined with nylon screen cloth and filled with rocks taken from the stream bed. The baskets were left in the water for a period of approximately 30 days. A hand screen was also used to collect benthos samples.

"In situ" analysis of alkalinity as $CaCO_3$, total hardness and pH on samples from the Susitna River and the seven east side tributaries below the Parks Highway Bridge was performed at biweekly intervals, using a Hach chemical kit, Model Al-36B. Samples were collected approximately one to three meters from the bank, at or near the surface. Temperatures at sample collection points were recorded from just below the surface.

Conductivity and turbidity samples for the Susitna River and the seven east side tributaries were collected at the same time as the above samples, placed in one-liter polyethylene bottles, and analyzed at the U.S. Geological Survey, Division of Water Resources Laboratory, using the Hach 2100A turbidmeter and a Beckman RB3 conductivity meter. All conductivity measurements were standardized at 25°C.

All thermographic data collected from the Susitna River and two tributaries were gathered using a Ryan thermograph model D-30, which was reset every 30 days. Temperatures were recorded in Fahrenheit on thermograph tape.

The Susitna River water quality parameters from upstream of the Parks Highway bridge were gathered using a Hach chemical kit model DR-EL/2. Two sample sites were used; one approximately 50 meters above Portage Creek and the other about 150 meters above Gold Creek. All samples were collected approximately five to ten meters from the bank, at or near the surface. Restricted access and limited time prohibited more extensive data collection during the field season.

The Susitna River sloughs and tributaries between Devil Canyon and Talkeetna were also analyzed with Hach chemical kits, model DR-EL/2 and Al-36B. All measurements were made approximately two to five meters from the bank and 50 meters from the mouths of the sloughs, at or near the surface. Temperatures were recorded in Fahrenheit to the nearest whole degree and later converted to the nearest 0.5° centigrade.

RESULTS AND DISCUSSION

FISHERIES

Interviews with staff members provide evidence of resident and rearing anadromous salmonid fishes migrating downstream from the tributaries into the mainstem Susitna River during the fall, and back upsteam into the tributaries during the spring. A hypothesis was formulated that this migration occurs in part because of severe icing conditions and reduced flows in the tributaries during the winter months, which may result in 1) territorial displacement of certain species and sizes of fish, and 2) winter habitat preferences, i.e., Arctic grayling (Thymallus arcticus) appear to prefer larger bodies of water during the winter, substantial space and, in general, a higher quality environment may be provided for aquatic species. Concern about this undefined migration is the basis for designing a biological and limnological study the included the tributaries as well as the mainstem Susitna River.

The Commercial Fish Division initiated studies in 1974 on the sloughs and mainstem Susitna River from the Chulitna River upstream to Devil Canyon (Barrett, 1974). This work was continued and expanded into the Talkeetna and Chulitna Rivers (Friese, 1975). It was not the intent of the Sport Fish Division to duplicate work conducted by Barrett and Friese, but to supplement it with limnological data and to further study resident species and habitat areas not included in their prior and on-going studies.

The numbers of fish and/or species collected during the fishery studies are not statistically significant in that the sample sizes or numbers collected are inadequate to define specific population sizes. The samples obtained are important, however, as they document the presence of a number of fish species, seasonally, in both the Susitna River mainstem and tributary waters.

The seasonal fisheries investigations have provided considerable insight into 1) the extreme difficulty in assessing either summer or winter mainstem Susitna River fish stocks due to high flows carrying debris and extreme ice and snow conditions respectively, and 2) future study requirements necessary to determine the significance and extent of the intra-system migrational phenomenon exhibited by resident and anadromous fish species.

Winter:

Winter investigations to document the presence of rearing salmonid fry in the mainstem Susitna River began February 10, 1975 and continued through April, 1975. The mainstem Susitna River was sampled with minnow traps, gill nets, and electroshocker at 11 locations between Susitna station and the Parks Highway Bridge, a distance of approximately 50 miles, and two locations above Devil Canyon. Studies conducted during March and April, 1975 documented rearing coho, chinook, chum, (O. keta), grayling, sculpin (Cottus cognatus), burbot (Lota lota), whitefish (Coregonus sp.) and sucker (Catostomus catostomus) over-wintering in the mainstem Susitna River downstream from the Parks Highway Bridge (Table 1). The sampling sites and distribution findings are also plotted on aerial photographs in the Appendix of this report.

Minnow traps were installed in Montana Creek, near the three forks, and Willow Creek, under the highway bridge, during the first week of April, 1975 when water with enough depth under the ice could be found to effectively fish a trap. Prior to this date, difficulty was experienced in finding sufficient water levels under the ice to set minnow traps in the tributaries. Five Dolly Varden (Salvelinus malma) ranging from 85 mm to 142 mm were trapped in Willow Creek and four chinook fry ranging from 48 mm to 74 mm were captured in Montana Creek.

Table 1. Results of Winter Fry Sampling in Mainstem Susitna River, Devil's Canyon Project, 1975.

Date	Location	Sampling Method	Hours Sampled	Number and Species Captured
Feb. 10	Directly off mouth of Sheep Creek	6 Minnow Traps	24	0
Mar. 18	2.3 miles south of Montana Creek	6 Minnow Traps	72	2 SS 1 S
	2 miles south of Kashwitna River	6 Minnow Traps	72	1 SS
Mar. 19	Directly off mouth of Deshka River	12 Minnow Traps 8 Set Lines	48 48	0
Mar. 25	Directly off mouth Montana Creek	4 Minnow Traps	48	0
	Directly off mouth Caswell Creek	6 Minnow Traps	48	0
Apr. 10	2.2 miles north of Willow Creek	25 Minnow Traps	192	3 KS
Apr. 23	100 yards down-stream Jay Creek	12 Minnow Traps 1 Gill Net	48 48	0 0
	100 yards down-stream Deadman Cr.	6 Minnow Traps 1 Gill Net	24 24	0 0
Apr. 28	50 yards upstream Montana Cr. mouth	Electroshocker		7 CS
Apr. 30	Susitna Station	Electroshocker		1 GR 1 WF 1 BB
	3 miles south of Parks Hwy. Bridge	Electroshocker		1 S 1 SC

*SS - coho salmon, KS-chinook salmon, CS-chum salmon, S-sucker, GR-grayling, WF-whitefish, BB-burbot, SC-sculpin

Minnow traps and gill nets were installed in the mainstem Susitna River above Devil Canyon from April 21 to April 24, 1975. A gill net and 12 minnow traps were stationed 100 yards downstream from Jay Creek for 24 hours with negative results. Six traps and one gill net were placed 100 yards downstream from Deadman Creek for 12 hours, also without capturing fish.

The most successful winter sampling technique for the Susitna River appeared to be the backpack electroshocker. However, this technique is limited to late winter after certain areas become ice free and before high silt laden flows begin. Minnow traps were not as effective during the winter as during the summer because fish are lethargic in cold water and may not enter the trap as readily. Thus, samples collected may not be indicative of fish numbers present at any given site. There is a need for testing of more effective trapping or fish collecting devices during the winter season.

Summer:

Summer investigations of fish species inhabiting the mainstem Susitna River began June 17, 1975. Following a reconnaissance and general familiarization trip to identify potential sampling sites, a base camp was established on the Deshka River near the confluence with the Susitna River. Beginning the week of June 23, 1975, a crew of two biologists spent four days each week through July, 1975 sampling for rearing fish in the mainstem Susitna River from the Parks Highway Bridge downstream. The results of this five week sampling period indicate the following: 1) Anadromous salmon fry, rainbow trout, and grayling are scarce in the silt laden water of the mainstem Susitna River during this time of year and, 2) whitefish, sculpin, and suckers were commonly captured in the turbid Susitna River. Two coho fry, 50 and 69 mm in length, were captured at a sandbar near the mouth of Sheep Creek and two chinook fry, 59 and 60 mm in length, were collected downstream of Willow Creek. With the exception of these four fry, no other salmon fry, rainbow trout, or grayling were captured in the Susitna River when the silt load was high. The reasons for the scarcity of salmonids in the mainstem Susitna could be attributed to a preference for clearwater by these species and the outmigration of chinook and coho salmon smolts, pink and chum salmon fry before sampling efforts were initiated. The only sampling techniques which proved feasible for collecting fry during the high flow period of the Susitna River were hand seines and dip nets. Gill nets were ineffective because of drifting debris in the river during the high summer flows. The backpack electroshocker is also unsatisfactory when turbidity is high because affected fish cannot be seen or captured.

On August 6, 1975 the base camp was moved from the Deshka River to Gold Creek. Sloughs in the Gold Creek area and upstream to Devil Canyon were sampled for fish in conjunction with the limnological study. Results of the fish collections are shown in Table 2. Seining was conducted at four sites in the mainstem Susitna between Gold Creek at Portage Creek with negative results.

Winter and summer observations of rearing fry in the Susitna River lend support to the hypothesis that salmonids migrate downstream from tributaries during the fall to overwinter in the Susitna and return to the tributaries during the spring.

Table 2. Fish Collected in Sloughs Between Talkeetna and Portage Creek, Devil's Canyon Project, 1975.

Date	Slough Number	Species Collected	Number Collected	Fish Size (mm)
Aug. 13	11	Chinook	1	53
		Grayling	1	56
		Sucker	1	49
	13	Grayling	1	46
		Whitefish	1	37
Aug. 14	15	Chinook	4	43-53
	16	Whitefish	1	50
	19	Whitefish	5	39-45
Aug. 15	20	Chinook	10	52-66
		Grayling	2	43,62
	21	Grayling	2	56,58
		Whitefish	5	39-48
Aug. 19	17	Coho	2	39,48
		Grayling	4	33-65
		Burbot	1	59
		Sucker	1	52
	18	Chinook	4	51-55
		Coho	4	39-54
		Grayling	1	53
		Whitefish	3	48-53
		Burbot	1	49
		Sucker	2	47,54

Arctic grayling are the most common resident recreationally important species indigenous to the Susitna River Basin. Grayling occur in the majority of fresh water tributaries of the Susitna River, both upstream and downstream of the Devil's Canyon Dam site, and were documented specifically in those immediate downstream tributaries of Portage and Fourth of July creeks, and Indian River.

An age-length frequency of 33 grayling collected from Portage Creek is presented in Tables 3 and 4 as general indication of grayling size and age composition.

Arctic grayling exhibit intra-system migrations and a need exists for comprehensive studies of these seasonal movements and their significance to determine the overall effects of the potential loss of any of their aquatic habitat.

All five species of salmon utilize the Susitna River and all are equally important. The Sport Fish Division recognizes the chinook and coho salmon as having the greatest potential for satisfying future recreational needs. The Commercial Fish Division studies pink, chum, and sockeye (O. nerka) salmon and reported on these species in their section.

A number of key tributaries of the Susitna River were selected for chinook salmon escapement during 1975 (Tables 5 and 6). It should be noted these escapement counts do not constitute total numbers, but indicate relative abundance and depict the importance of the Susitna River as an avenue of access. Upstream impoundment may affect the migration of fish into key spawning streams. Prior to impoundment the magnitude of anadromous salmon escapements should be enumerated totally.

Benthos

Species diversity has become widely used as an indicator of water quality. Diversity indices may be applied to any biotic community but have had widest application with the benthos. Such indices relate the number of kinds of organisms to the total number of organisms and to the number of individuals of each kind. Undisturbed natural communities are assumed to have a high diversity; that is, a relatively large number of species, with no species having disproportionately large numbers of individuals, (Lind, 1974). Diversity is considered to be a sensitive bioassay for assessing environmental stress (Cantlon, 1969; Wilhm, 1970). The diversity of a community is a meaningful parameter which can be measured (Warren, 1971). Warren emphasized the importance of diversity in defining the environmental impacts of changes to a system. To properly assess impacts, a diversity index should be computed, using identical methodology, before, during, and after construction.

In order to use a species as an indicator organism, its environmental requirements must be reasonably well defined within rather narrow limits (McCoy, 1974). It has been demonstrated that presence of species in the orders Ephemeroptera and Plecoptera in streams indicate unpolluted waters. Members of both these orders were observed on rocks in the impoundment area of the Susitna River during the late winter field trip, April 21 through April 24, 1975 and downstream of Devil Canyon throughout the summer.

Table 3. Age Analysis of Grayling Sampled from Portage Creek, Devil's Canyon Project, August 12, 1975.

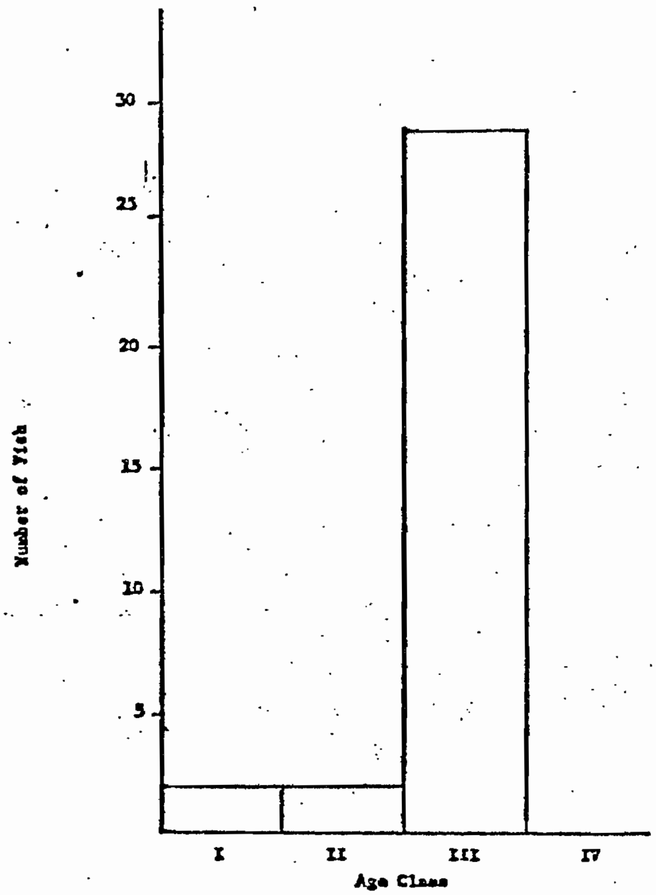


Table 4. Length Variation of Grayling Sampled from Portage Creek, Devil's Canyon Project, August 12, 1975.

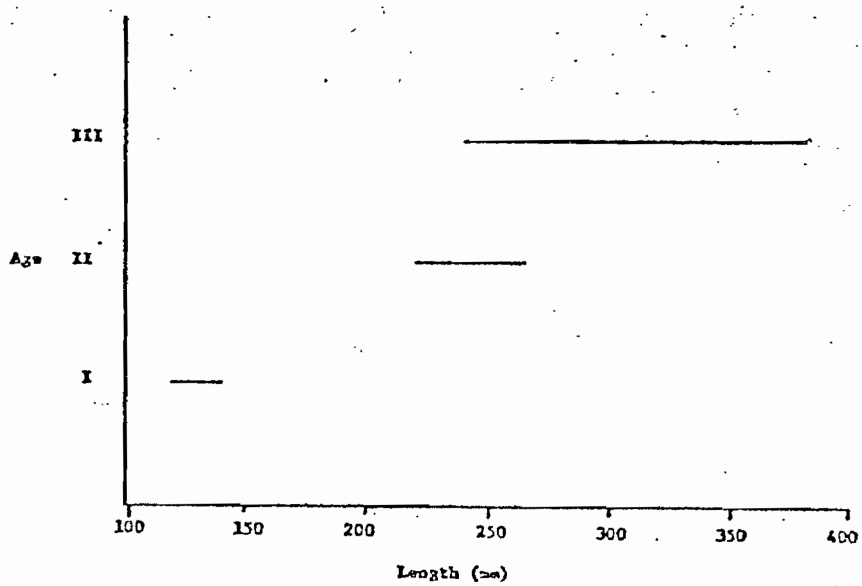


Table 5. West Side Susitna River Chinook Salmon Escapement, Devil's Canyon Project, 1975.

Stream		Helicopter Counts
Deshka River System		4,737
Alexander Creek System		1,878
Lake Creek System*		281
Talachulitna River *		120
Peters Creek*		14
Canyon Creek*		2
	Total	7,032

Table 6. East Side Susitna River Chinook Salmon Escapement, Devil's Canyon Project, 1975.

Stream	Helicopter Aerial Counts	Fixed Wing Aerial Counts	Ground Counts
Willow Creek	-	-	177
Little Willow Creek	103	-	-
Kashwitna River	33	-	-
Sheep Creek	-	42	-
Goose Creek	-	13	-
Montana Creek	-	-	229
Chunilna Creek*	101	-	-
East Fork Chulitna River*	-	7	-
Middle Fork Chulitna River*	-	55	-
Prairie Creek*	-	-	369
Indian River	-	31	-
Portage Creek	-	32	-
Total	237	180	775
Total All Counts			1,192

*Not a direct tributary to Susitna River; however, salmon must use the Susitna as a pathway to arrive at these rivers.

Benthic invertebrates were sampled during the summer season with eight artificial substrates (Tables 6 and 7). Substrates were placed in the mainstem Susitna River one mile upstream from the Deshka River, 100 yards upstream of Willow Creek, and immediately above Gold Creek. Waterfall Creek and Fourth of July Creek, which are clear water tributaries of the Susitna, were also sampled. All locations with the exception of Fourth of July Creek were sampled with two artificial substrates for a period of 30 days. Fourth of July Creek was sampled by hand holding a screen (36" x 36") and stirring the substrate immediately upstream. Aquatic insects collected in both the Susitna and tributaries are typical of clean cold water streams in Alaska. Due to the restricted time frame available for this study and report preparation, aquatic invertebrates are keyed only to family.

Limnology

The limnological study was initiated March 26, 1975 establishing sample sites on the Susitna River and all major east side tributaries from the Parks Highway Bridge downstream. Water samples were collected on a bi-weekly basis at the bridge crossings of each tributary. Parameters measured were water temperature, pH, turbidity, conductivity, total alkalinity, total hardness, and dissolved oxygen.

Temperatures were also monitored with Ryan Themographs (Model d-30^{o} F.) in the Susitna River, Birch Creek, and Willow Creek. It is interesting to note the similarity in temperature trends between the Susitna River and note the similarity in temperature trends between the Susitna River and tributaries (Figures 1, 2, and 3). For example, both the Susitna River and Willow Creek measured 32^{o} F. on April 1, 1975. A slow warming trend was observed in both rivers until May 14, 1975 when temperatures of both rivers were measured at approximately 34^{o} F. A steady upward trend occurs after May 15 until the maximum temperature was reached in mid-July. The maximum water temperature in the Susitna River was 55.5^{o} F. July 12, 1975. Willow Creek exhibited a maximum of 56^{o} F. during the period July 7 through July 10,1975. Maximum and minimum daily water temperatures monitored by the thermographs are presented in Tables 9 and 10. The temperature remained relatively stable in both rivers between July 15 and August 30, 1975, fluctuating between 48^{o} F. and 53^{o} F. The water temperature began to decrease by September 5, 1975 and was 45^{o} F. in both the Susitna River and Willow Creek on September 23, 1975 when the thermographs were removed.

East side tributaries of the Susitna River downstream from the Parks Highway Bridge do not have lake systems present, but are the result of surface and subsurface runoff from the surrounding mountains and foothills. Montana Creek, Sheep Creek, Goose Creek, Caswell Creek, Kashwitna River, and Little Willow Creek temperatures were taken biweekly and trends were consistent with measurements of the Susitna River and Willow Creek (Figures 4-11).

Birch Creek was selected as a thermograph site to collect temperature data on a creek draining a lake. Birch Creek is the outlet of Fish Lake and empties into the Susitna River upstream of the Parks Highway Bridge. It also differed from the tributaries downstream of the Parks Highway Bridge by having less gradient and volume. Temperatures were considerably warmer in Birch Creek, as suspected, reaching a high of 69^{o} F. on July 10, 1975 (Table 11). Lentic environments have the capacity to retain heat, resulting in different thermal patterns than lotic environments. Lakes also act as a buffer by stabilizing fluctuating flows. The thermal patterns and stabilized flows in the outlets of lakes benefit productivity.

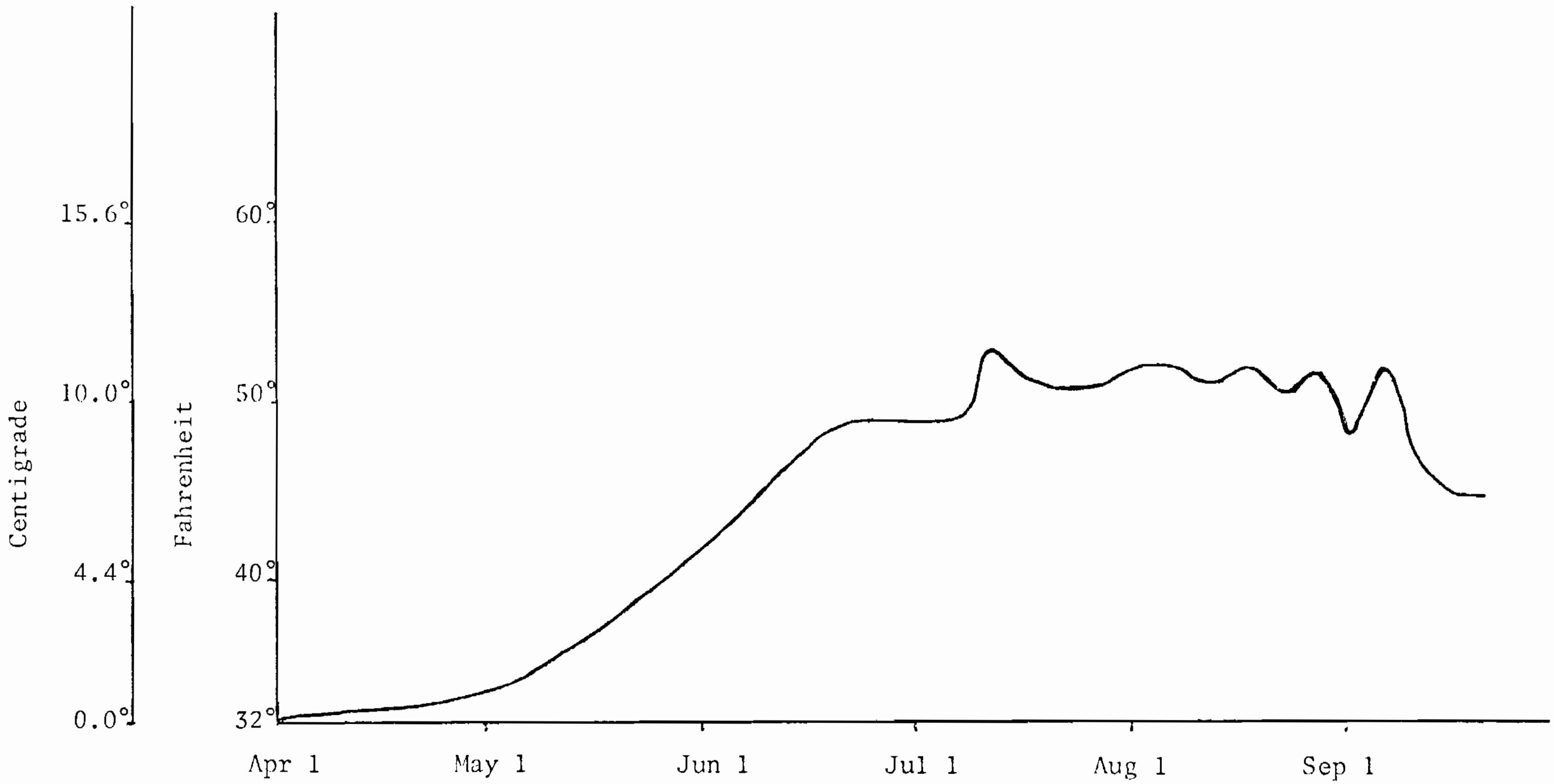
Table 7. Aquatic Invertebrates Collected in Clearwater Tributaries of the Susitna River, Devil Canyon Project, 1975.

Location	Order	Family	No.	Collection Method	Collection Dates
Fourth of July Creek	Trichoptera	Sericostomatidae	1	Hand Screen	Aug 13
		Rhyacophilidae	4		
		Rhyacophilidae	1		
	Dipteria		1		
	Plecoptera	Perlodidae	5		
		Perlodidae	7		
	Ephemeroptera	Heptageniidae	6		
		Baetidae	3		
	Turbellaria		1		
Waterfall Creek	Diptera	Type 1	6	Artificial Substrate basket (2)	Aug 7 - Sep 7
		Type 2	4		
		Type 3	1		
		Type 4	10		
		Type 5	2		
		Type 6	3		
	Plecoptera	Perlodidae	17		
	Ephemeroptera	Baetidae	1		
	Oligochaeta	Type 1	13		
		Type 2	1		
	Gastropoda		5		

Table 8. Aquatic Invertebrates Collected in Susitna River, Devil Canyon Project, 1975.

Location	Order	Family	No.	Collection Method	Collection Dates
Mainstem Susitna Upstream from Gold Creek	Trichoptera	Rhyacophilidae	1	Artificial Sub-strate basket (2)	Aug 7 - Sep 7
	Diptera	Type 1	3		
		Type 2	4		
	Plecoptera	Perlodidae	1		
		Perlodidae	5		
	Ephemeroptera	Baetidae	1		
	Olgochaeta		1		
Mainstem Susitna Upstream from Willow Creek	Tricoptera	Sericostomatidae	3	Artificial Sub-strate basket (2)	Jul 1 - Sep 1
	Diptera		2		
	Ephemeroptera	Heptageniidae	5		
		Baetodae	7		
	Plecoptera	Perlodidae	8		
Mainstem Susitna Upstream from Deshka River	Tricoptera	Sericostomatidae	1	Artificial Sub-strate basket (2)	Jul 1 - Aug 1
	Plecoptera	Perlodidae	11		
	Ephemeroptera	Heptageniidae	3		

Figure 1. Daily Water Temperatures (Monitored with a Ryan Thermograph) of the Susitna River Approximately Three Hundred Yards Downstream from the Parks Highway Bridge, Devils Canyon Project, June 20 to September 23, 1975.



Note: Temperatures taken prior to June 20th were with a thermometer on a bi-monthly basis.

Figure 2. Maximum Daily Water Temperatures (Monitored with a Ryan Thermograph) of Birch Creek Approximately Five Hundred Yards Upstream of the Alaska Railroad, Devil Canyon Project, April 10 to August 30, 1975.

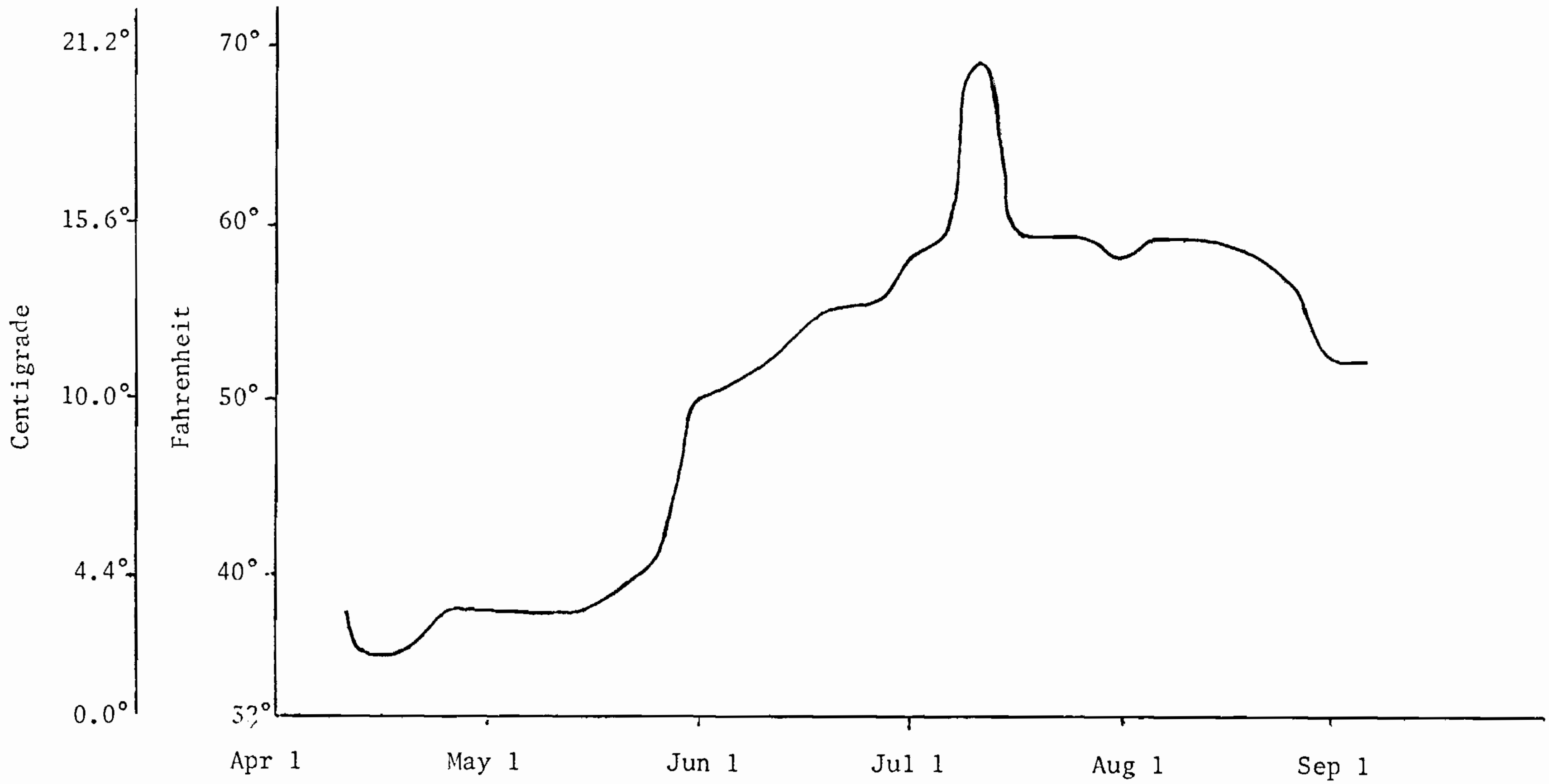


Figure 3. Maximum Daily Water Temperature (Monitored with a Ryan Thermograph) of Willow Creek Approximately Two Hundred Yards Upstream of the Confluence with Deception Creek, Devil Canyon Project, April 10 to September 23, 1975.

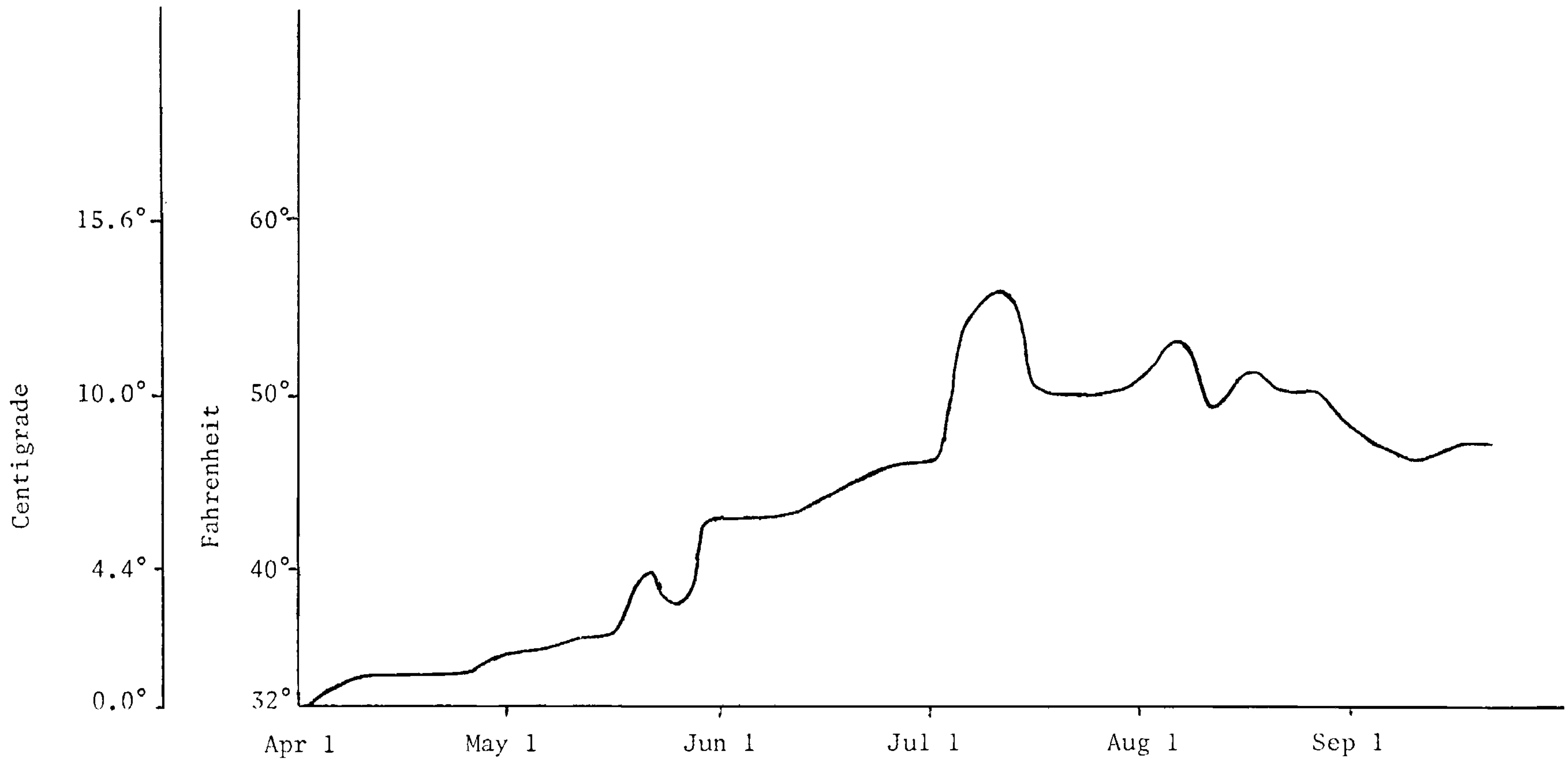


Table 9. Maximum and Minimum Daily Water Temperatures (°F-"Ryan" Thermograph, Model D-30) from the Susitna River at Parks Highway Bridge, Devil Canyon Project, 1975.

Date	Temperature Max.	Min.	Date	Temperature Max.	Min.	Date	Temperature Max.	Min.
Jun 20	49.0	-	Jul 22	51.5	51.0	Aug 23	53.0	-
21	49.0	-	23	51.5	-	24	53.0	52.0
22	49.0	48.0	24	51.5	-	25	52.0	-
23	47.8	47.8	25	51.0	-	26	52.0	-
24	48.8	47.8	26	52.0	51.0	27	52.0	-
25	49.0	-	27	52.0	-	28	52.0	50.0
26	49.0	-	28	52.0	51.5	29	50.0	48.0
27	49.0	-	29	51.5	-	30	48.0	-
28	50.0	49.0	30	51.5	51.0	31	48.0	-
29	50.0	-	31	51.0	-	Sep 1	48.0	-
30	50.0	49.0	Aug 1	52.0	51.0	2	53.0	48.0
Jul 1	49.0	-	2	52.0	-	3	53.0	49.0
2	49.0	-	3	52.0	-	4	52.0	48.0
3	49.0	-	4	52.0	-	5	52.0	49.0
4	49.0	-	5	52.0	51.0	6	50.0	48.0
5	49.0	-	6	51.0	-	7	48.0	-
6	50.0	49.0	7	51.0	-	8	48.0	-
7	51.0	50.0	8	51.0	-	9	47.5	-
8	52.0	51.0	9	51.0	-	10	47.0	-
9	54.0	52.0	10	51.0	-	11	47.0	-
10	55.0	54.0	11	51.0	-	12	47.0	-
11	55.0	-	12	52.0	-	13	46.0	-
12	55.5	54.0	13	52.0	-	14	46.0	45.0
13	54.0	53.0	14	52.0	-	15	45.0	-
14	53.0	51.5	15	52.0	-	16	45.0	-
15	51.7	-	16	52.0	-	17	45.0	-
16	51.7	50.5	17	52.0	51.0	18	45.0	-
17	52.0	51.0	18	50.5	-	19	45.0	-
18	52.0	-	19	50.5	-	20	45.0	-
19	52.0	51.0	20	50.5	-	21	45.0	-
20	51.0	-	21	50.5	-	22	45.0	-
21	51.0	-	22	53.0	-	23	45.0	-

TABLE 10. Maximum and Minimum Daily Water Temperatures (°F- Ryan Thermograph, Model D-30) from Willow Creek, Devil Canyon Project, 1975.

Date	Temperature Max.	Temperature Min.	Date	Temperature Max.	Temperature Min.	Date	Temperature Max.	Temperature Min.
Apr 10	34.0	-	Jun 5	43.0	37.0	Jul 31	50.0	-
11	34.0	-	6	43.0	39.0	Aug 1	51.0	50.0
12	34.0	-	7	44.0	38.0	2	52.0	51.0
13	34.0	-	8	44.0	39.0	3	52.0	51.0
14	34.0	-	9	44.0	38.0	4	53.0	51.0
15	34.0	-	10	43.0	38.0	5	53.0	-
16	34.0	-	11	43.0	39.0	6	51.0	-
17	34.0	-	12	44.0	38.0	7	51.0	50.0
18	34.0	-	13	44.0	38.0	8	50.0	-
19	34.0	-	14	45.0	40.0	9	50.0	-
20	34.0	-	15	44.0	40.0	10	49.0	48.0
21	34.0	-	16	44.0	-	11	49.0	-
22	34.0	-	17	44.0	-	12	49.0	-
23	34.0	-	18	44.0	-	13	49.0	-
24	34.0	-	19	44.0	-	14	51.0	49.0
25	34.0	-	20	45.0	44.0	15	51.0	-
26	35.0	-	21	44.0	43.0	16	51.0	49.0
27	35.0	-	22	43.0	-	17	50.0	-
28	35.0	-	23	45.0	43.0	18	50.0	-
29	35.0	-	24	45.0	-	19	50.0	-
30	35.0	-	25	46.0	45.0	20	50.0	-
May 1	35.0	-	26	50.0	46.0	21	50.0	-
2	35.0	-	27	52.0	46.0	22	50.0	-
3	35.0	-	28	47.0	-	23	50.0	-
4	35.0	-	29	46.0	-	24	50.0	-
5	35.0	-	30	46.0	-	25	50.0	-
6	35.0	-	Jul 1	48.0	46.0	26	50.0	-
7	36.0	35.0	2	48.0	-	27	52.0	50.0
8	38.0	35.0	3	47.0	46.0	28	48.0	-
9	36.0	-	4	51.0	46.0	29	48.0	-
10	36.0	35.0	5	54.0	49.0	30	48.0	-
11	35.0	-	6	54.0	50.0	31	47.0	-
12	34.0	-	7	56.0	52.0	Sep 1	48.0	47.0
13	34.0	-	8	56.0	52.0	2	48.0	-
14	34.0	-	9	56.0	53.0	3	48.0	-
15	36.0	35.0	10	56.0	54.0	4	48.0	-
16	36.0	35.0	11	55.0	52.0	5	47.0	44.0
17	36.0	-	12	51.0	49.0	6	44.0	-
18	36.0	-	13	51.0	49.0	7	44.0	42.0
19	39.0	36.0	14	51.0	-	8	44.0	42.0
20	40.0	35.0	15	50.0	48.0	9	44.0	42.0
21	38.0	35.0	16	52.0	48.0	10	44.0	42.0
22	38.0	36.0	17	52.0	-	11	43.0	-
23	42.0	37.0	18	52.0	51.0	12	45.0	40.0
24	42.0	39.0	19	51.0	49.0	13	44.0	40.0
25	38.0	36.0	20	50.0	49.0	14	43.0	41.0
26	42.0	36.0	21	49.0	-	15	45.0	43.0
27	40.0	36.0	22	49.0	-	16	44.0	-
28	43.0	37.0	23	50.0	49.0	17	44.0	-
29	42.0	36.0	24	50.0	-	18	44.0	-
30	42.0	36.0	25	50.0	-	19	43.0	-
31	46.0	35.0	26	50.0	-	20	45.0	43.0
Jun 1	43.0	38.0	27	52.0	50.0	21	44.0	43.0
2	42.0	40.0	28	52.0	-	22	45.0	43.0
3	42.0	38.0	29	51.0	-	23	45.0	44.0
4	42.0	38.0	30	50.0	-			

Table 11. Maximum and Minimum Daily Water Temperatures (°F-"Ryan" Thermograph, Model D-30) from Birch Creek, Devil Canyon Project, 1975.

Date	Temperature Max.	Temperature Min.	Date	Temperature Max.	Temperature Min.	Date	Temperature Max.	Temperature Min.
Apr 11	38.0	-	May 29	47.0	46.0	Jul 15	59.0	-
12	38.0	36.0	30	47.0	46.0	16	59.0	-
13	37.0	35.0	31	48.0	46.0	17	59.0	-
14	35.0	-	Jun 1	50.0	48.0	18	59.0	-
15	35.7	35.0	2	51.0	-	19	59.0	-
16	35.5	-	3	51.0	-	20	59.0	-
17	35.5	-	4	51.0	-	21	59.0	57.0
18	35.7	35.0	5	51.0	50.0	22	60.0	59.0
19	36.0	34.0	6	51.0	50.0	23	60.0	-
20	36.0	34.0	7	51.0	-	24	60.0	59.0
21	36.0	34.5	8	51.0	-	25	59.0	-
22	37.0	35.0	9	51.0	50.0	26	60.0	59.0
23	38.0	35.0	10	52.0	51.0	27	60.0	-
24	38.0	36.0	11	54.0	52.0	28	60.0	58.0
25	37.0	36.0	12	54.0	-	29	58.0	-
26	37.0	36.0	13	54.0	52.0	30	58.0	-
27	37.0	36.0	14	54.0	-	31	58.0	-
28	38.0	36.0	15	54.0	-	Aug 1	60.0	58.0
29	38.0	36.0	16	54.0	-	2	59.0	57.0
30	38.0	37.0	17	54.0	-	3	56.0	-
May 1	38.1	36.3	18	54.0	-	4	60.0	56.0
2	39.0	36.0	19	54.0	-	5	59.0	58.0
3	40.0	38.0	20	55.0	-	6	59.0	-
4	38.0	-	21	56.0	55.0	7	59.0	-
5	38.0	-	22	55.0	54.0	8	59.0	-
6	39.0	37.0	23	54.0	53.0	9	out of order	
7	38.0	36.2	24	55.0	53.0	10	out of order	
8	38.3	37.0	25	55.0	-	11	out of order	
9	38.8	38.0	26	59.0	55.0	12	out of order	
10	38.0	-	27	59.0	57.0	13	out of order	
11	38.0	-	28	60.0	58.0	14	out of order	
12	38.0	-	29	60.0	58.0	15	out of order	
13	38.0	-	30	58.0	57.0	16	out of order	
14	38.0	-	Jul 1	58.0	57.0	17	out of order	
15	38.0	-	2	58.0	56.0	18	out of order	
16	38.0	-	3	59.0	56.0	19	out of order	
17	39.0	-	4	60.0	59.0	20	out of order	
18	39.0	-	5	59.0	-	21	out of order	
19	39.0	-	6	62.0	59.0	22	58.0	-
20	39.5	-	7	62.0	-	23	58.0	57.0
21	40.0	-	8	64.0	62.0	24	57.0	56.0
22	40.0	-	9	66.0	63.0	25	56.0	-
23	41.0	40.0	10	69.0	66.0	26	56.0	-
24	41.0	-	11	68.0	-	27	56.0	53.0
25	41.0	-	12	68.0	64.0	28	53.0	52.0
26	41.0	-	13	64.0	61.0	29	53.0	52.0
27	43.0	41.0	14	61.0	59.0	30	52.0	-
28	45.0	43.0						

The highest, lowest and mean values of limnological data collected from the Susitna River and east side tributaries downstream of the Parks Highway Bridge are presented in Table 12.

A more detailed analysis can be made by referring to Figures 4 through 11, which represent the six limnological characterisitcs measured in the Susitna River and seven east side tributaries.

Hydrogen ion concentration in the tributaries exhibited a tendency to rise during the summer (Figures 4 through 11). A similar rise is also evident in the hydrogen ion data collected from the Susitna River at the Parks Highway Bridge.

Total alkalinity, represented in Figures 4 through 11, exhibited an overall rise throughout the summer months; except in the Kashwitna River, which demonstrates a less distinct increase. The highs and lows varied depending upon the tributary (Table 12), although the maximum limits in all cases were no greater than 86 mg/l $CaCO_3$. It appears the lower Susitna River has a greater total alkalinity than its tributaries.

Hardness, (Figures 4 through 11) shows a decrease from the end of March to the middle of May. For example, it dropped from 85 mg/l $CaCO_3$ to 17 mg/l $CaCO_3$ at Caswell Creek. This drop, in all seven lower Susitna River tributaries, appears to have occurred just as the waters began to warm significantly. As summer progressed, it appears the hardness of these waters remained relatively low and stable. The relative stability reflected in Susitna River tributarial waters during the months of July and August is evident in information presented in Figure 4. These comparisons demonstrate a constant 51 mg/l $CaCO_3$ through July and August, whereas the relative stability of tributarial waters ranges between 17 and 34 mg/l $CaCO_3$. It would appear the tributarial waters have a consistently lesser degree of hardness than the Susitna River waters with the same relatively low summertime constancy. Tributaries exhibited high late winter hardness levels.

Conductivity measurements for the seven east side lower Susitna tributaries (Figures 4 through 11) all reflect a similar decrease from late winter to early summer with 28 umhos/cm reflecting the average low and 107 umhos/cm reflecting the average high. Once the minimum specific conductance is reached from the middle of May to the middle of June, a general rise in conductance is observed during the summer months. Samples collected on June 27, reflect an abnormally high increase in specific conductance, which may be attributed to extreme heavy rains prior to or during sample collection. The Susitna River displays a substantially higher specific conductance than that of the seven east side tributaries and a general increase from early June through August.

There appears to be no consistent trend in turbidity in all seven east side Susitna River tributaries under investigation. Both the Kashwitna River and Caswell Creek demonstrated an increase in turbidity from mid-April to mid-August. This increase was significantly greater in the Kashwitna River because of its glacial origin. However, there was a high degree of fluctuation in turbidity in both streams. A similar fluctuation was demonstrated in the remaining five tributaries, i.e., Montana, Goose, Sheep, Little Willow and Willow creeks (Figures 4 through 11). This high variability in turbidity can, in all likelihood, be attributed to precipitation.

TABLE 12. Highest, Lowest and Mean Values of Limnological Data Collected From The Susitna River and Seven Tributaries of the Susitna River.

Tributary	Time Period Collected 1975	Water Temperature (C)			Conductivity (µmhos/cm)			Turbidity (JTU)			pH			Total Alkalinity (mg/l-CaCO3)			Hardness (mg/l-CaCO3)		
		High	Low	Mean	High	Low	Mean	High	Low	Mean	High	Low	Mean	High	Low	Mean	High	Low	Mean
Susitna River at Parks Highway Bridge	3/26 - 8/18	13.0	0.0	8.2	210	74	126	185	35	105	8.5	7.5	7.9	103	34	48	120	51	105
Montana Creek	3/26 - 8/18	14.5	0.0	8.2	105	27	48	27	0.3	4.9	7.5	6.7	7.2	68	17	31	51	17	25
Goose Creek	4/4 - 8/18	12.0	0.0	7.3	77	27	43	64	0.3	9.4	7.7	6.7	7.1	68	17	34	34	17	24
Sheep Creek	4/4 - 8/18	14.0	0.0	7.7	80	30	46	31	1.0	4.3	7.6	6.6	7.1	68	17	37	51	17	31
Caswell Creek	5/14 - 8/18	16.5	0.0	10.6	175	30	62	28	1.0	5.1	7.6	6.6	7.2	68	17	42	86	17	36
Kashwitna River	4/24 - 8/18	13.0	6.5	8.9	77	37	53	110	2.0	38	7.6	6.9	7.3	51	17	39	68	17	37
Little Willow Creek	4/24 - 8/18	14.0	0.0	6.8	73	20	41	15	1.2	2.8	7.5	6.6	7.0	86	17	38	51	17	27
Willow Creek	3/26 - 8/18	14.0	0.0	6.7	160	26	73	20	0.5	3.6	7.7	6.6	7.2	51	17	39	60	17	37

Note: This data was collected biweekly from each of the tributaries during the time frame indicated. This is general information only, a more detailed analysis can be made by referring to Figures 4 through 11.

Turbidity in the Susitna River was relatively low at 55 Jackson turbidity units during May and June (Figure 4). On July 7 a substantial rise to 170 J.T.U. was measured and a peak of 185 J.T.U. was reached on August 18, 1975. The maximum reading for east side tributaries below the Parks Highway Bridge was 110 J.T.U. in the Kashwitna River on August 18, 1975.

Data collected by the U.S. Geological Survey on three Susitna River east side tributaries provides a limited means with which to compare data collected in this study between March and September, 1975, (Table 13).

With respect to Montana Creek, the available figures would tend to support temperature, pH, hardness and specific conductance as determined in the field during the summer of 1975. Sheep Creek figures cannot be compared due to the time frame in which the one set of data was collected. With respect to Caswell Creek, temperature and specific conductance are the only parameters which fall closely within the range of U.S. Geological Survey data. Hardness and pH are significantly different from more recently collected data.

The base camp was relocated from the Deshka River upstream to Gold Creek on August 6, 1975 to collect limnological data on the Susitna River and tributaries closer to the proposed dam site.

Data collected at four tributaries, i.e., Fourth of July, Gold, and Portage creeks, and Indian River, are shown in Table 16. Because only a single sample was collected, no trends are observable. One tributary, Gold Creek, does differ from the remaining tributaries, however, in that it reflected a significantly higher pH, total alkalinity, and hardness. No fish populations were found in Gold Creek other than a few grayling, at the mouth. A probable reason for the absence of fish is a placer gold mining operation approximately 6.5 miles up the Gold Creek Canyon. Findings for Fourth of July Creek, Indian River, and Portage Creek are within the range of parameters investigated on the lower portion of the Susitna River tributaries.

Chemical and physical parameters collected at two locations along the Susitna River at Portage Creek and Gold Creek are presented in Tables 17 and 18. All data were collected on four different days and will be valuable for future comparative analysis. Hardness and total alkalinity may be consistent within specified limits at both Gold Creek and Portage Creek.

Conductivity, in many previous cases, tended to increase over the spring and summer months; although later winter-early spring findings have demonstrated an unusually high specific conductance. This same apparent trend appears true for the Susitna River at Sunshine, although data is limited.

The freshwater sloughs adjacent to the Susitna River, as identified by Barrett (1974) and Friese (1975) between Talkeetna and Portage Creek are important salmonid habitat. These sloughs are used for both spawning and rearing and could be greatly affected by changes in the flow regime.

Table 19 is a compilation of field investigations reflecting the limnological data collected on sloughs 8 through 21, along the Susitna River from August 7 through 14. In all cases, except slough 12, there were fish fry

TABLE 13. A Compilation of U.S. Geological Survey Limnological Data of Specific Concern, Collected From Susitna River Tributaries.

Name of Tributary	Date	Water Temperature (C)	Specific Conductance (umhos/cm)	Discharge (cfs)	Suspended Sediment	Suspended Sediment Discharge (Tons/Day)	pH	Nitrate (mg/l-NO_3)	Hardness (mg/l-$CaCO_3$)	Dissolved Ortho-Phosphate (mg/l-P)	Dissolved Nitrate & Nitrite (mg/l-NO_2&NO_3)
Montana Creek	7/1/71	7.0	24	2,280	205	1,260	-	-	-	-	-
	8/9/71	9.5	24	3,500	183	1,750	-	-	-	-	-
	9/17/71	8.5	43	376	2	20	7.2	1.00	15	-	-
	8/11/72	16.5	47	182	-	-	7.4	-	17	.00	.05
	9/26/72	4.5	37	606	-	-	6.3	-	13	.11	.03
Sheep Creek	3/4/72	-	63	-	-	-	7.5	0.36	25	-	-
Caswell Creek	9/8/72	13.5	54	23	-	-	6.8	-	20	.05	.00
	9/26/72	4.0	51	31	-	-	7.2	-	19	.02	.00

Table 14. Water Quality Analysis of Samples by the U.S. Geological Survey Central Laboratory in Salt Lake City, Utah. Collected March 25, 1975 from the Susitna River at Sunshine.

Alk, Tot (as $CaCO_3$)	mg/l	71	NO_2+NO_3 as N Diss	mg/l	0.21
Bicarbonate	mg/l	86	Phos Ortho Dis as P	mg/l	0.04
Calcium Diss	mg/l	29	Phosphate Dis Ortho	mg/l	0.12
Chloride Diss	mg/l	21	Potassium Diss	mg/l	2.1
Color		0	Residur Dis Cacl Sum	mg/l	137
Conductivity		242	Residue Dis Ton/Aft		0.19
Fluoride Diss	mg/l	0.2	Residue Dis 180C	mg/l	141
Hardness Noncarb	mg/l	20	Sar		0.5
Hardness Total	mg/l	91	Silica Dissolved	mg/l	9.2
Iron Dissolved	ug/l	10	Sodium Diss	mg/l	11
Magnesium Diss	mg/l	4.5	Sodium Percent		20
Manganese Dissolved	ug/l	0	Sulfate Diss	mg/l	17
Nitrogen NHf as N tot	mg/l	0.05	Nitrogen Tot Org N	mg/l	0.18
Nitrogen Tot as N	mg/l	0.42	Nitrogen Tot KJD as N	mg/l	0.23
Nitrogen Tot as NO_3	mg/l	1.9	NO_2+NO_3 as N Tot	mg/l	0.19
			Phosphorus Tot as P	mg/l	0.01

Cations	mg/l	meq/l	Anions	mg/l	meq/l
Calcium Diss	29	1.448	Bicarbonate	86	1.410
Magnesium Diss	4.5	0.371	Chloride Diss	21	0.593
Potassium Diss	2.1	0.054	Fluoride Diss	0.2	0.011
Sodium Diss	11	0.479	Sulfate Diss	17	0.345
			NO_2+NO_3 as N D	0.21	0.015
Total		2.349	Total		2.381

Table 15. Compiled Data of Interest Collected by U.S. Geological Survey from the Susitna River at Sunshine.

Date	pH	Specific Conductance (umhos/cm)	Suspended Sediment (mg/l)
7/2/71	7.5	138	1,040
7/2/71	7.5	131	1,140
8/11/71	9.0	170	3,510

Figure 4. Limnological Data Collected from the Susitna River at the Parks Highway Bridge, March 26 to August 18, Devil's Canyon Project, 1975.

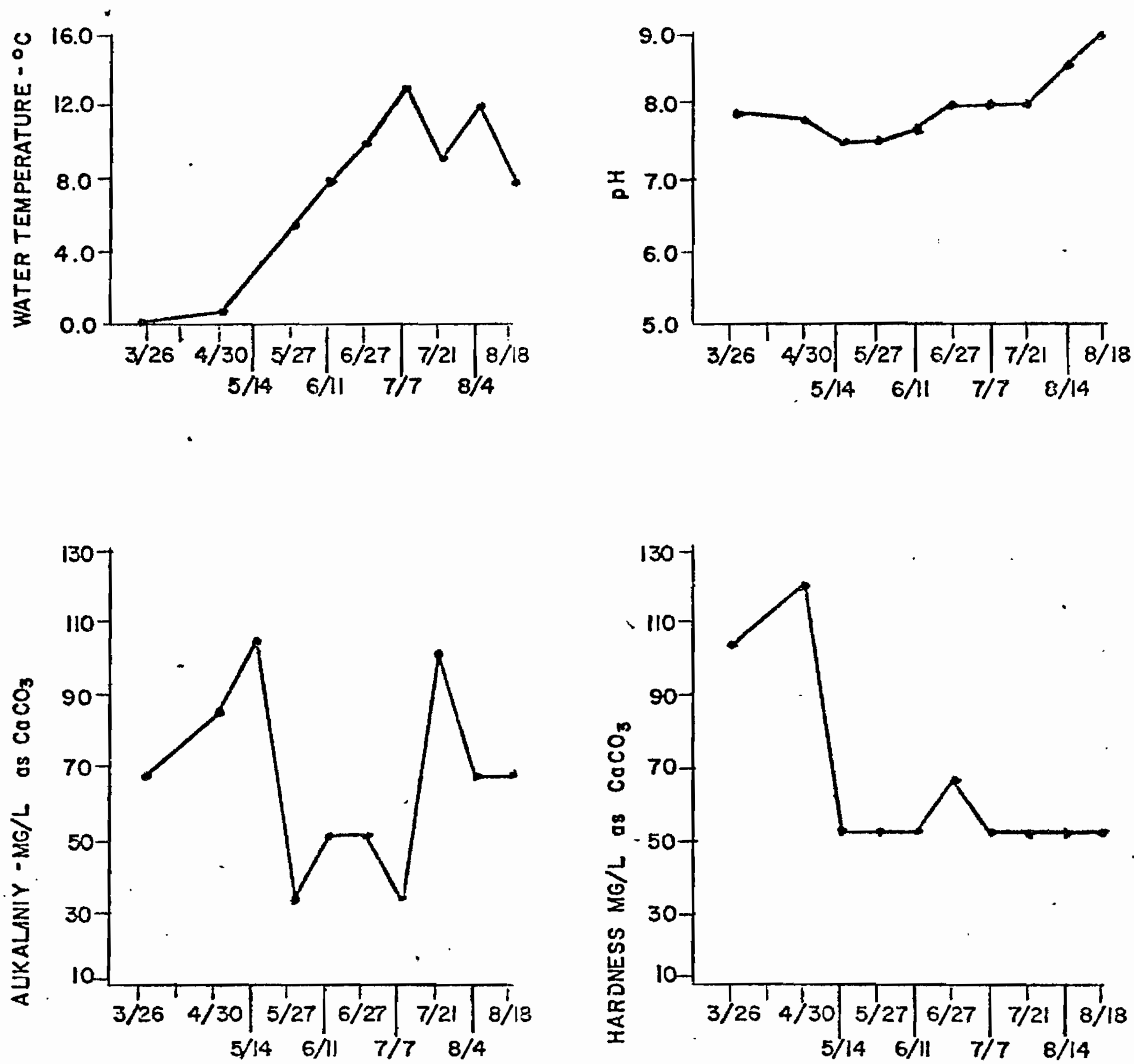
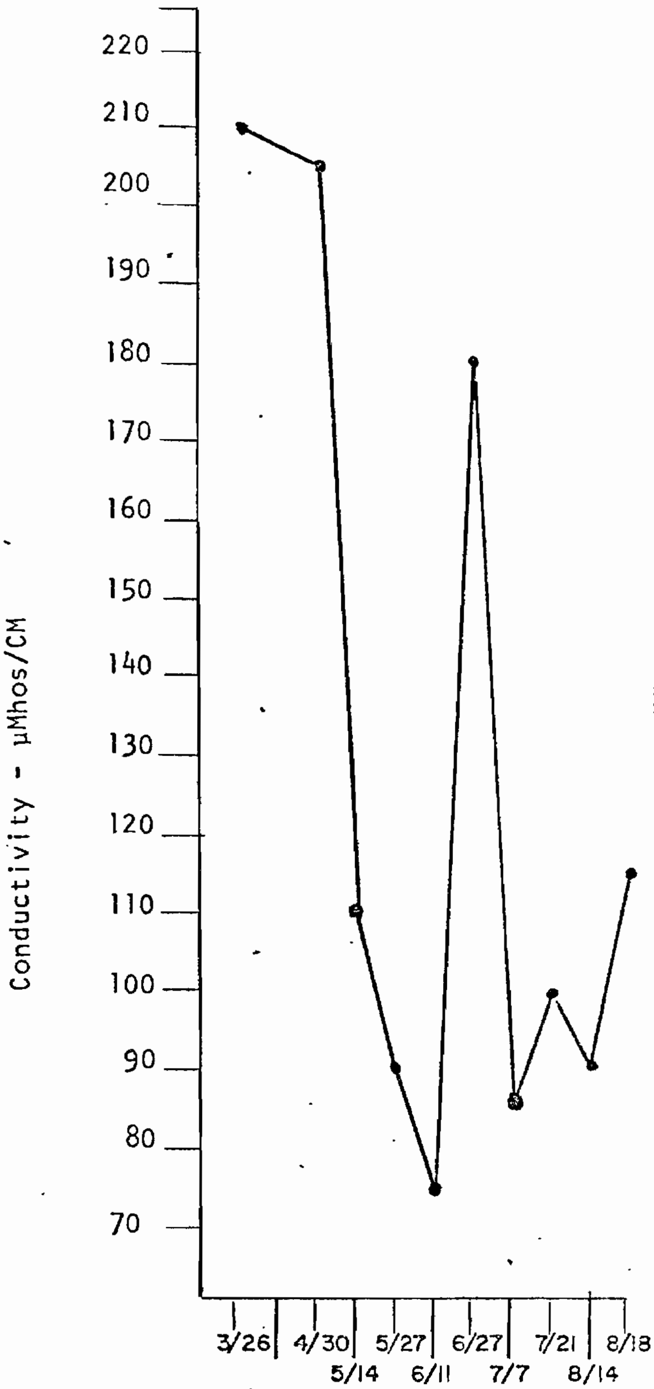


Figure 4. (Cont.) Limnological Data Collected from the Susitna River at the Parks Highway Bridge, March 26 to August 18, Devil's Canyon Project, 1975.



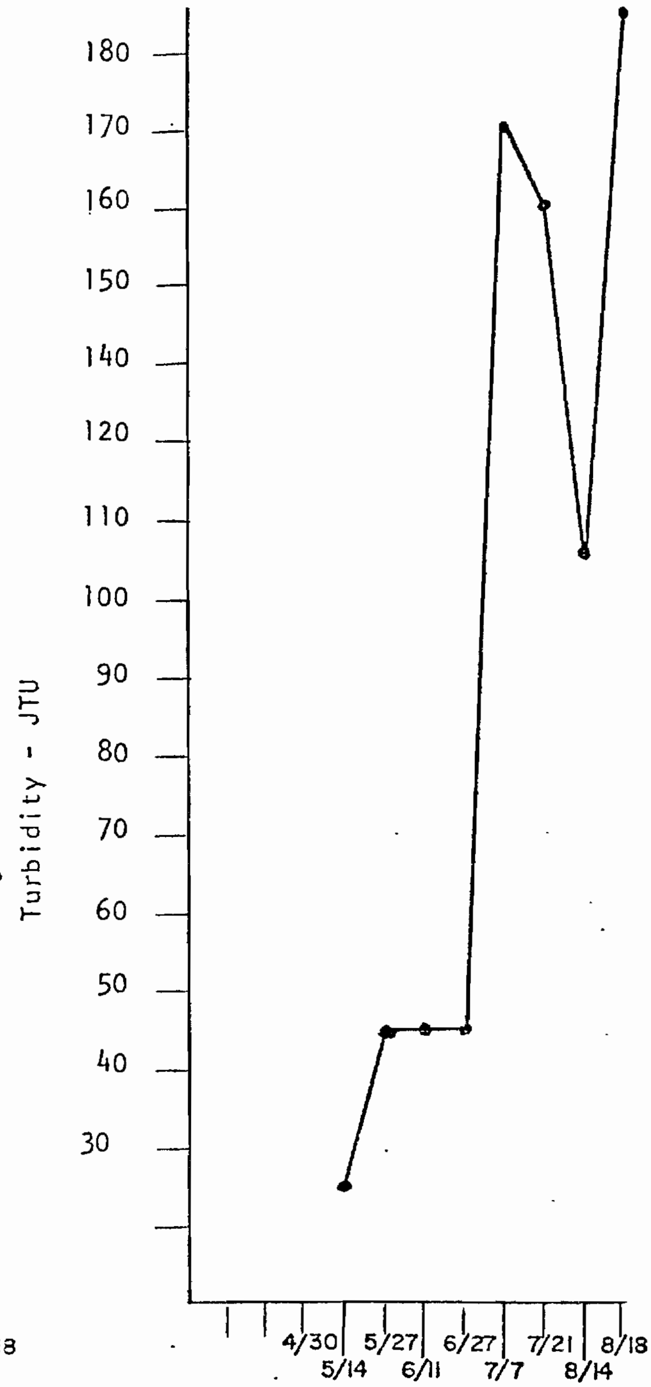


Fig. 5. Limnological Data Collected from Montana Creek at the Highway Bridge, March 26 to August 18, Devil's Canyon Project, 1975.

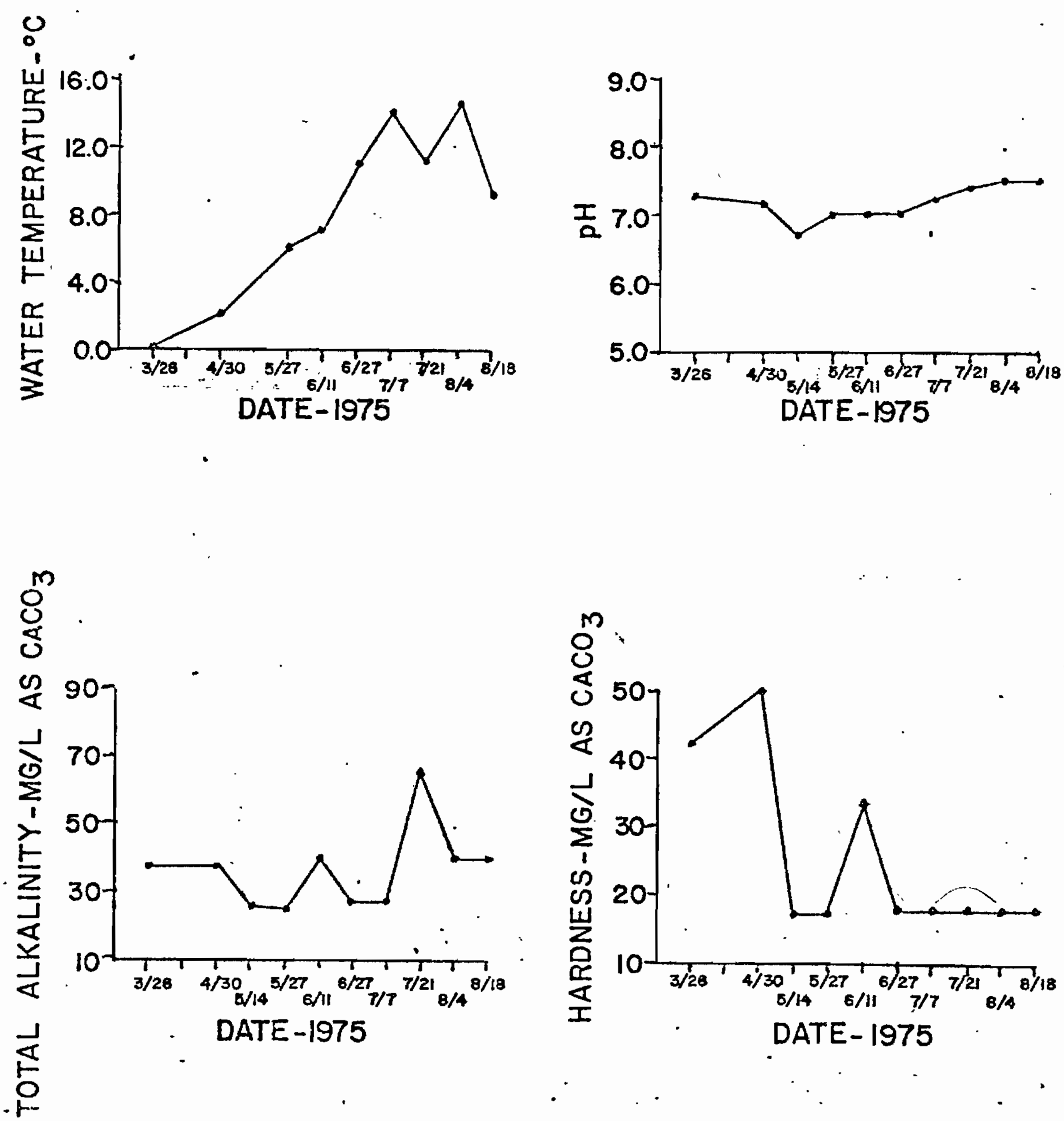
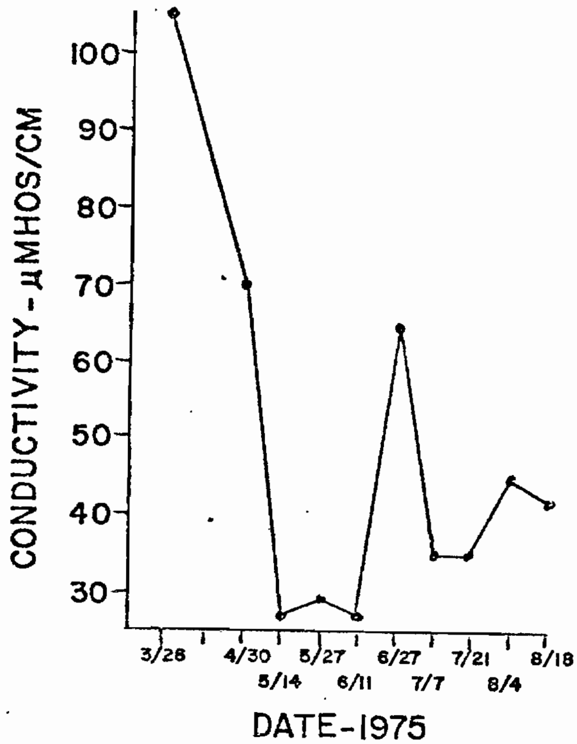


Fig. 5. (Cont). Limnological Data Collected from Montana Creek at the Highway Bridge, March 26 to August 18, Devil's Canyon Project, 1975.



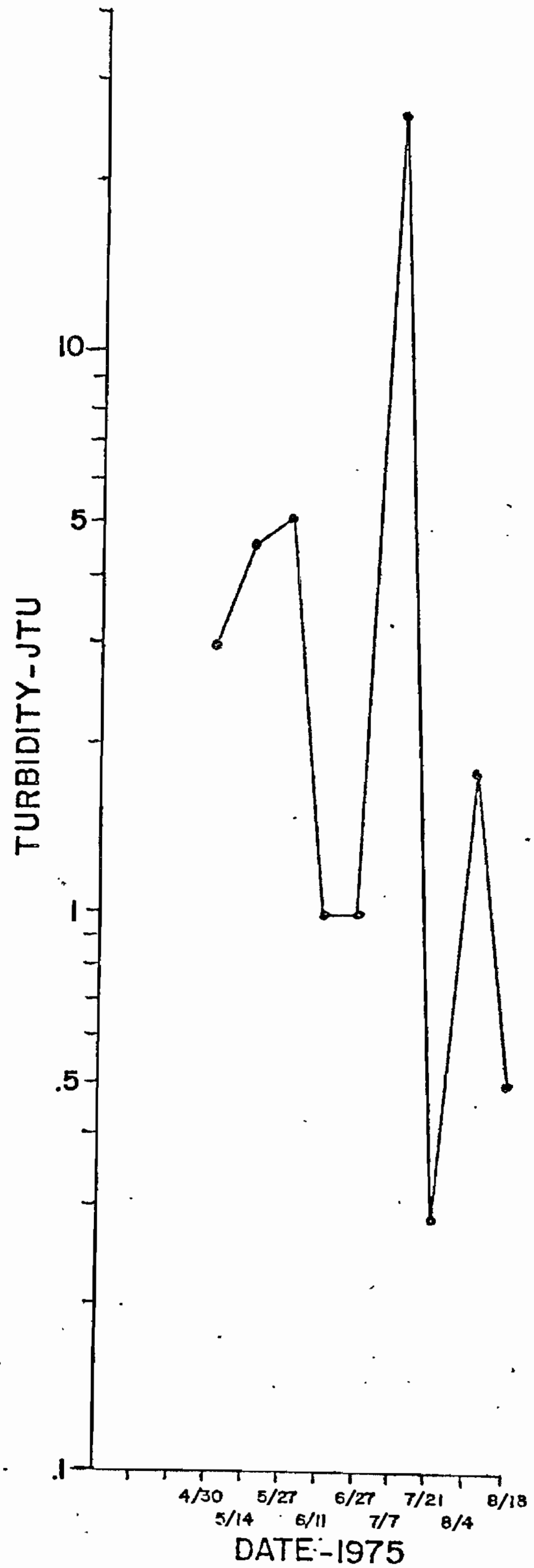


Fig. 6. Limnological Data Collected from Sheep Creek at the Bridge, March 4 Through August 18, Devil's Canyon Project, 1975.

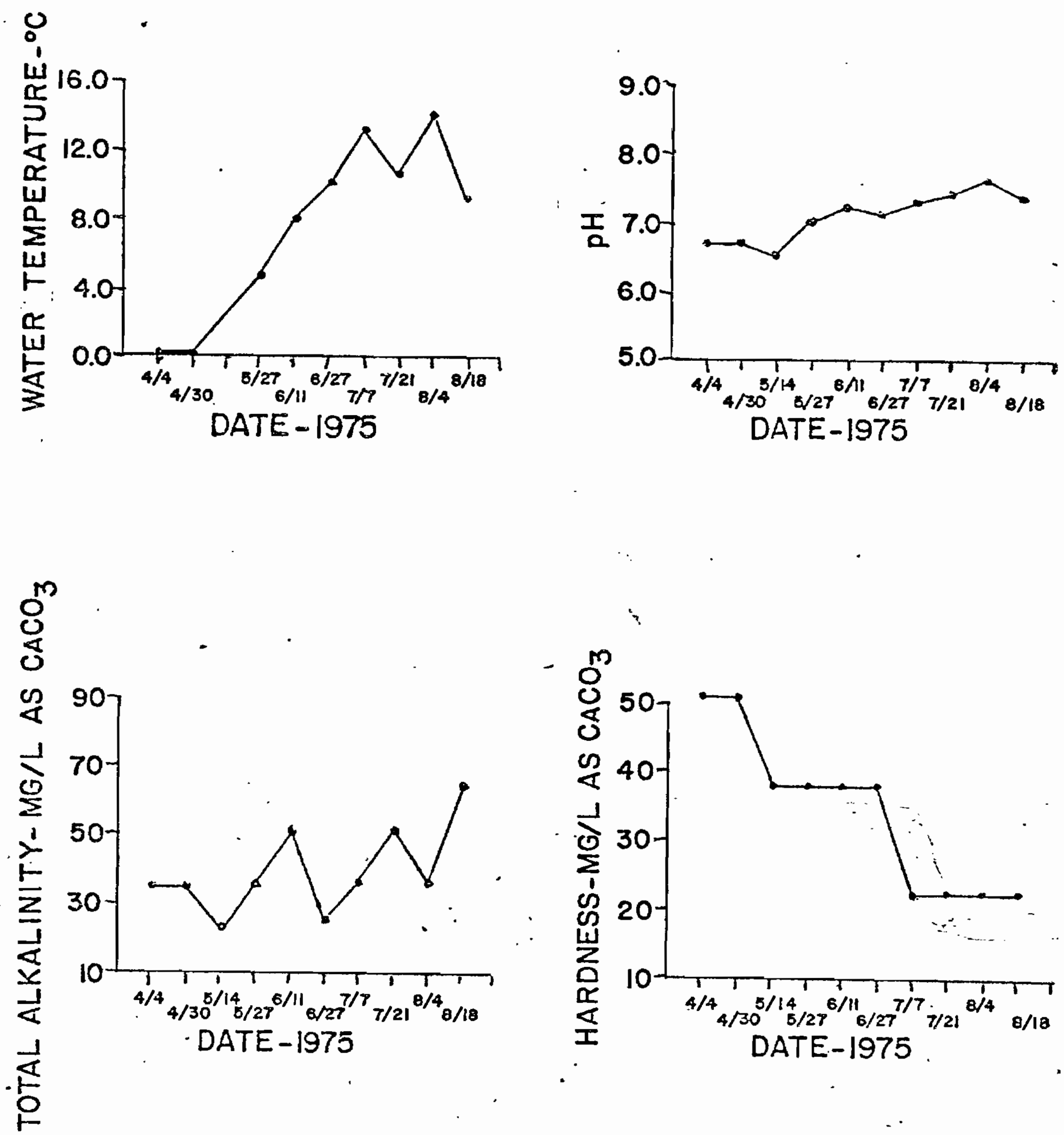
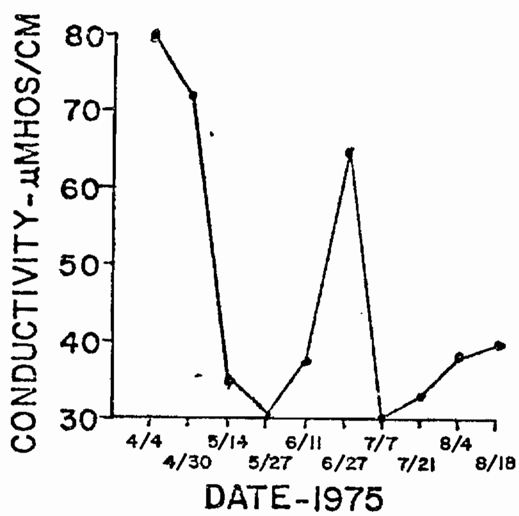


Fig. 6. (Cont). Limnological Data Collected from Sheep Creek at the Bridge, March 4 Through August 18, Devil's Canyon Project, 1975.



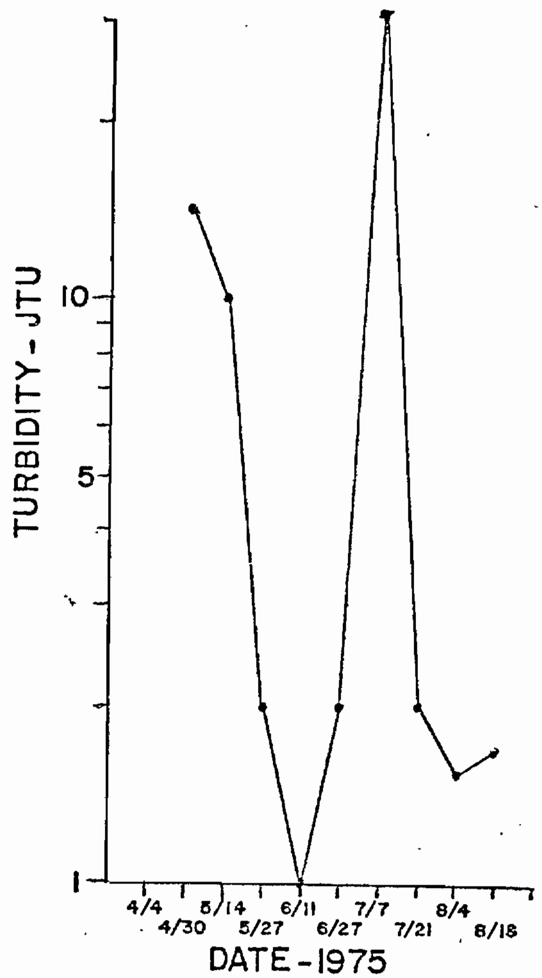


Fig. 7. Limnological Data Collected from Goose Creek at the Bridge, March 4 Through August 18, Devil's Canyon Project, 1975.

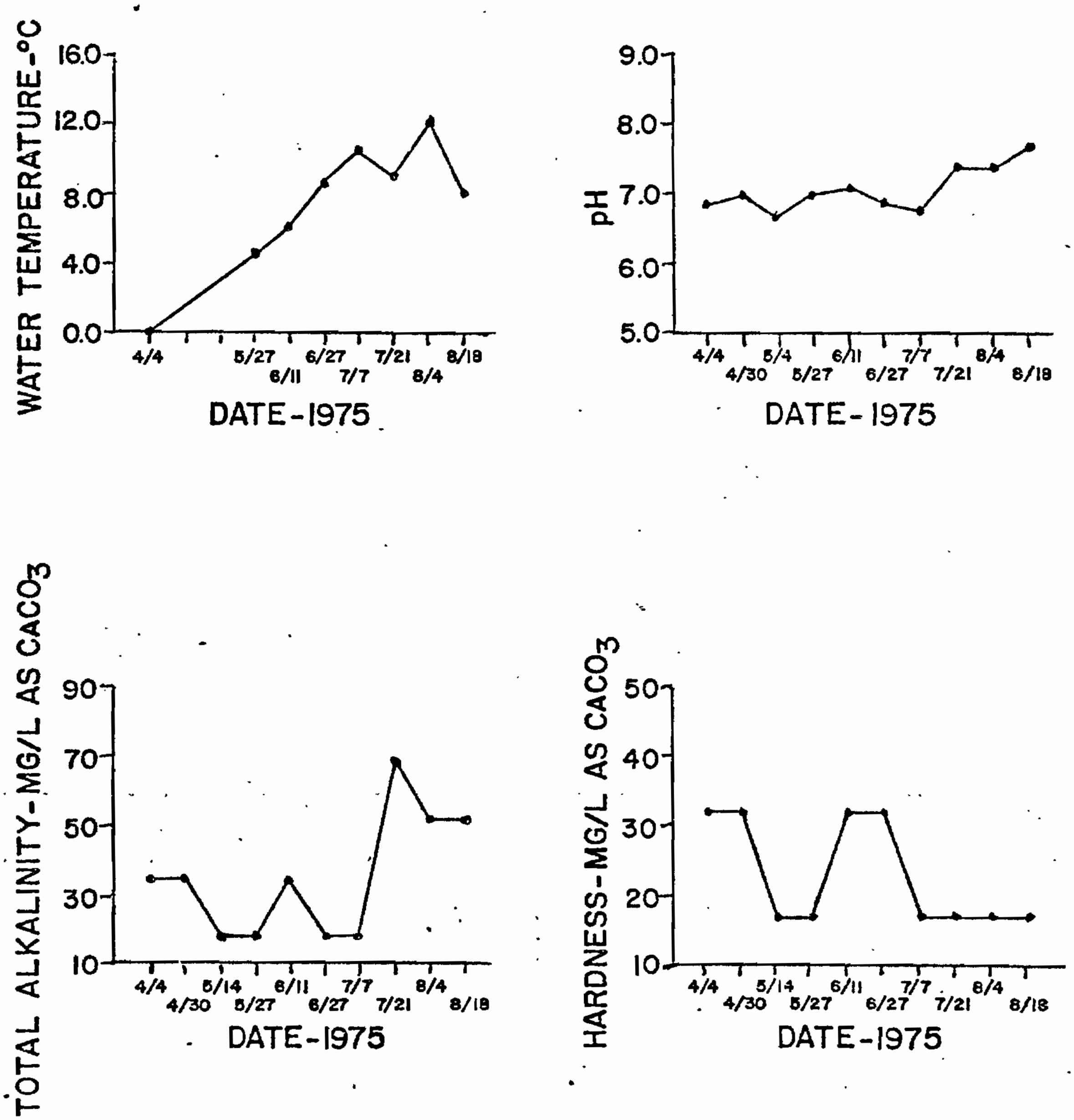


Fig. 7. (Cont). Limnological Data Collected from Goose Creek at the Bridge, March 4 Through August 18, Devil's Canyon Project, 1975.

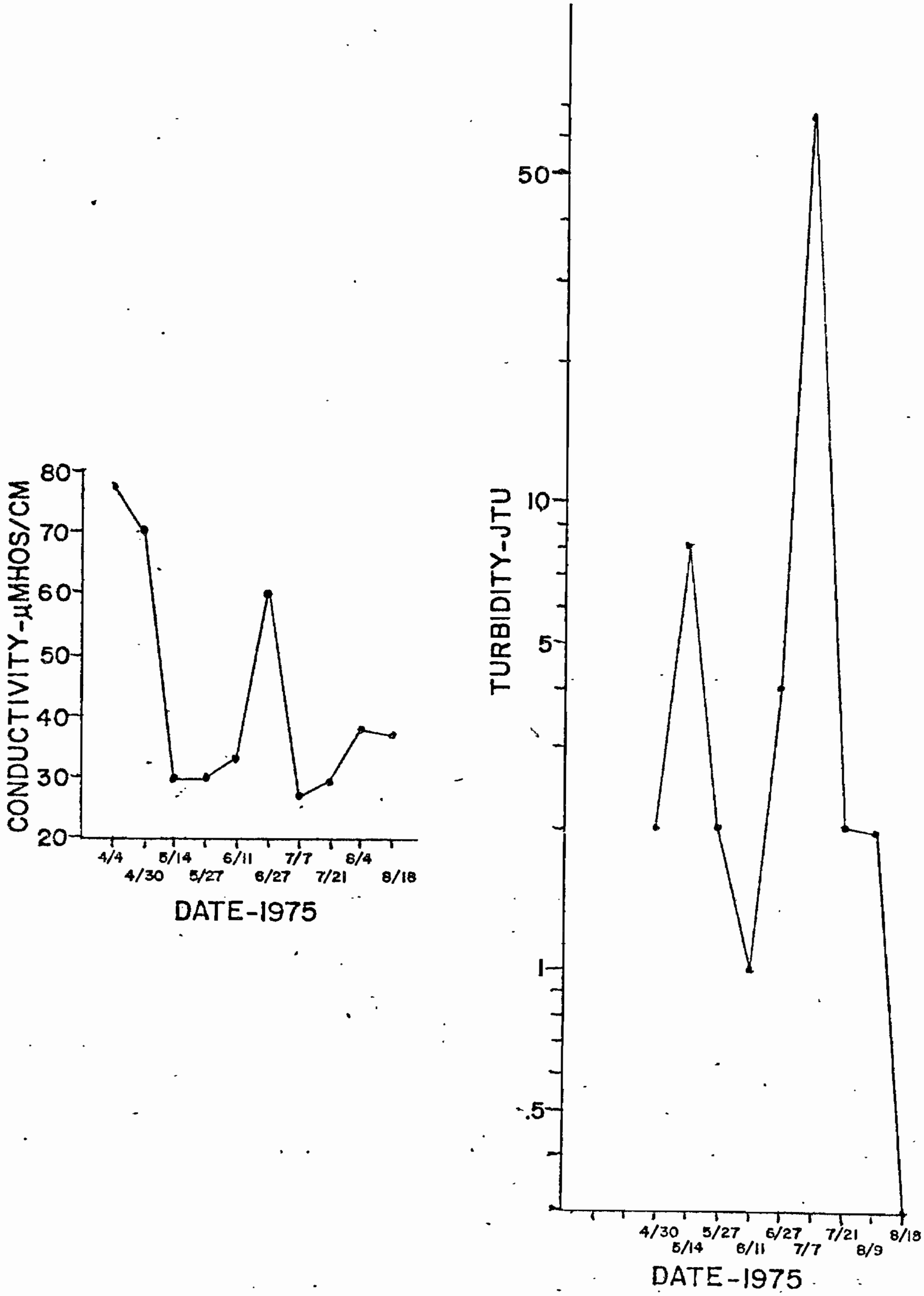


Fig. 8. Limnological Data Collected from Caswell Creek at the Bridge, March 26 Through August 18, Devil's Canyon Project, 1975.

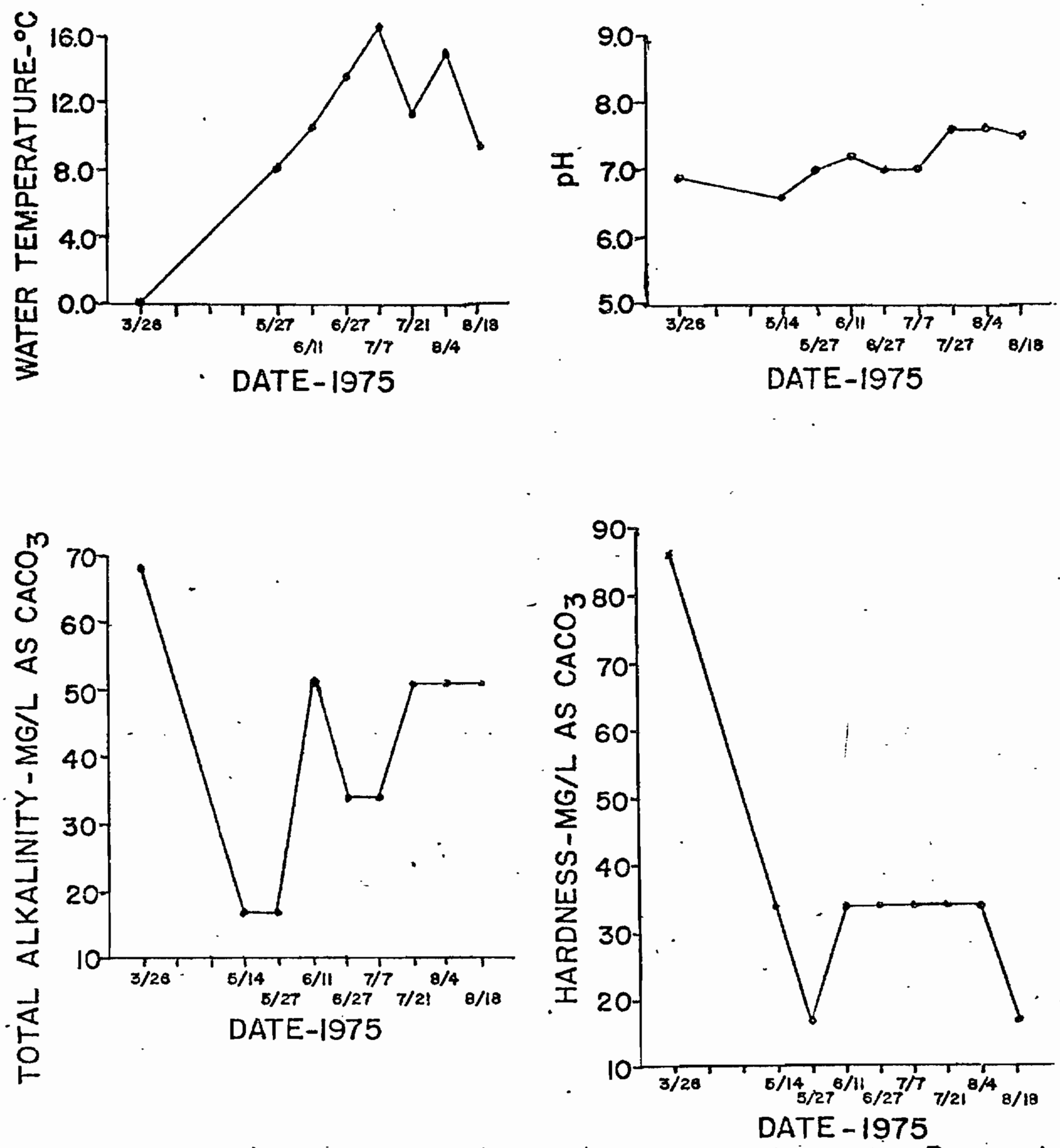
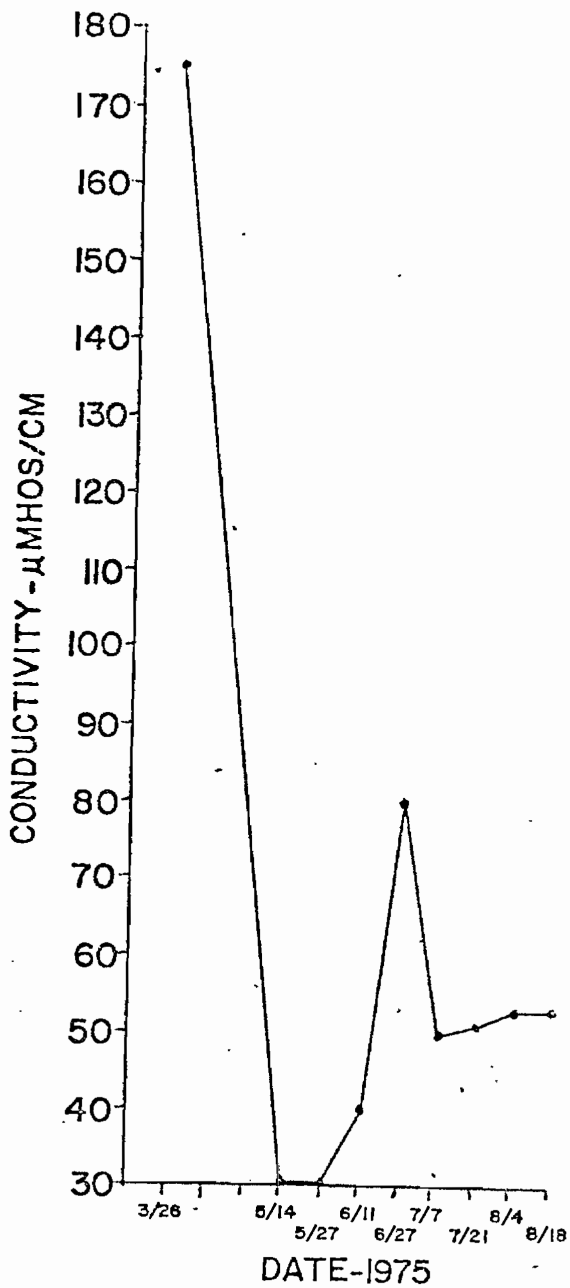


Fig. 8. (Cont). Limnological Data Collected from Caswell Creek at the Bridge, March 26 Through August 18, Devil's Canyon Project, 1975.



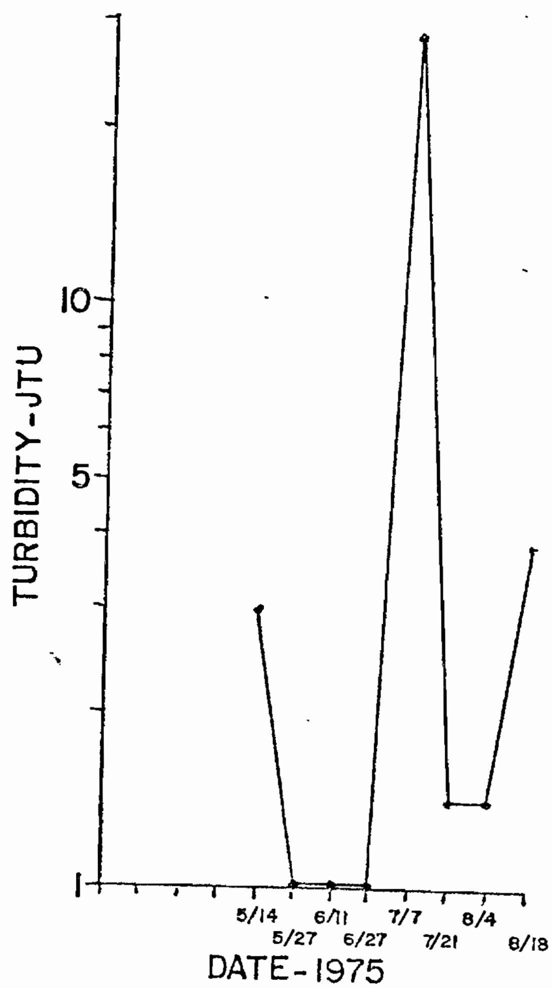


Fig. 9. Limnological Data Collected from the Kashwitna River at the Bridge, April 24 Through August 18, Devil's Canyon Project, 1975.

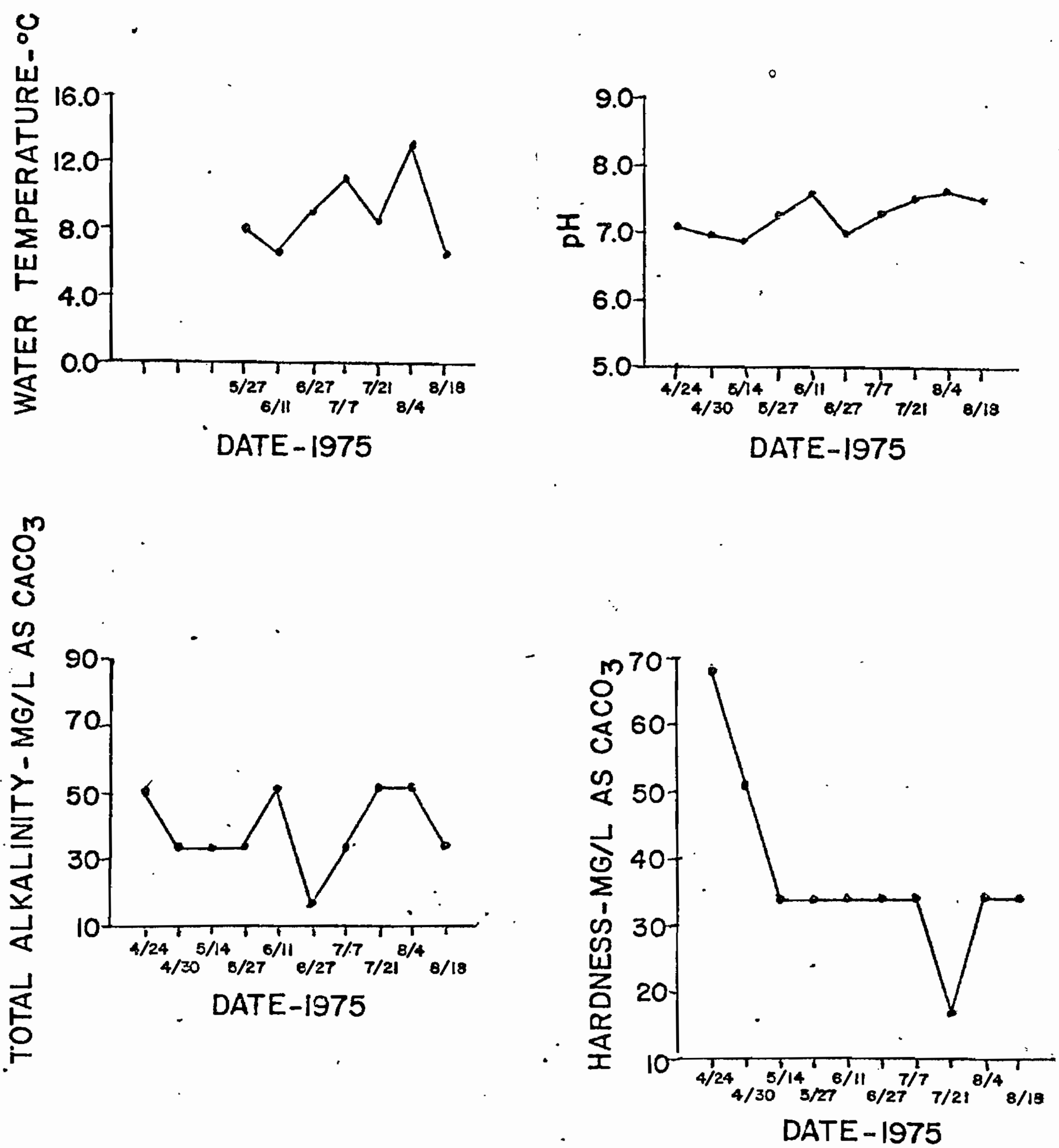


Fig. 9. (Cont). Limnological Data Collected from the Kashwitna River at the Bridge, April 24 Through August 18, Devil's Canyon Project, 1975.

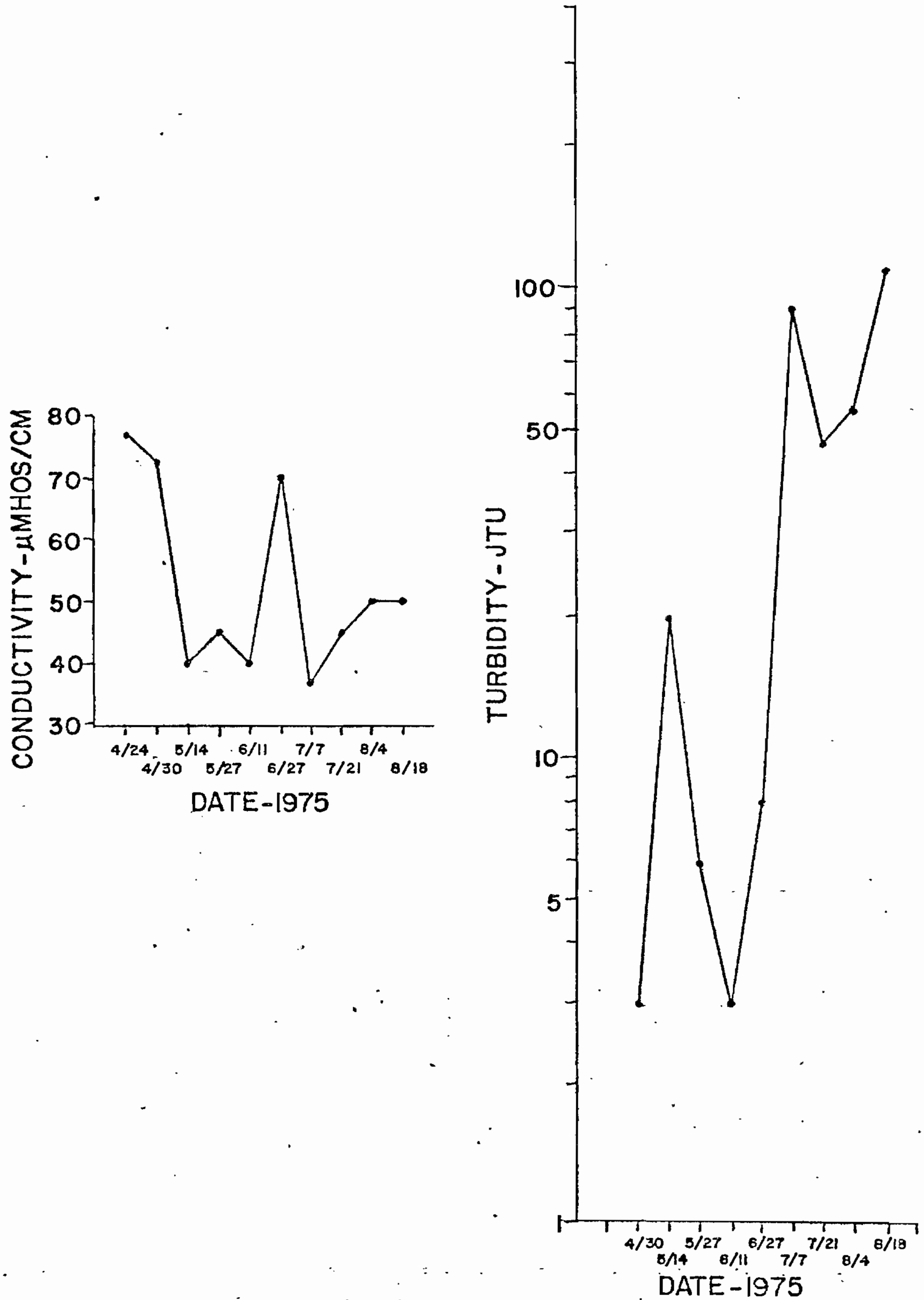


Fig. 10. Limnological Data Collected from Little Willow Creek at the Bridge, April 24 Through August 18, Devil's Canyon Project, 1975.

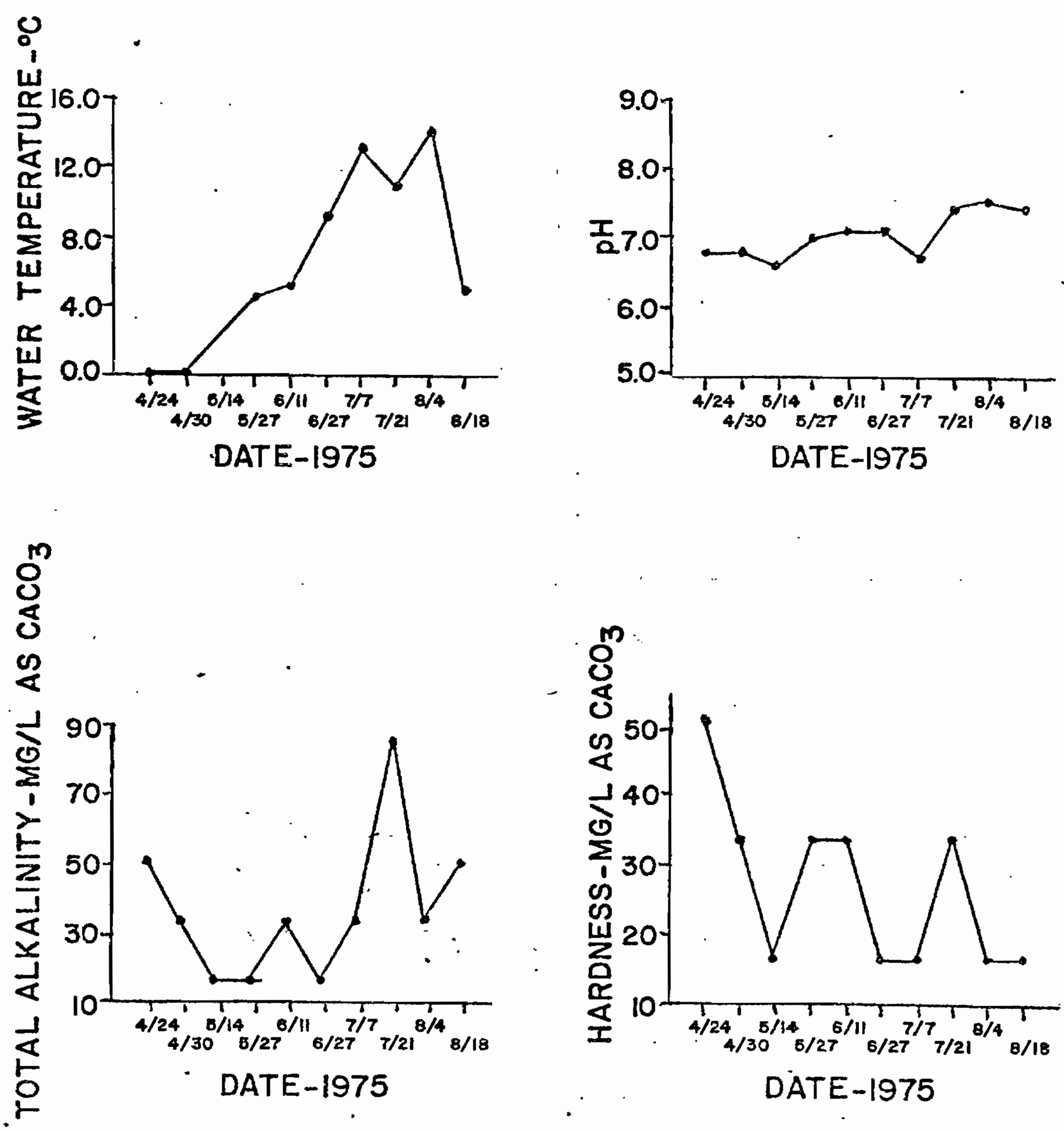
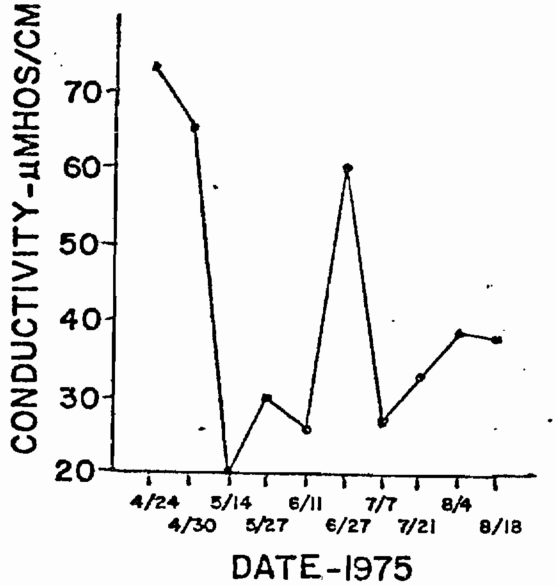


Fig. 10. (Cont). Limnological Data Collected from Little Willow Creek at the Bridge, April 24 Through August 18, Devil's Canyon Project, 1975.



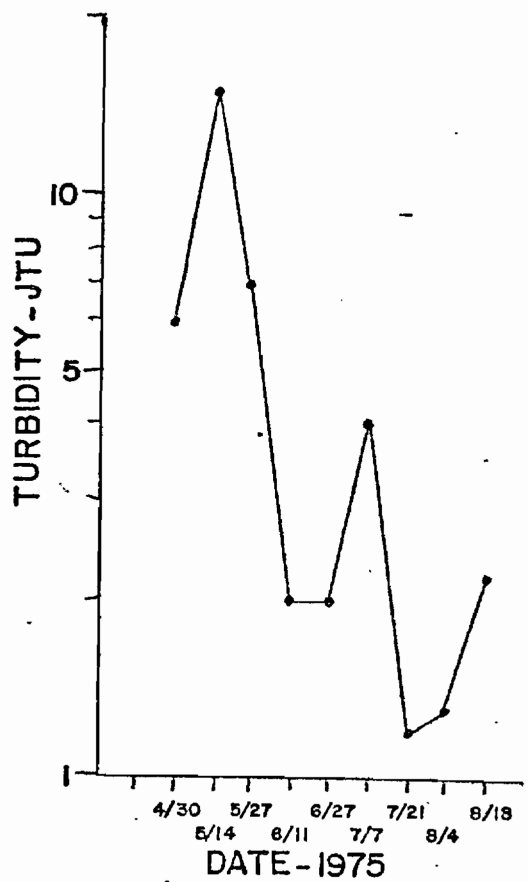


Fig. 11. Limnological Data Collected from Willow Creek at the Bridge, March 26 Through August 18, Devil's Canyon Project, 1975.

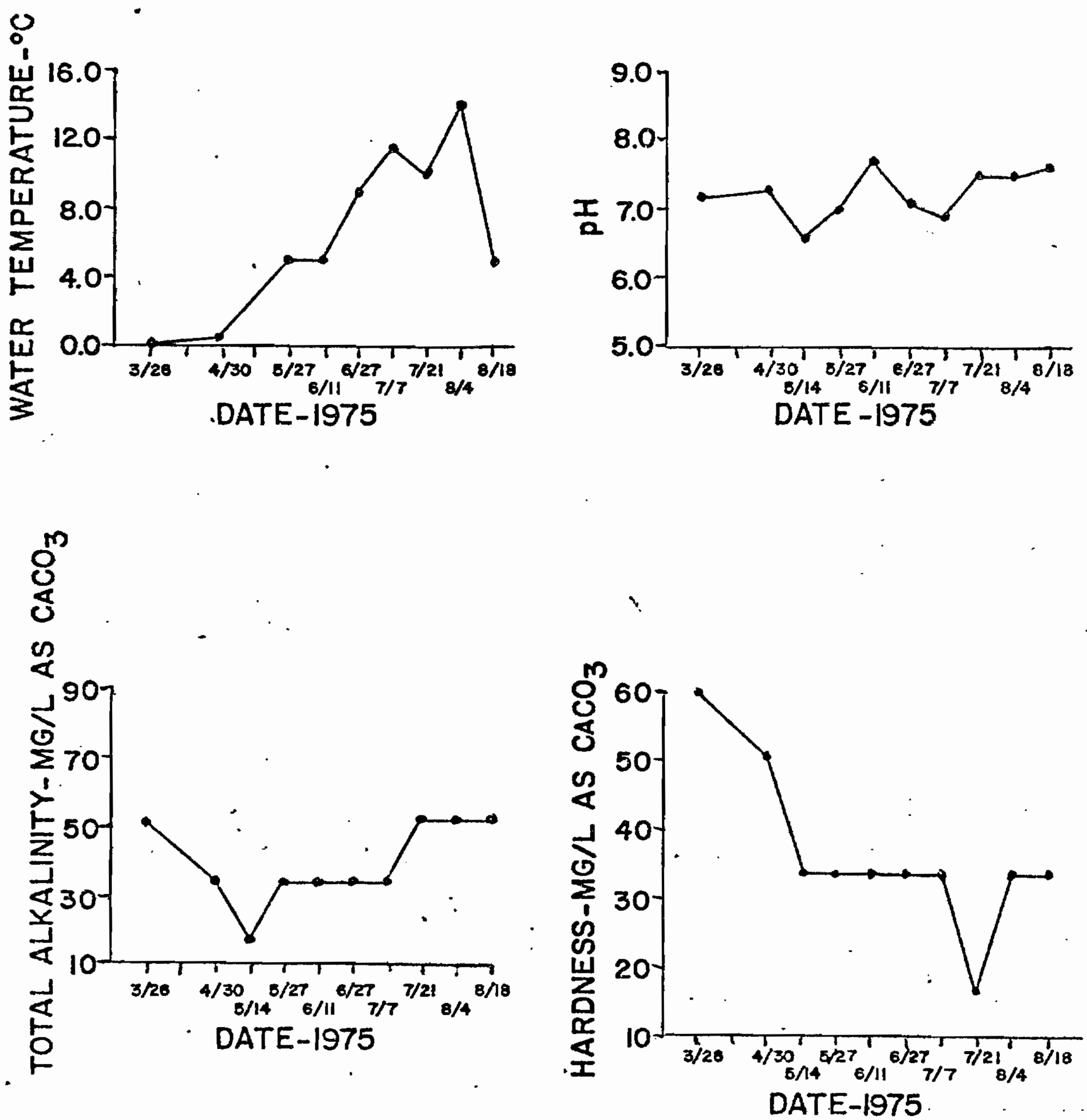
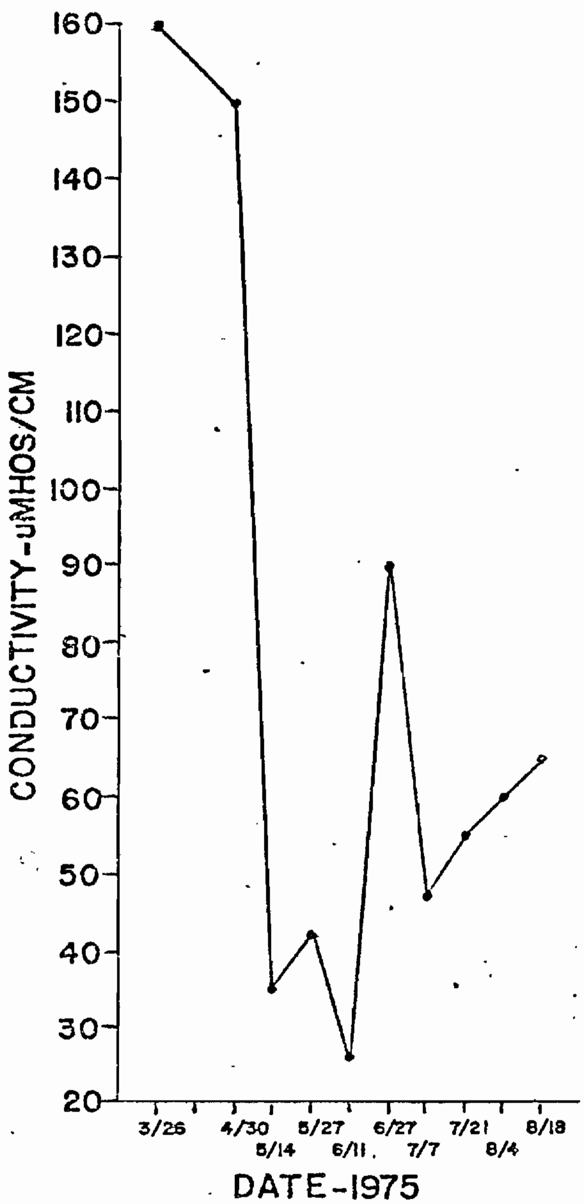


Fig. 11. (Cont). Limnological Data Collected from Willow Creek at the Bridge, March 26 Through August 18, Devil's Canyon Project, 1975.



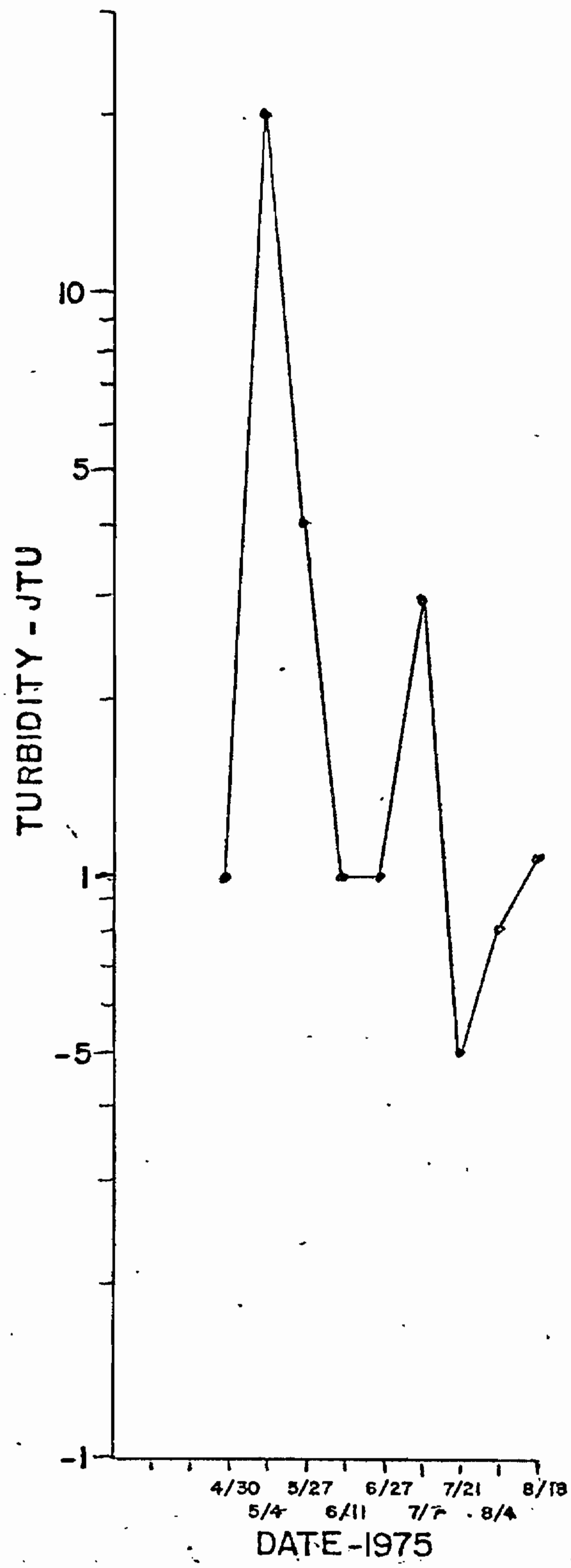


Table 16. Limnological Data Collected from Four Tributaries of the Susitna River.

Type of Data	Tributary: Fourth of July Creek	Gold Creek	Indian River	Portage Creek
Date (1975)	8/9	8/13	8/19	8/10
Time	4:13 p.m.	6:00 p.m.	11:50 a.m.	5:00 p.m.
Depth range (feet)	1-3	.5-3	1-4	.5-4
Water temperature (C)	14.0	12.0	9.0	9.0
pH	7.5	8.1	7.5	7.5
Total alkalinity (mg/l as $CaCO_3$)	34	120	34	51
Hardness (mg/l as $CaCO_3$)	17	160	34	34
Dissolved oxygen (mg/l as O_2)	9	11	11	11

Table 17. Limnological Data Collected from the Susitna River Immediately Above Gold Creek, August 1975.

Type of Data	8/13 6:00 p.m.	8/18 3:00 p.m.
Water temperature (C)	14.0	12.0
pH	8.0	8.0
Total alkalinity (mg/l as $CaCO_3$)	86.0	86.0
Hardness (mg/l as $CaCO_3$)	94.0	110.0
Dissolved oxygen (mg/l as O_2)	11.0	10.0
Orthophosphate (mg/l as P)	-	0.04
Nitrate (mg/l as N)	-	>0.01
Nitrate (mg/l as N)	-	>0.10
Turbidity (FTU)	70.0	-
Specific conductance (umhos/cm)	165.0	-

Table 18. Limnological Data Collected from the Susitna River Immediately Above Portage Creek, August 1975.

Type of Data	8/12 1:10 p.m.	8/18 3:00 p.m.
Water temperature (C)	13.0	11.0
pH	8.0	8.0
Total alkalinity (mg/l as $CaCO_3$)	68.0	94.0
Hardness (mg/l as $CaCO_3$)	68.0	103.0
Dissolved oxygen (mg/l as O_2)	13.0	11.0
Orthophosphate (mg/l as P)	0.05	0.05
Nitrite (mg/l as N)	0.01	0.02
Nitrate (mg/l as N)	0.5	0.3
Turbidity (FTU)	85.0	190.0

TABLE 19. Limnological Data Collected From Fifteen Sloughs Along The Susitna River Between Talkeetna And Portage Creek.

Slough Number	Date 1975	Time	Depth (feet)	Temp. (C)	Bottom Type*	pH	Total Alkalinity (mg/1-$CaCO_3$)	Hardness (mg/1-$CaCO_3$)	Dissolved Oxygen (mg/1-O_2)
8a	8/9	2:50pm	-	13.5	S,Sa,G,C	7.5	86	68	8
9	8/9	1:16pm	0.85	8.0	S,Sa,G,C	7.0	51	68	7
10a	8/7	-	-	9.5	M,S,G	7.0	68	68	-
10b	8/7	-	-	10.0	M,S,G,C	7.5	86	100	-
11	8/7	-	2.30	8.5	Sa,G,C	7.5	103	120	10
12	8/7	-	-	5.5	M,S,G,C	7.5	137	120	8
13	8/13	4:25pm	0.66	6.5	Sa,G	7.5	103	100	9
14	8/7	-	1.46	9.0	S,Sa,G,C	7.0	68	51	-
15	8/8	12:05pm	1.63	13.5	S,Sa,G	7.0	51	34	9
16	8/8	1:26pm	0.50	7.0	S,G,C	6.5	51	34	7
17	8/14	9:00am	0.83	4.5	S,G,C	7.0	51	51	8
18	8/14	9:40am	0.75	8.0	M,S,Sa	7.5	68	68	9
19	8/10	11:25am	2.94	9.5	S,Sa,G,C	7.5	86	68	8
20	8/10	12:13pm	-	9.5	S,Sa,G,C	8.0	68	51	8
21	8/10	1:33pm	-	10.0	S,Sa,G,C,B	7.5	103	86	8

* M - Muck, S - Silt, Sa - Sand, G - Gravel, C - Cobble, B - Boulder

TABLE 20. Limnological Data Collected from the Impoundment Area of the Susitna River Near Jay, Watana, and Deadman Creeks, Devil's Canyon Project, April 24, 1975.

Type of Data	Jay Creek (100 Yds. Downstream)	Watana Creek (3 Mi. Upstream)	Deadman Creek (100 Yds. Downstream)
Depth	Surface	Surface	Surface
Water Temperature (C)	0.0	0.0	0.0
pH	8.0	7.5	7.5
Total Alkalinity (mg/l as $CaCO_3$)	102.6	102.6	51.3
Hardness (mg/l as $CaCO_3$)	119.7	136.8	68.4
Dissolved Oxygen	13.0	13.0	13.0
Turbidity (JTU)	0.5	0.5	0.4
Conductivity (μmhos/cm)	280	255	220

present, including grayling, burbot, rainbow trout, whitefish, coho, and chinook salmon.

Except for slough 12, total alkalinity measurements ranged from 51 mg/1 to 103 mg/1 $CaCO_3$. Hardness values ranged from 34 mg/1 to 120 mg/1 $CaCO_3$. Dissolved oxygen measurements ranged from 7 to 10 p.p.m.

Table 20 shows the results reveal no alarming readings and are characteristic of undisturbed Alaska rivers.

The section of the Susitna River between Devil Canyon and Talkeetna will be most adversely affected by flow regulation of a hydroelectric dam. This section of river has not had a systematic limnological study conducted on a year-round basis. An expanded limnological study is necessary to fully understand the present characterisitcs of the Susitna River.

CONCLUSION

The Alaska Department of Fish and Game has not conducted studies of limnological characteristics or indigenous fish stocks of the mainstem Susitna River prior to 1974. Therefore, comparative data are either minimal or non-existent.

This fisheries study documented anadromous and resident fish fry utilizing the Susitna River for rearing during the winter when the water is silt free. It appears the majority of salmonids migrate to freshwater tributaries and other periphery areas of the Susitna River when the silt loads increase during the summer. This undefined migration warrants additional study which should attempt to define species composition of the Susitna River on a seasonal basis. The section of river which will be most affected is directly downstream of the proposed Devil Canyon Dam site. A limited amount of sampling of resident fish stocks in this area revealed populations of grayling in all tributaries except Gold Creek. The timing in which these grayling and other resident fish utilize the Susitna River is not known, and should be documented.

The limnological aspect of this study contains important baseline data that should be continued and expanded in order to document changes in water chemistry following impoundment. It has become apparent during this study that one of the more critical areas which require additional research is definition of flows. Minimum seasonal flows should be established through regulation to insure access in and out of sloughs for fish.

ACKNOWLEDGEMENTS

The author wishes to acknowledge the assistance of Jeffrey D. Hock, temporary Fishery Biologist, the U.S. Geological Survey, Water Resources Division, for their advice and use of their laboratory, and the U.S. Fish and Wildlife Service for funding.

POTENTIAL IMPACTS

Following is a list of impacts the Fisheries Divisions of the Alaska Department of Fish & Game has compiled. This is not necessarily a complete list, as other impacts may become apparent during the course of the study. Environmental impacts will occur both up and downstream from the dams. Two phases of development of the hydroelectric facilities will occur: (1) the construction period projected to extend over a 12-year period, and (2) the operation of the facility. Environmental impacts of this project will be (1) those occurring during the construction period, and (2) those occurring during the post-construction period which constitutes the entire life of the project.

Construction Period Impacts

Construction of the dams will necessitate the diversion of the Susitna River from its natural course. The major effect during this period is expected to be an increase in silt load due to construction activities. This decrease in water quality may cause the following impacts:

1. Disorientation of adult salmon returning to their home streams may result in a decrease of fish production in the upper areas of the river.

2. Change in substrate composition in sloughs resulting in decreased spawning and rearing area. Chum and sockeye salmon are known to utilize these areas for spawning.

3. Lack of clearwater conditions during fall and winter months limiting fry from utilizing the mainstem Susitna River for rearing.

4. Degradation of water quality resulting in possible alterations in the aquatic food chain. Some orders of insects, important food items for salmon fry, may be unable to adapt to the changed water quality.

5. Reduced flows associated with filling of the reservoir may reduce downstream spawning habitat and could alter fish distribution below dam. During the low flow construction period a substantial risk of water pollution from concrete pouring, oil spillage, etc. will be present.

6. Reduction in run of salmon could follow reduction of flow (Penn, 1975). Reducing flows could result in reduced access for salmon utilizing the upper stream areas.

Post-Construction Impacts

1. Turbidity - The Susitna River currently carries a heavy load of glacial silt in spring and summer. The river's water is clear during fall and winter months. Impoundment will result in increased turbidity and silt loads year-round. Also, turbidity may be increased if there is permafrost in the area (Afton, 1975). This condition may constribute to:

    a. Inability of fry to utilize the mainstem for rearing.

b. Decreased summer turbidity allows greater light penetration which would encourage more primary production. Rate of zooplankton development may not necessarily be increased due to possible lower temperature in April-May period. Rearing salmon depend on zooplankton stock at this time.

c. Influence of bedrock on impoundment water quality may affect fisheries (Duthie and Ostrofsky, 1975).

d. Increased mortality due to decreased summer turbidity resulting in higher predation success.

e. Decreased spring and summer turbidity would likely limit downstream migration to the darker hours, thereby extending the downstream migration periods further than at present since some migration occurs in the turbid waters during daylight. There is evidence suggesting that increased time to migrate increases young salmon mortality (Geen, 1975).

2. Temperature - Normal temperature regimes will be altered by impoundment. Various effects may be seen. These include, but are not limited to:

a. Any change in downstream fall temperatures could affect spawning success of salmon. There is evidence that relatively high temperatures are associated with poor returning runs (Geen, 1975).

b. Changes in the incubation period of salmon eggs and incubation conditions.

c. Premature fry emergence and seaward migration due to increased rate of development could result in increased mortality because the migration may occur prior to the warming of estuaries and the development of estuarine zooplankton populations.

d. Alteration of the normal thermal regime would change the overall productivity of the river, which could add extreme stress to fry populations.

e. Summer temperature decrease could affect upstream migrational time for adult salmon.

f. Changes in the aquatic food chain, due to the inability of some organisms to adapt to even slight thermal alterations.

3. Chemical and Physical Parameters.

a. Supersaturation of nitrogen and oxygen depletion resulting from stratification and spillage are possible, impacting downstream fishes for an unknown distance.

b. Increases in dissolved nitrogen gas can also be due to air vented into turbines to reduce negative pressures during weekend periods of sustained low generating levels (Ruggles and Watt, 1975).

c. Dams slow water transport which gives more time for the biochemical oxygen demand to consume available oxygen, thus reducing dissolved oxygen content. Dissolved oxygen levels will probably be altered due to changes in river conditions. Low levels could preclude the suvival of fish in downstream slough areas.

d. Conductivity, alkalinity, and pH can increase after impoundment construction (Geen, 1975).

4. Organic Debris

a. Debris has a time frame of 100-200 years, reduced with time, resulting from forest drowning.

5. Flows

a. Altered lake levels may result in flooding, slumping, erosion, and general shoreline degradation. Littoral zone changes affect fisheries.

b. Changed ice regimes can also affect river and lake shorelines. A change in water quality can be expected due to erosion and sediment processes from altered water levels, flows and ice regimes, (Dickson, 1975).

c. Changes in substrate composition of spawning areas due to lack of natural scouring; this would also affect winter survival of eggs.

d. Decreases in water levels during June and July will affect adult access to spawning areas.

e. Reduced discharge during summer could alter upstream migration of salmon.

f. Reduction of flow could affect survival of young salmonids moving to saline water during April-May. Seaward migration is directly related to river velocity and therefore could extend this period, (Geen, 1975).

g. Reduction of normal spring and summer flows could result in a decrease of fry rearing habitat and could leave out-migrating smolts stranded.

RECOMMENDATIONS

Before the full effects of this project on fish and wildlife are identified, considerable studies are necessary which will be both long term and costly. Following is a brief resume of biological studies and investigational goals required prior to final definition of impacts resulting from impoundment of the Susitna River at Devil Canyon and Watana.

I <u>A thorough hydrologic study is essential</u>. This study will have to be conducted in close coordination with ADF&G, the U.S. Corps of Engineers, U.S.G.S., and other appropriate agencies. The following is a partial list of necessary information:

1. Current unregulated flows and projected regulated flows.

2. Temperature regimes.

3. Turbidity and sediment data.

4. Anticipated physical changes to the natural locations, on a seasonal basis.

II A comprehensive fishery study to address adult and juvenile salmonid abundance, distribution, migrational patterns, and age composition by species for areas both upstream and downstream of the proposed Devil Canyon Dam.

The Cook Inlet fishery is of mixed stock and presents many problems for its proper management. Total escapement data by species is not available for the Susitna River drainage. Until total escapement into the drainage is determined the value of the salmon stocks in the upper Susitna River cannot be evaluated. Spawning ground surveys demonstrate the importance of this area to chum and pink salmon.

Data collected since July 1974 provides baseline information only. Generalizations may be made, but sufficient information is not available to determine full impacts of dam construction and operation upon the fishery. Intense investigational projects should be initiated in the study area to provide pre-construction data to adequately evaluate possible impacts.

III A study of affected habitat areas will be conducted in conjunction with the fisheries program. Productivity and limiting factors can be defined by a thorough limnological study. Physical, chemical, and biological conditions of the Susitna River and other affected areas should be examined. Specific concerns are:

1. Changes in quality and quantity of spawning habitat both upstream and downstream of the proposed dam sites as a result of (a) flow and releases, (b) innundation of upstream areas and (c) effects of periodic pool fill and drawdown.

2. Effects upon the habitat and fisheries resource directly as a result of construction activities.

3. Effects of increased human use resulting from improved air and road access upon both the Susitna River drainage and adjacent fisheries.

4. Environmental assessment of transmission line system to determine effects of stream crossings upon resident and anadromous fish populations and habitat during both construction and subsequent operational maintenance.

For further information on biological study proposals refer to the package presented to U.S. Fish and Wildlife Service and U.S. Army Corps of Engineers on November 18, 1975.

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APPENDIX

The aerial photographs in this appendix show the sample sites (fish, limnological, and benthos) used in this study. The exact site was located under the letter which denotes the type of sample ... A, R, B, or L.

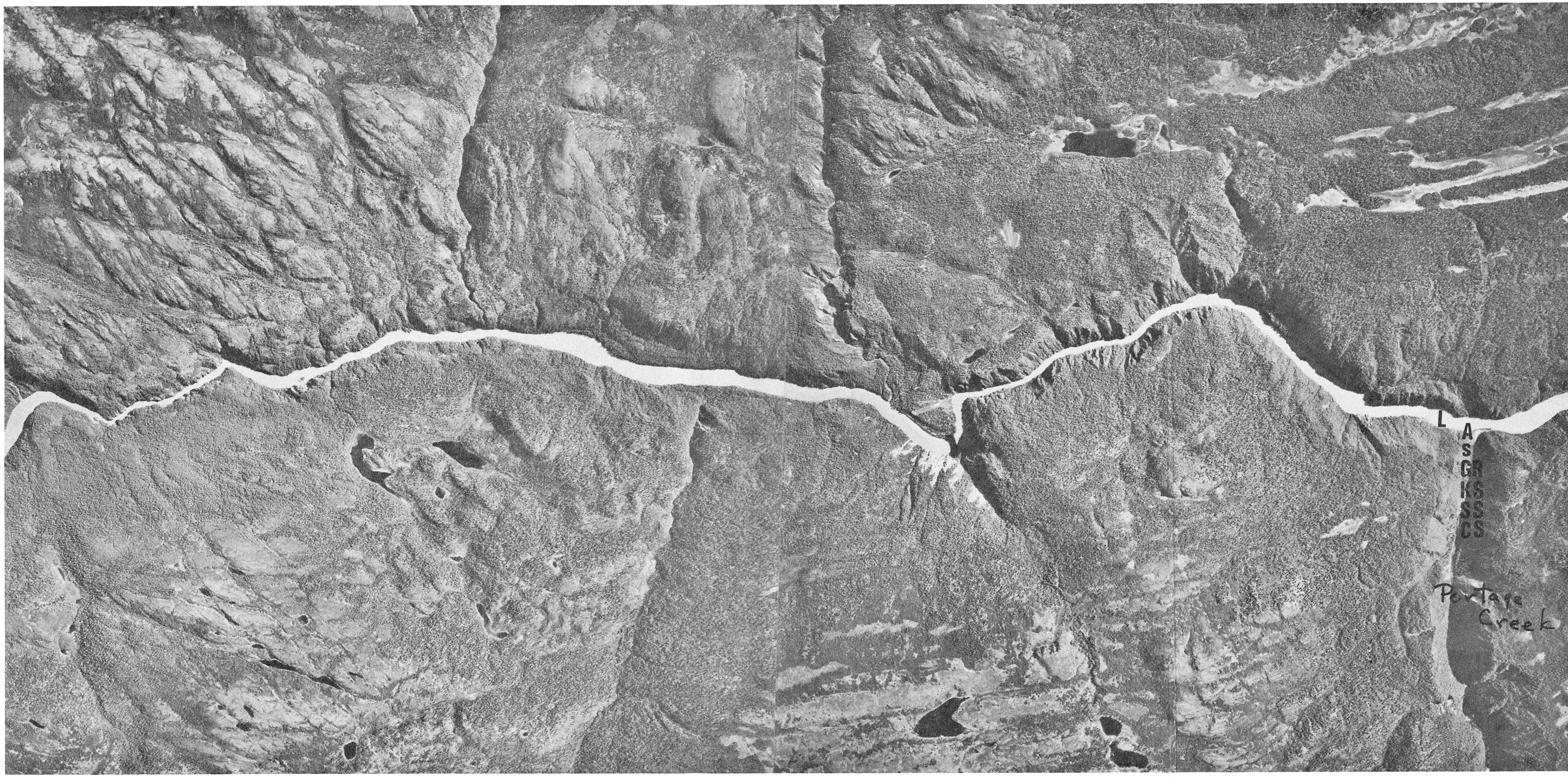
There is approximately a six-mile stretch of river near the Sherman area not covered by aerial photographs. With the exception of this stretch, the river is completely covered by photographs from Devil Canyon downstream to the mouth. The scale from Gold Creek downstream is 1:63.360 and the scale upstream from Gold Creek is 1:30.000. These photographs were taken in July, 1975.

LEGEND

A - Adult fish
R - Rearing fish
B - Benthos sample site
L - Limnological study points
W - Winter collection
S - Summer collection
KS- King salmon
SS- Silver salmon

RS - Red Salmon
CS - Chum salmon
PS - Pink salmon
RT - Rainbow trout
GR - Grayling
DV - Dolly Varden
BU - Burbot
WF - Whitefish


Gold Creek
Indian River
R s RT GR WF
B
R s KS GR SS
R s WF GR
R s KS SS GR WF BU
R s SS GR BU
A L s KS SS PS CS RT GR
R s KS WF
R s SS KS
L B L
SS CS
A R s W
R s GR WF SS
R s KS GR SS
A R w s Ss
RS RT GR
R s SS GR WF


L
A
S
GR
KS
SS
CS
Portage Creek


R
s
SS
A
R
s
KS
CS
PS
R
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SS
SS
WF
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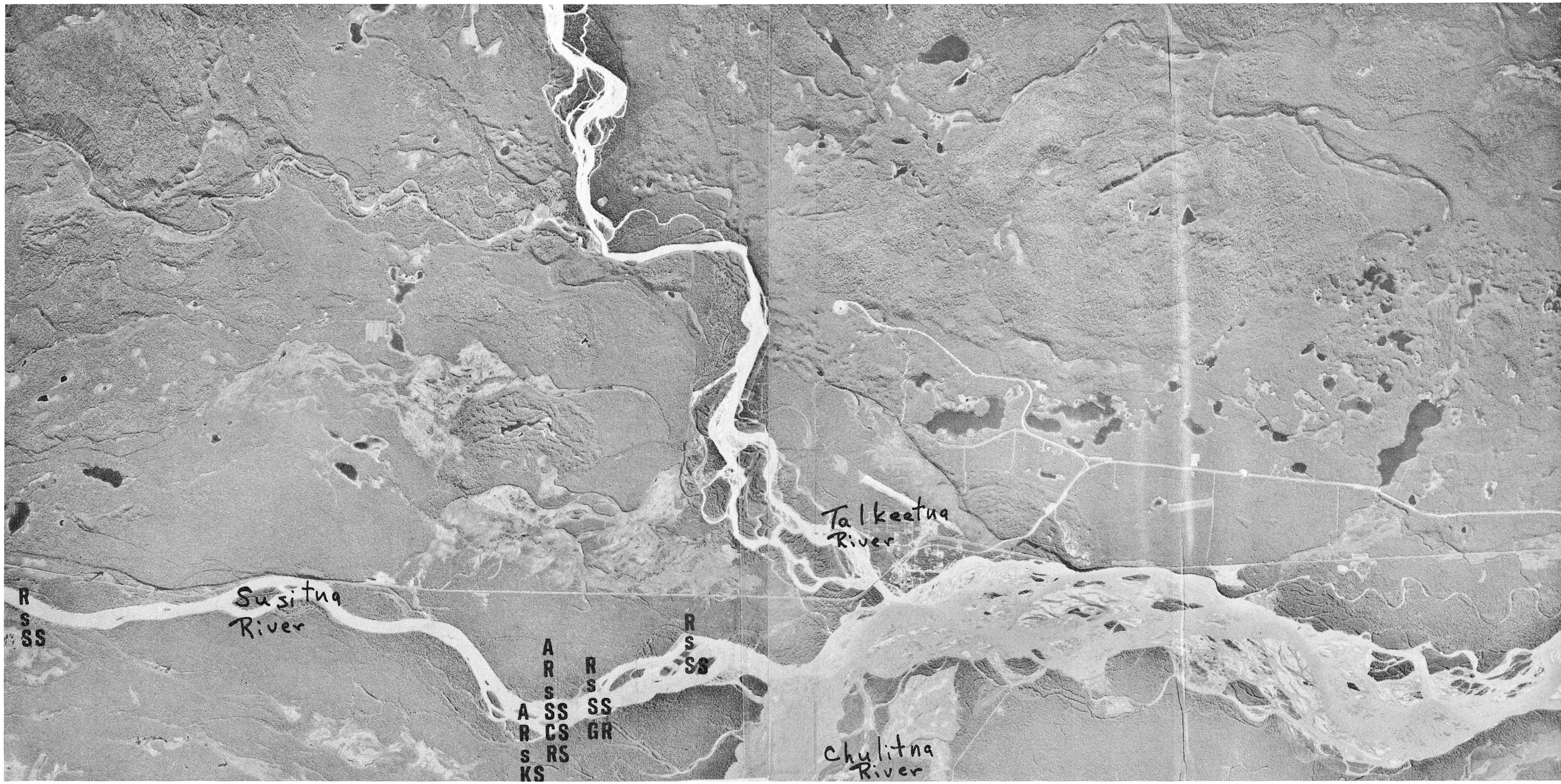
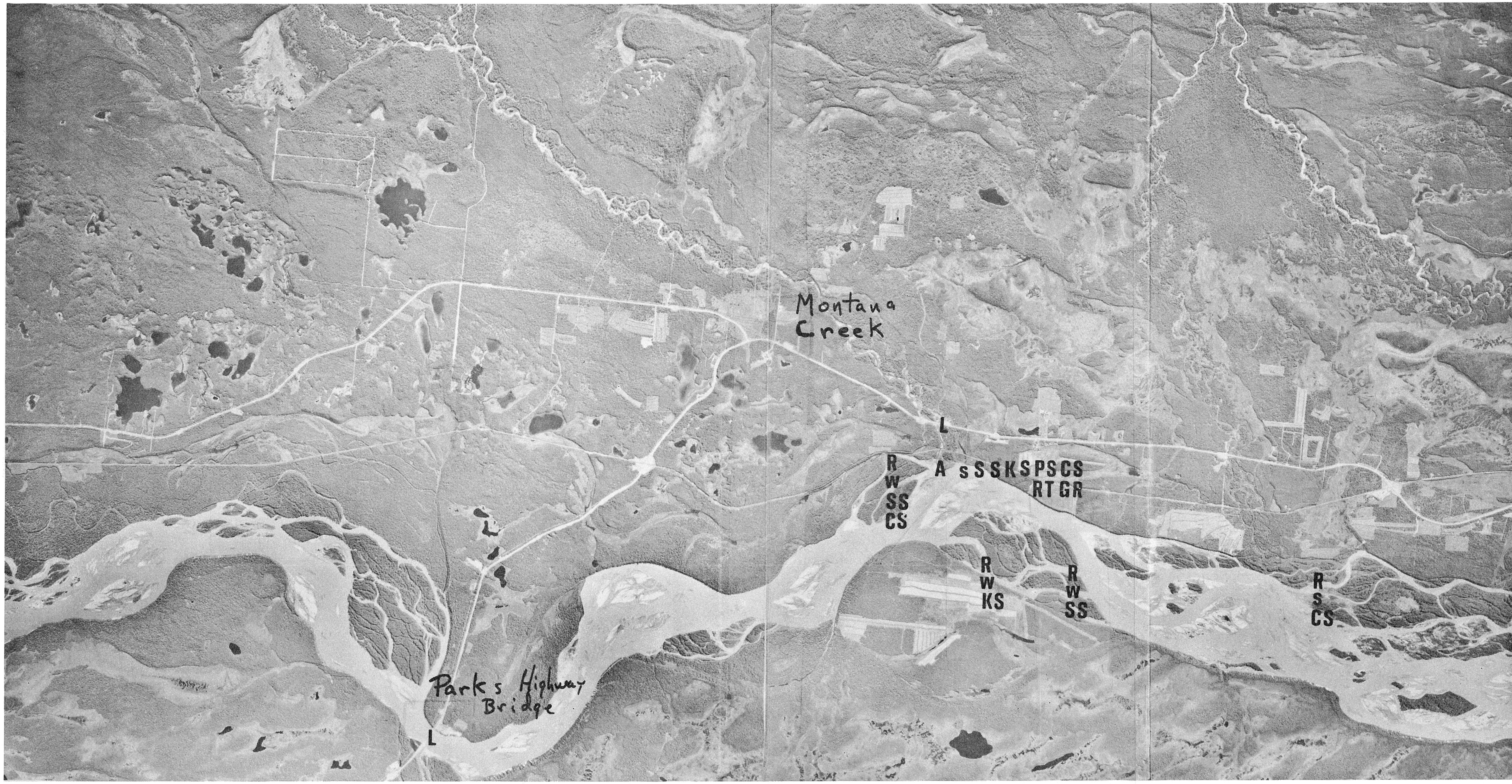
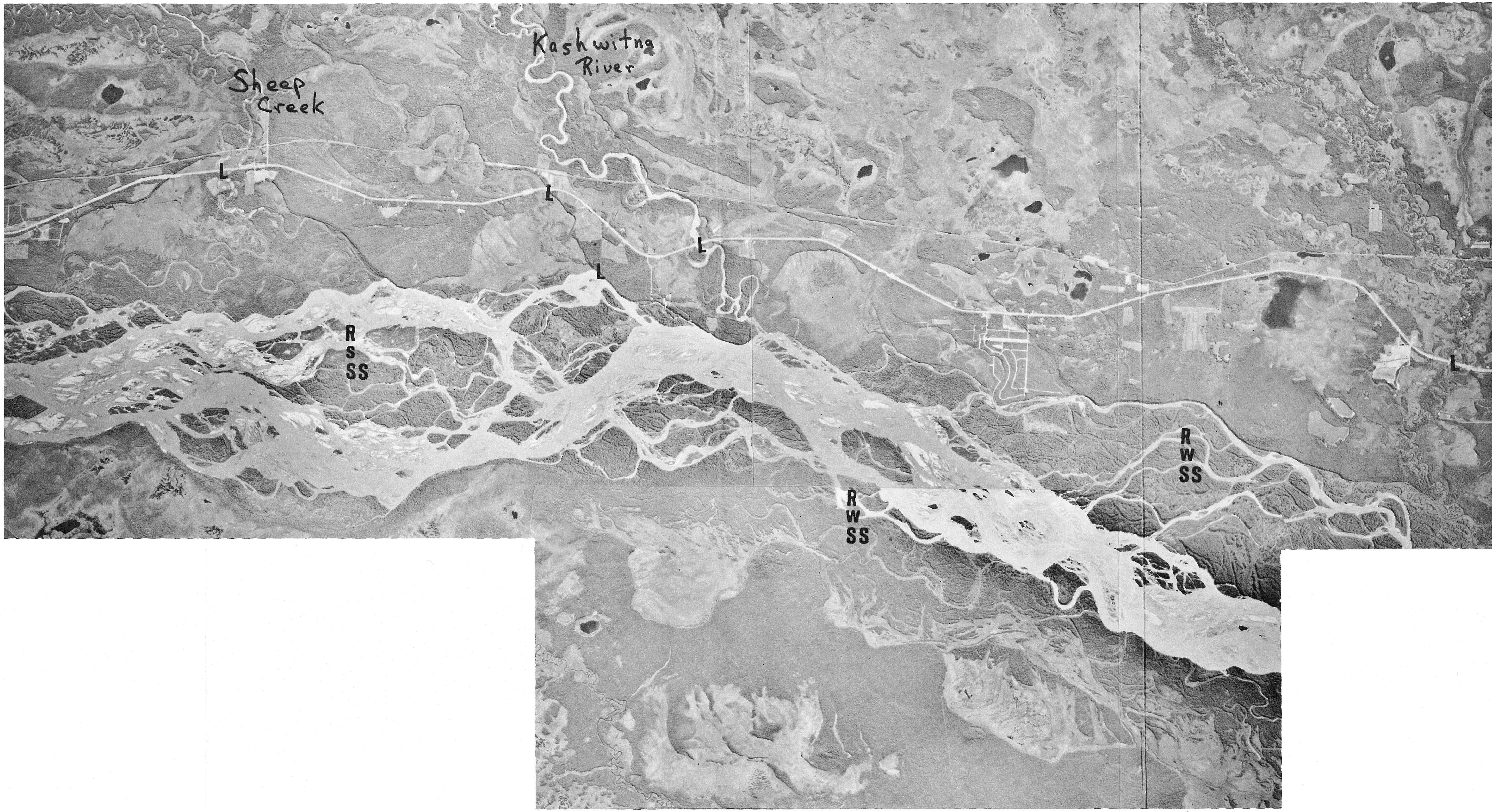
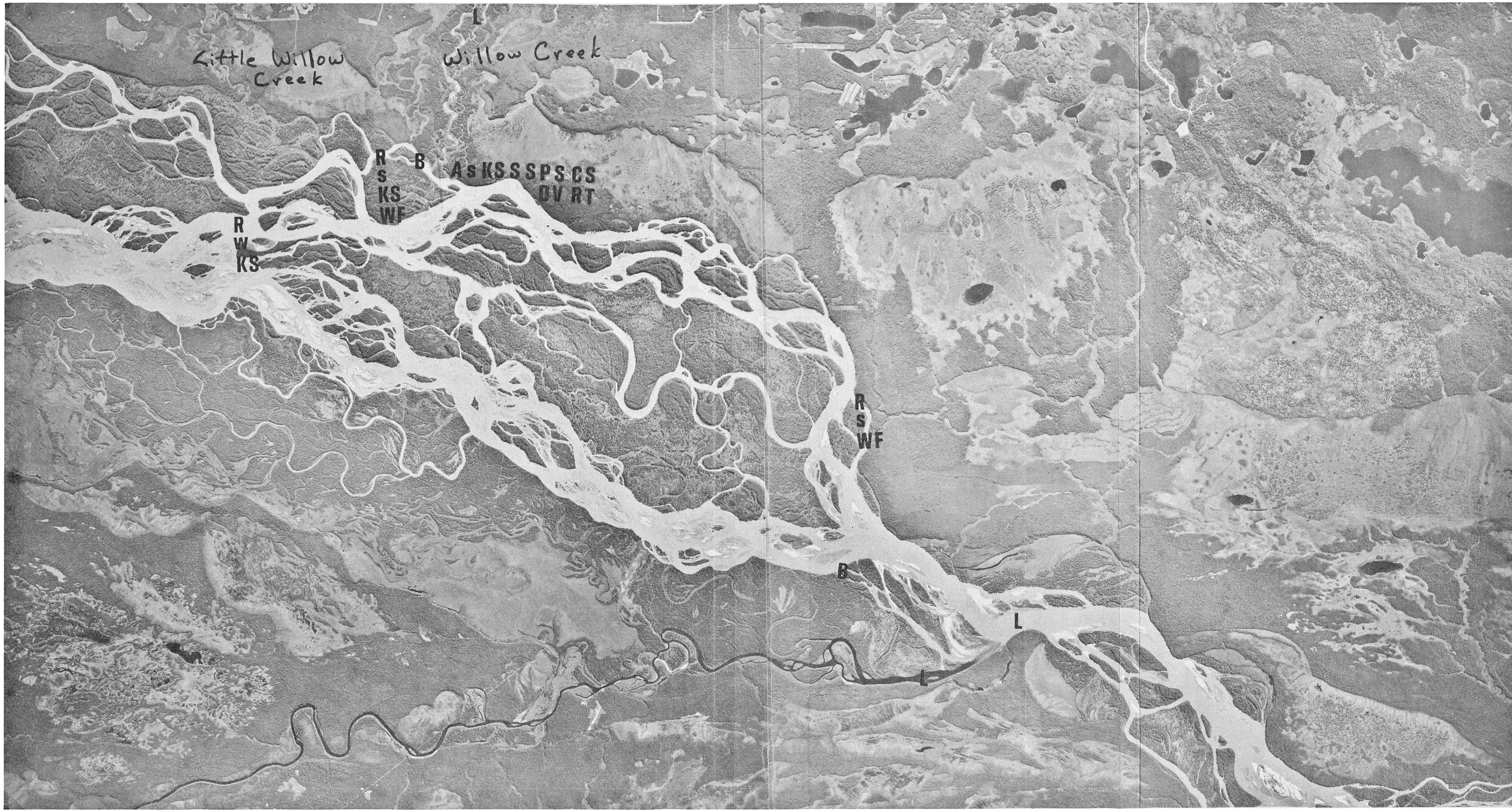
SS
A
R
s
CS

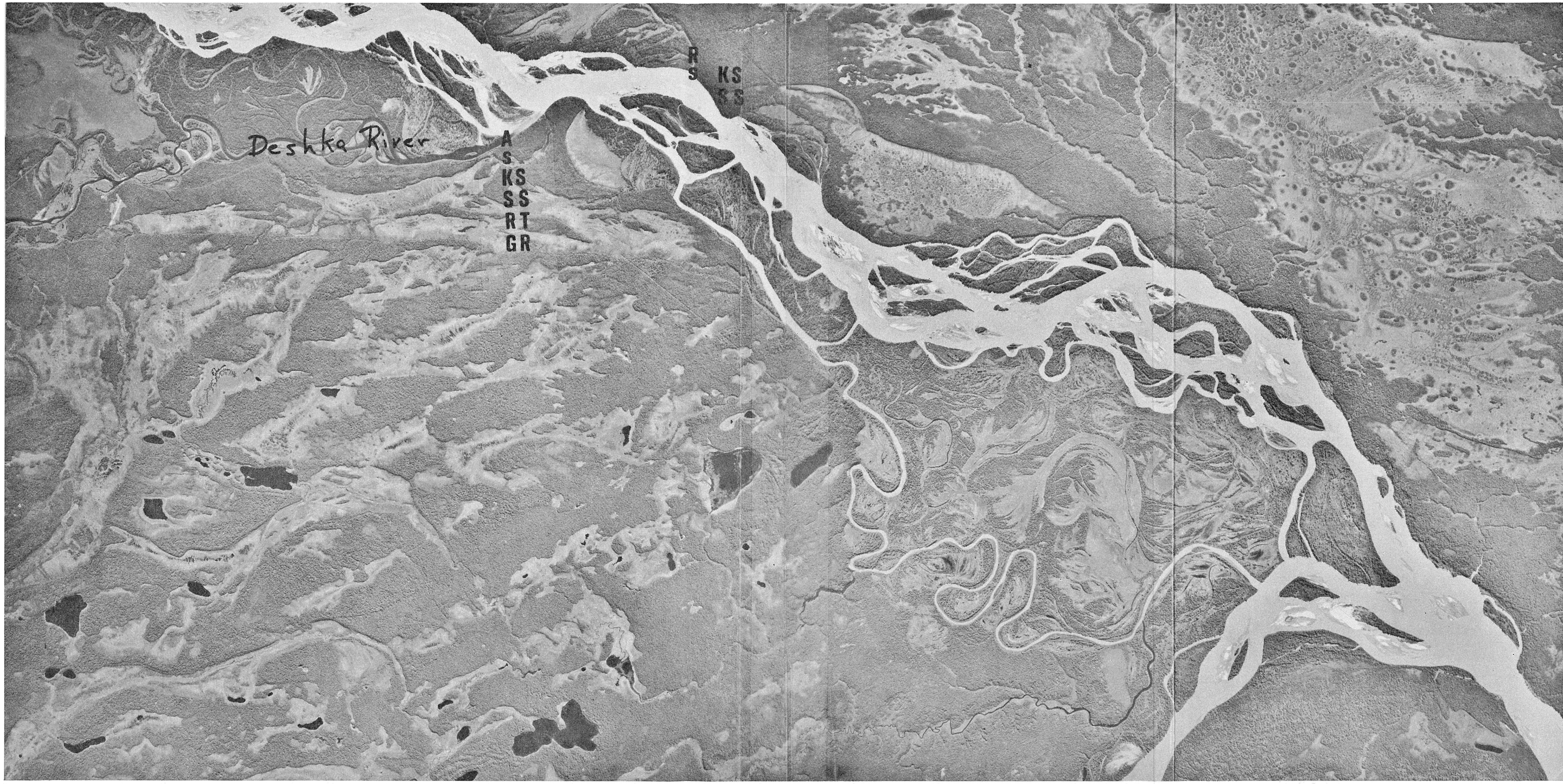

Talkeetna River
Susitna River
Chulitna River
R s SS
A R s KS
A R s SS CS RS
R s SS GR
R s SS



Montana Creek
L
R W SS CS
A sSSKSPSCS
RTGR
R W KS
R W SS
R s CS
Parks Highway Bridge
L


Sheep Creek
Kashwitna River
L
L
L
L
L
R
s
SS
R
W
SS
R
W
SS


L
Little Willow Creek
Willow Creek
R
s
KS
WF
B
AsKSSSPSCS
DV RT
R
W
KS
R
s
WF
B
L
L


Deshka River
A
S
KS
SS
RT
GR
R
S
KS
SS


Yentna River
R
W
GR
WF
Alexander
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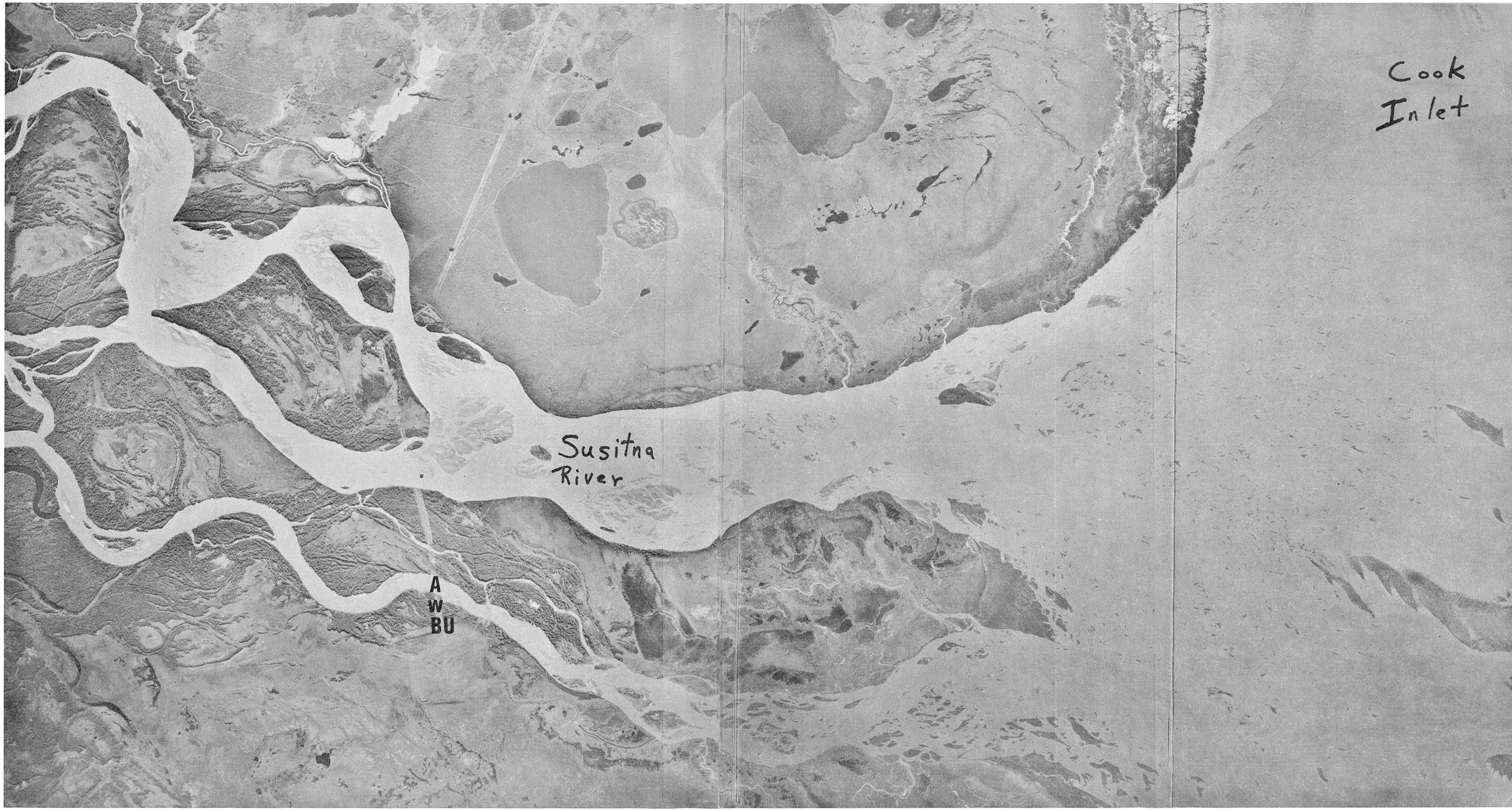
S
KS
SS
RT
GR



Cook
Inlet
Susitna
River
A
W
BU

UPPER SUSITNA RIVER WILDLIFE STUDIES

by: Carl McIlroy
Game Biologist III
Alaska Department of Fish and Game

INTRODUCTION

Reconsideration of portions of the Susitna River as a source of hydroelectric power has necessitated a reevaluation of the effects of a dam or dams on the area's indigenous and transient wildlife. Former studies included an evaluation of the monetary values of the Susitna basin based strictly on estimated harvests (Anon. 1954). However, the applicability of those data to the present is limited because of changing harvest patterns and changing calculations placed on an animal's worth. A detailed report on the fish and wildlife resources of the Susitna basin and the impacts of the proposed Devil Canyon and Denali dams on those resources (Anon. 1960) was an excellent evaluation considering the limited information available at that time. This report is intended to supplement the 1960 study by updating inventory and harvest data, by reporting on big game distributions observed during the spring of 1974 and the winter of 1974-75, by reevaluating the main effects on wildlife caused by the proposed Devil Canyon and Watana Dams, and by suggesting mitigating actions and future studies based on the current perspective.

PROCEDURES

Moose distribution surveys during June, 1974 were flown with a PA-18 supercub by ADF&G biologists. The Susitna River above the proposed Devil Canyon Dam up to the Susitna Glaciers and the lower portions of its major tributaries were surveyed (Fig. 1). Flight lines within the surveyed area were approximately one mile apart, representing a survey of moderate intensity. Big game distributions during the winter of 1974-75 were assessed by making five aerial surveys over the Susitna study area at roughly monthly intervals. The Susitna study area for these flights was defined as the Susitna River upstream from Gold Creek and the lower portions of the Susitna River's major tributaries (Fig. 2). Observations of all larger mammals were recorded, and those observation numbers were located on a map. The upper limit of surveys was the highest elevation that moose were found. The initial flight during November was intensive, and moose sex and age composition were obtained along with big game distributions. Complete subareas were searched for moose. Because of poor weather, decreasing daylight, and increasing ratios of ferry time to count time, not all of the study area was surveyed. Subsequent flights, from January through April (Fig. 3-6), were less intensive, and roughly fixed flight patterns were flown with no attempt to search all subareas for moose. The November survey was flown with PA-18 aircraft, January, February, and part of March flights were made with a Cessna 185, and the remainder of March and April surveys were made with a PA-18.

Moose condition evaluations were made during the April survey. A body fat condition evaluation of each moose observed was made based on a scale of (1) dead - due to natural mortality other than predation, (2) bony - poor coat, slab-sided, hips and ribs obvious, (3) moderately fat - fair coat, moderately rounded, hips and ribs not obvious, and (4) fat - good coat, rounded shape, hips and ribs well-covered. Range use evaluations during April were made to delineate areas of preferred or critical winter range that would be inundated by construction of the Devil Canyon and Watana dams. Classification of each area and boundaries for each area were determined by the relative density of cumulative moose tracks observed from early winter until April 23, 1975. The classification categories were: (1) light use - occasional tracks with little cratering, (2) moderate use - tracks and cratering common but not dense, and (3) heavy use - tracks dense and cratering extensive. The square miles of each range category were determined by overlaying a mileage grid over a map showing the classified areas.

Harvest data were obtained from harvest report returns. Because many hunters do not report where their animal was taken, reported harvests for specific areas are usually less than actual harvests.

RESULTS

Moose Distributions During June, 1974.

A survey of the upper Susitna River and lower portions of major tributaries was flown during June, 1974 to obtain spring moose distributions and to locate any areas with high densities of cows and calves (calving areas). Results of these surveys are shown on Figure 1. A high moose density was observed south of the MacLaren River, but no other areas with high moose densities were observed. Few moose were seen above 3,500 feet.

Moose Wintering Distributions, 1974-75.

Locations of moose observed during November, January, February, March, and April surveys are shown on Figures 2 to 6, respectively. The decrease in moose numbers observed with advancing winter was partly due to less intensive survey procedures and partly due to poorer visibility of moose as they move below timberline. A comparison of these maps shows that, in most cases, moose moved from higher to lower elevations along drainages as winter progressed. For example, moose seen near the Susitna glaciers during November (Fig. 2) apparently moved down to Valdez Creek by January (Fig. 3), and down to Windy Creek by February (Fig. 4). One possible exception to this movement pattern from high to low elevations within a drainage system was noted. The large moose concentration along the "big bend" of the Susitna River observed during

November was not apparent during later surveys. It is possible that these moose crossed the Susitna River to join wintering moose con-concentration along the "big bend" of the Susitna River observed during later surveys. It is possible that these moose crossed the Susitna River to join wintering moose concentrations observed along the Oshetna River and Sanona Creek during late winter. Heavy trailing on and along major drainages was commonly observed. Trails criss-crossed drainages within moose concentration areas, indicating that vegetation along both banks was being utilized.

Moose Abundance and Composition.

Within the Susitna study area as defined for the 1974-75 winter surveys, 2,225 moose were counted during intensive November surveys. However, not all of the drainages were surveyed (Fig. 2). Extrapolations for areas not counted can be made by multiplying the square miles of each unsurveyed area times the moose density that was observed in nearby similar habitat. Based on this procedure, we may have counted 2,826 moose if all of the Susitna study area were surveyed. In the Gulkana drainage system observers saw 40 percent (28 of 70) of the moose that were collared approximately two weeks prior to surveys. Assuming a similar sightability of moose in the Susitna River drainages, 7,065 moose may have been in the Susitna study area. Calculated composition ratios for the Susitna study area were 15 bulls per 100 cows and 26 calves per 100 cows.

Evaluation of Moose Winter Range, Moose Condition, and the Loss of Winter Range by Inundation.

Observations of moose distribution through the winter indicated that several habitat types were successively used as winter progressed. During November surveys (Fig. 2), most moose were at or near timberline or in riparian willow patches above timberline. A previous ground survey (May 31, 1974) of the vegetation near timberline habitat within the big bend of the Susitna River above the mouth of Goose Creek was the basis for the following observations. This slope just below tree line contains black spruce and alder as major tall shrubs and trees, dwarf birch, alder, Salix alaxensis and Salix arbusculoides as important low shrub species, and Ledum sp., Vaccinium vitis-idaea and Carex sp. as the more important ground vegetation. Salix alaxensis, mainly found along small drainages, was severely hedged with many decadent stems. A large percentage of terminal twigs of other willow species were utilized, and some utilization of alder was observed. Small willow shrubs were scattered among the more plentiful black spruce, dwarf birch, and alder away from drainages, and many of these willows had been repeatedly browsed by moose to snowline during previous winters. The usual snow-line has apparently been at about 2 feet on flat portions of these slopes, perhaps indicating substantial wind in this area in the winter. Low bush cranberry is plentiful on this slope and is a potential food source. The annual available forage on this slope appears great, but Salix alaxensis has been over-utilized, and other willow species are at least moderately-to-heavily utilized. Most moose observed below timberline were also near riparian willow habitat.

An increasing concentration of moose along the margins of larger, lower elevation drainages had become apparent by January (Fig. 3). This may have been partially due to increasing snow depths that reduced the availability of lower-growing alpine willows. An increasing use of vegetation growing on the steep slopes along the banks of the Susitna River below Goose Creek was noted during January and February surveys (Fig. 3 and Fig. 4). Many of the willow-supporting islands of the Susitna River were examined, and it was speculated that most of the available browse on these sites had been utilized, forcing the moose to go elsewhere for food.

Ground examination of these river bottom willow-covered sandbars were made during two different periods. A ground examination of a willow bar at the mouth of the Tyone River during May 31, 1974 was the basis for the following observations. We landed initially alongside a willow-covered river bar near the mouth of the Tyone River. Six to ten foot tall balsam poplar with a low density of taller willows dominated the vegetation in the center of the bar. Utilization of these willows was light to moderate. The periphery of the bar consisted of a 2 to 3 foot high moderately dense stand of willows that appeared to be almost evenly cropped (mainly moose cropping, some rabbit clipping) at the presumed snow line. Fred Williams, sport fish biologist conducting the sport fish studies at that time, stated that utilization of willows was also high on the sand bars he has visited. During April, 1975 two willow-covered sandbars on the Susitna River below the MacLaren River were examined and the willow bar near the mouth of the Tyone River was revisited. These willow bars were completely tracked over by moose. Although maximum snow depths had receded by the time of these surveys, it appeared that essentially all of the willow twigs above snowline had been cropped. A moose calf that had starved was lying on the Tyone River sandbar.

By late April, there were relatively few moose or moose tracks crossing the Susitna River below the mouth of the Tyone River. The snow had accumulated to above normal depths in the northern portion of the Susitna study area, and most moose were observed in relatively large concentrations. Moose range was evaluated during April and was placed into light, moderate, or heavy use categories depending on the density of cumulative tracking and cratering (Fig. 6). The contour intervals of areas that would be inundated by the proposed Devil Canyon and Watana Creek dams were superimposed on these moose range maps, and categories of moose range that would be inundated were measured to obtain the following results.

Proposed Dam	Maximum Water Level	Moose Range Category	Area Indundated, Sq. Mi.
Devil Canyon	1450	Light	6.8
		Moderate	5.6
		Heavy	0
Watana	2045	Light	0
		Moderate	20.2
		Heavy	44.0
Combined		Light	6.8
		Moderate	25.8
		Heavy	44.0

Our data indicated that 12.4 mi.^{2} would be inundated by the Devil Canyon Dam (vs 11.8 mi.^{2} calculated by the U.S. Corps of Engineers) and 64.2 mi.^{2} would be inundated by the Watana Dam (vs 67.1 mi.^{2} calculated by the U.S. Corps of Engineers). It is assumed that the differences are due to our necessarily crude methods of measuring areas. It is apparent that the Devil Canyon Dam will have less serious consequences by inundation of moose winter range than the Watana Dam. Examination of Figure 6 shows that any flooding of the Susitna River above Deadman Creek will result in the loss of heavy or moderately-used moose winter range.

Moose body condition was evaluated to compare moose in different drainages and to see how well moose fared during the 1974-75 winter. Samples were too small to compare moose in different drainages, so the pooled results for the upper Susitna study area are shown below.

Area	Condition Rating	Percent (No.) of Moose Adults	Percent (No.) of Moose Calves
Combined Coal Creek,	Dead:	0% (1)	3% (1)
MacLaren River, and	Bony:	18% (21)	72% (26)
Clearwater Creek.	Moderate:	65% (75)	25% (9)
	Fat:	17% (20)	-- (0)

This information shows that the wintering areas used by adult moose during the 1974-75 winter (with above average snowfall) were adequate to maintain them in a moderately fat condition, but moose calves became food limited. An assessment of moose wintering on the Oshetna River indicated that the adults were moderatly fat but snow was shallower and browse was more available in comparison to the Clearwater Creek - MacLaren River area.

Caribou Distributions and Trails.

Observations of caribou during the winter surveys are shown on Figures 2 to 5. Generally, few caribou wintered in the Susitna study area. Several hundred caribou have been observed on the Susitna River above the Denali Highway and the adjacent higher country between Valdez Creek and the East Fork of the Susitna River during previous November surveys. A total of 255 were seen in this area during November 1974 (Fig. 2) but they were not seen during subsequent monthly surveys. In addition to the caribou groups shown in Figures 2 to 5, tracks of a band of caribou located just south of Devil Canyon during November (Fig. 2) indicated that perhaps 50-100 caribou were in that vicinity.

The observation of well-defined, rutted caribou trails crossing the Susitna River east of Watana Creek (Fig. 2) were of especial interest. These trails were observed on opposite banks of the Susitna River, indicating this is a traditional crossing area. Other trails north of Watana Mountain led to the Susitna River but could not be found on the opposing north bank. A substantial portion of the Nelchina caribou herd (numbering from 8,000 to 60,000 during the last twenty years) usually appears around the Deadman Lake - Butte Lake area during the summers, and it is possible that these animals may frequently use the observed crossing site of the Susitna River. No rutted trails crossing the Susitna River were seen elsewhere during the 1974-75 surveys.

Harvests and Hunting Pressure.

Reported harvests of moose, caribou and sheep and annual numbers of moose hunters are shown in Table 1. Since 1963, an average of 1,315 moose have been harvested annually from Unit 13 by an average of 3,666 hunters. A ratio of moose killed in the Susitna study area to moose killed in the center of Unit 13 was derived from 1974 harvest reports; if that ratio was constant in past harvests, the Susitna study area would have yielded an average of 413 moose annually harvested from the upper Susitna River drainages. Variance in hunter harvest reports over the years does not provide all data needed to fully qualify that figure.

Estimated caribou harvests from Unit 13 based on harvest reports indicate that an average of 5,386 caribou annually have been harvested since 1963. The portion of this kill from the upper Susitna River drainages has probably varied widely over the years, but it may have approximated one-third of the average annual harvest from Unit 13.

The reported harvest from the Watana Hills Dall sheep herd is usually about 3 sheep.

Observations of Other Mammals.

A group of approximately 200 Dall sheep inhabit the range of hills lying east of Watana Creek - Butte Creek and west of Jay Creek - Coal Creek. These sheep are partially isolated from the larger sheep population of the Talkeetna Mountains by low country. Although immigrations and emigrations may occasionally be expected, in most years the Watana Hills sheep herd is probably distinct. A portion of this sheep herd was seen during the April survey (Fig. 6), even though no effort was made during the surveys to fly at the higher elevations where sheep sightings would be expected.

Wolves, wolverines, and foxes were frequently seen distributed throughout the Susitna study area, but observations are not recorded here.

DISCUSSION AND CONCLUSIONS

Surveys to obtain moose distributions have shown moose to generally be at low elevations in the late winter and spring and at higher elevations in the late fall and early winter. The proposed Susitna River dams, therefore, may effect moose in entire drainage systems and not merely those moose seen within or near the areas of inundation.

Those situtaions where many moose have crossed or traveled along river corridors that will be flooded or will have fluctuating water or ice levels are of particular concern. As an example of major river crossings, the available information suggests that most moose seen during early winter within the "big bend" north of the Susitna River cross the Susitna River to join moose wintering on the lower Oshetna River vicinity. These moose may still mostly be south of the Susitna River during June. As another example, the dense moose concentration seen south of the MacLaren River during June may be mainly the same wintering moose concentration that was found during April on Clearwater Creek. Prevention of these seasonal movements may result in a sharp reduction in numbers of the affected moose. Ice shelves created by fluctuating water levels in the winter or deep, wide impoundments may act as complete or partial barriers to movements.

In addition to river crossings as part of seasonal migrations, the criss-crossing of rivers by moose that spend a portion of the winter near rivers is of concern. Tracks indicated that moose use vegetation on both sides of streams, and it seems possible that prevention of moose crossings may lower local carrying capacity by (1) isolating pockets of vegetation where ready access is only via the frozen river and (2) creating localized pockets of browse that are insufficient in quantity to attract and support moose but would have contributed to the support of those moose attracted by additional nearby browse.

Moose generally appeared to successively use different habitat types during the winter. During early winter, most moose were near timberline, but they were found increasingly at lower elevations among riparian browse and along the steep slopes of the Susitna River by midwinter. By late winter, the steep slopes of the Susitna River and mid-elevations along the Susitna River, that had previously supported moose, were infrequently used and more moose were mostly found in larger concentrations in willow patches on the Susitna River's major tributaries. Following snow recession during the spring, most moose were thinly distributed at lower elevations except for a concentration area south of the MacLaren River. While the importance of some areas to moose may be proportional to the extensiveness, quality, and availability of contained browse, some areas may be of importance out of proportion to the contained browse depending on the winter snow accumulation, slope, time of leafing out of browse, or other factors. The relevance of this possibility is suggested by the observed shifting concentrations of moose in various areas of the Susitna River or its major tributaries at different time periods.

Over 7,000 moose may have been within the study area. Natural mortality due to predation is probably high and calf survival over the last decade has been low. The contained moose population may be somewhat below its optimum size.

The Susitna study area below the Denali Highway was not utilized by substantial numbers of wintering caribou. However, a large portion of the Nelchina caribou herd traditionally crosses the Susitna River from its calving area near Kosina Creek to spend the summer in the Deadman Lake - Butte Lake vicinity. A major crossing site on the Susitna River was located just east of Watana Creek. The Susitna River appears to be a formidable obstacle to calf caribou. Changing of conditions at this crossing may or may not prevent the passage of adult caribou, but the effects on calves as they attempt to follow the cows must also be considered. Should modifications of this crossing site make the Susitna River a barrier to caribou passage, the loss of habitat would directly lower the potential maximum population size. Secondarily, a reduction in recreational value of the upper Susitna River would result from the loss of recreational caribou hunting.

The Watana Hills sheep herd lies within the Susitna study area, but these sheep will probably not be directly affected by construction of dams on the Susitna River. Other big game or fur bearer populations would probably be impacted by indirect effects of increased human access and altered numbers of prey species, but these potential impacts were not studied and are presently unknown.

From the standpoint of recreational hunting, the Susitna study area may be one of the most important areas in the state. Harvest data show that the Susitna study area contributes a token sheep harvest but a moderately large moose harvest. Most of the moose harvest from the

Susitna study area is from the Denali Highway - Coal Creek vicinity and from the upper Oshetna River vicinity. Access has rapidly been increasing in recent years, and the central portion of this area will probably contribute to an increasing extent if past access trends continue. The usual contribution of the Susitna study area to the annual caribou harvest was assessed as perhaps one-third of the total. During the past three years, most moose and caribou hunting activity within Unit 13 appeared to be on both the north and south sides of the Susitna study area.

An indirect effect that would probably result from construction of Susitna River dams would be increased access into the center of Game Management Unit 13 through road construction and waterway access. Although this has both positive and negative implications to wildlife, the negative aspects predominate. A major increase in access would probably require more intensive management activities with a resulting increase in wildlife management costs. A highway corridor alongside the Susitna River may increase the potential barrier to caribou movements. In addition, any increased human activity near the Nelchina caribou's calving grounds is undesirable.

In summary, moose and caribou are the key wildlife assets of the upper Susitna River, and the major effect of dams on these ungulates is negative. Moose may be impacted by blockage of seasonal movements across or along river corridors due to fluctuating ice levels or deep water impoundments and by direct loss of critical winter range through flooding. Caribou movements may be similarly impacted by impounded water or fluctuating ice levels, and the Nelchina caribou calving area will probably be exposed to more human activity secondary to better access and dam construction activities. Wildlife management costs will necessarily increase, and the overall effect of these dams will be to decrease numbers of moose and caribou. The effect of the Devil Canyon Dam alone will be mild; the effect of the Watana Dam is expected to be moderately severe. Any dam on the Susitna River that impounds water above Deadman Creek will inundate moderately or heavily-used moose winter range; any dam that impounds water above Watana Creek may disrupt moose and caribou movements with potentially severe effects.

The scope of this paper does not extend to downstream wildlife or the effects that the dam would have on those species; effects may prove considerable.

MITIGATIVE ACTIONS

Prior to dam construction activities, detailed studies should be conducted to more fully determine the use of this area by resident wildlife, to gain a better understanding of the potential effects of dams on the area's vegetation and wildlife, and to evaluate range improvement techniques for possible use to offset loss of moose range. Ungulate movements across drainages are largely seasonal. Where operation of dams results in fluctuating ice levels that may impede wildlife movements, changes in timing of these operations perhaps could be made that would exchange a loss of operating efficiency for a reduced barrier to ungulate movements. Loss of moose winter range may be partially compensated for by well-planned, extensive range rehabilitation over a long period of time. However, even a good and extensive range improvement program probably won't fully mitigate any substantial losses of riparian willow habitat.

REFERENCES CITED

Anon. 1954. A progress report on wildlife of the Susitna River basin. 35 pp. U.S.D.I. Fish and Wildlife Service, Juneau.

Anon. 1960. A detailed report on fish and wildlife resources affected by the Devil Canyon Project, Alaska. 26 pp. U.S.D.I. Fish and Wildlife Service and Bureau of Commercial Fisheries, Juneau.

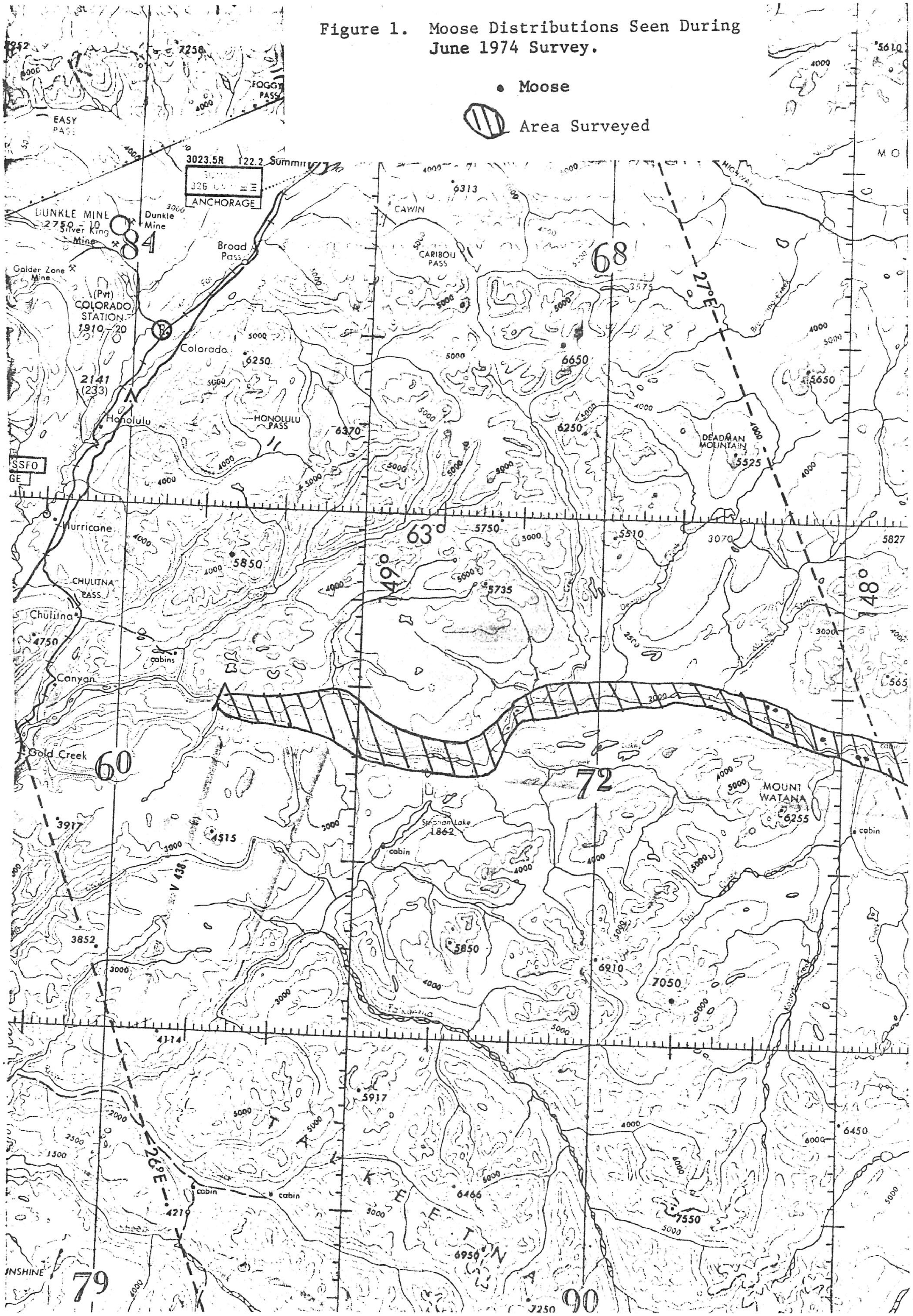
Table 1. Harvest Data from Game Management Unit 13.

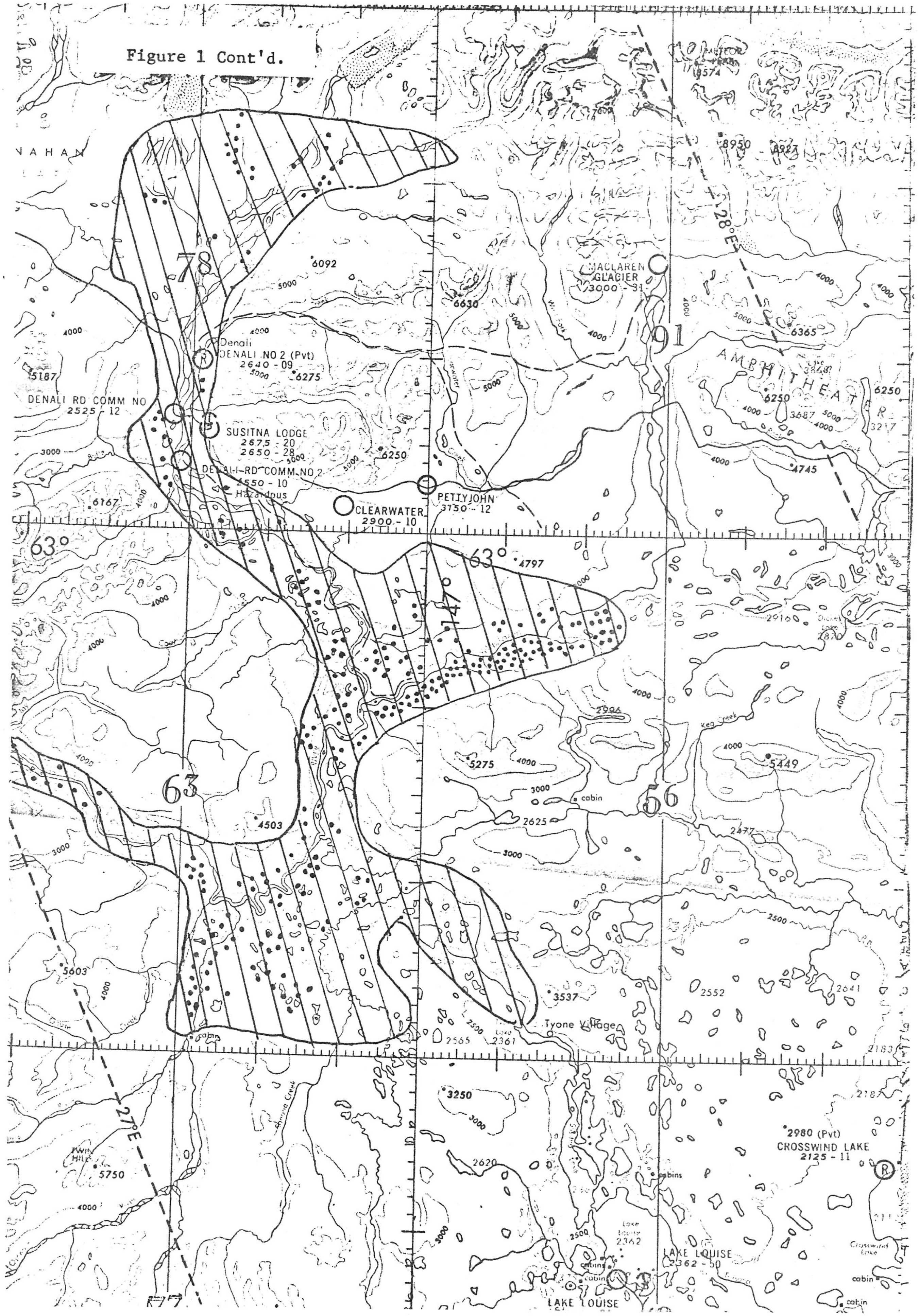
	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Reported Moose Harvest, Unit 13:	1735	1607	1331	1553	1552	1512	1219	1329	1815	712	618	794
Reported Moose Harvest, Center Unit 13[a]:	578	691	299	353	506	512	405	427	540	302	324	394
Estimated Moose Harvest from upper Susitna River drainages[b]:	537	642	278	328	470	476	376	397	502	281	301	366
Total Moose Hunters, Unit 13:	——	——	——	4163	4027	4476	3381	3585	4881	3199	2513	2770
Estimated Caribou Harvest, Unit 13:	6300	8000	7100	5500	4000	6000	7800	7247	10,131	555	810	1192
Reported Sheep Harvest, Watana Hills:						5	1	7	2	2	2	3

[a] Actual harvests are higher because of harvests where location of kill was not reported. The center of Unit 13 is that portion of Unit 13 bounded by the Glenn, Richardson, Denali, and Anchorage-Fairbanks Highway.

[b] Estimated harvests from the upper Susitna River drainages during past years were obtained by multiplying annual moose harvests from the center of Unit 13 times the 1974 ratio of (moose harvest from upper Susitna River drainages/moose harvest in the center of Unit 13).

Figure 1. Moose Distributions Seen During June 1974 Survey.





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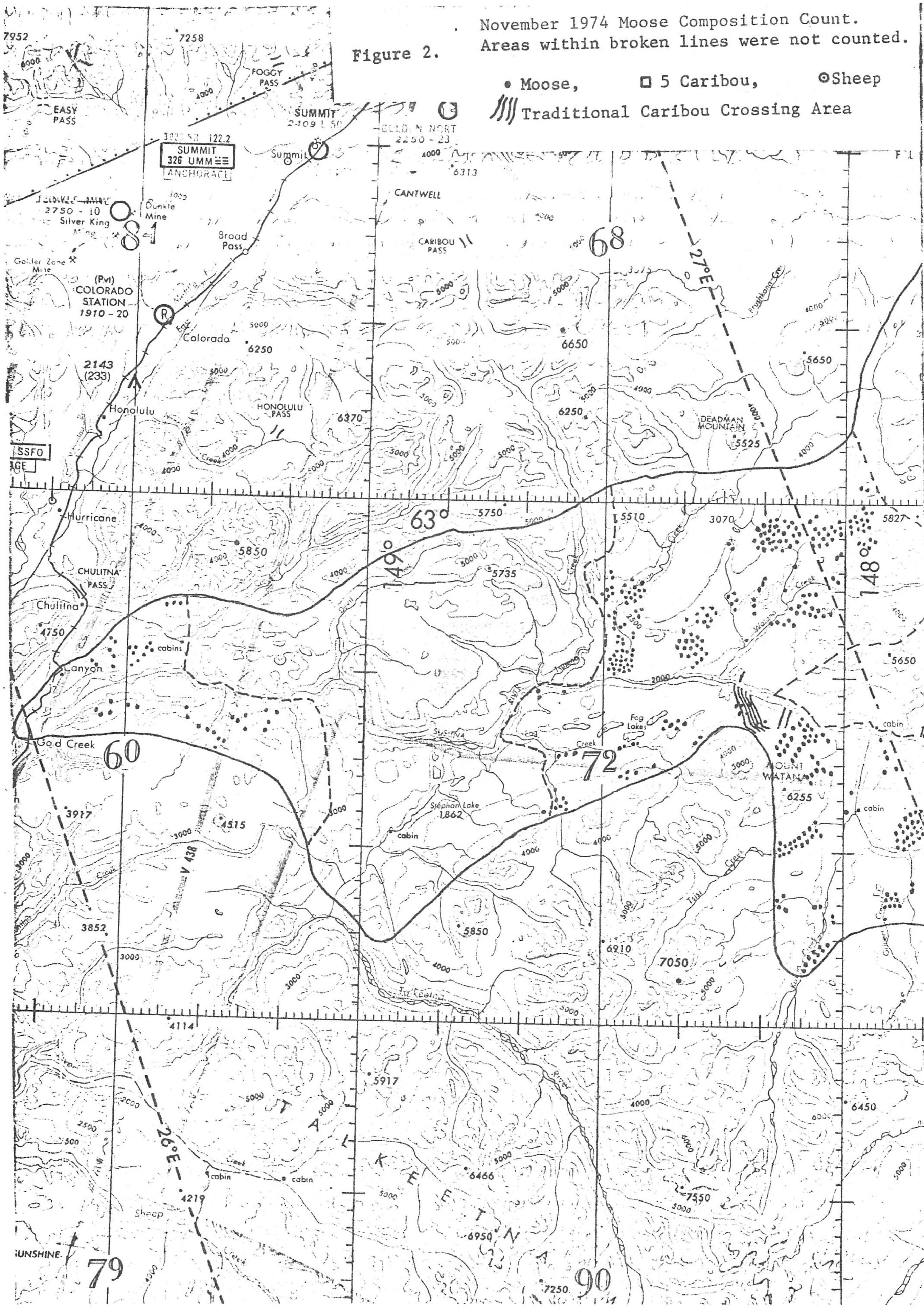


Figure 2. November 1974 Moose Composition Count. Areas within broken lines were not counted.

• Moose, ▫ 5 Caribou, ⊙ Sheep

/// Traditional Caribou Crossing Area

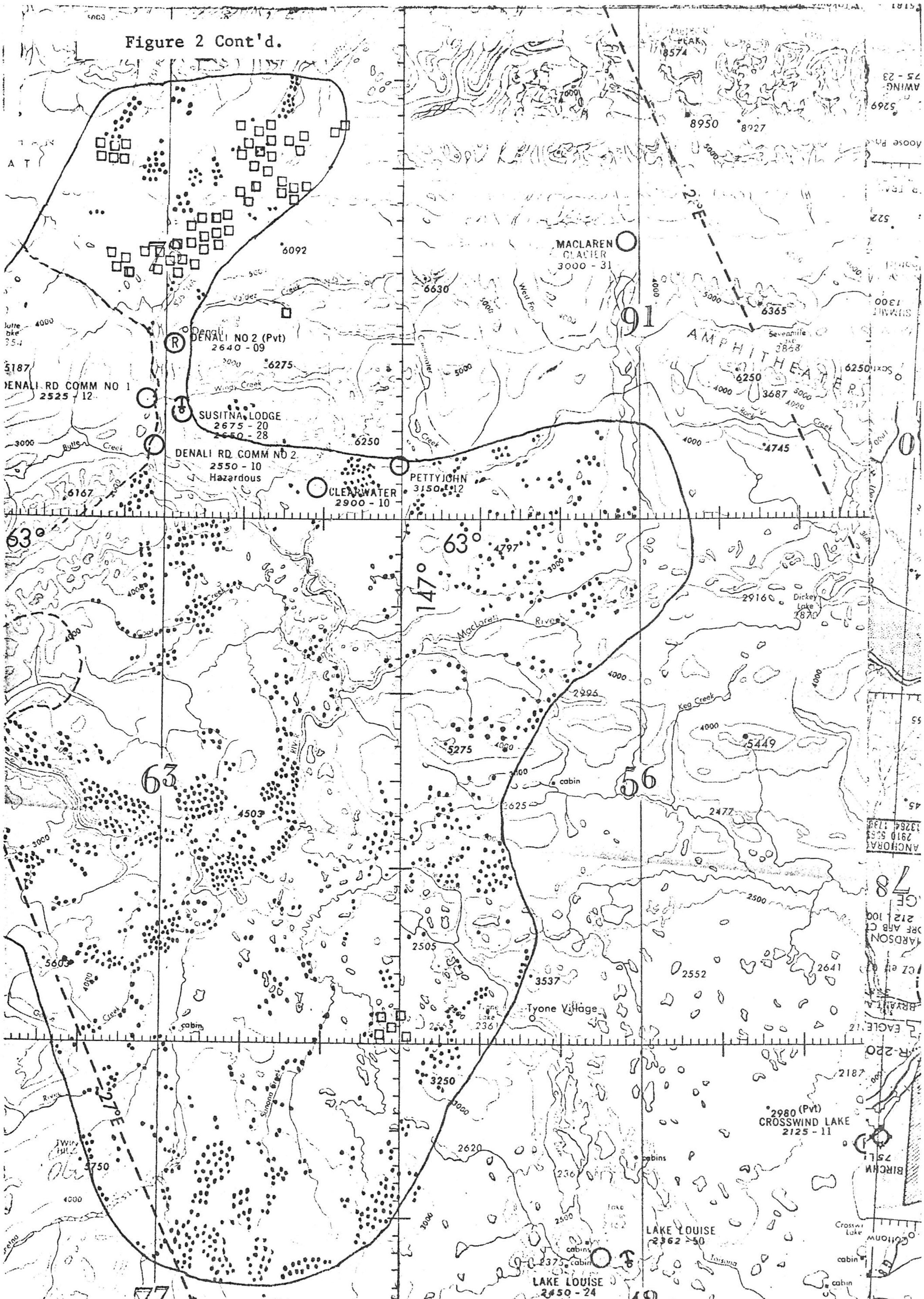


Figure 2 Cont'd.

Figure 3. Moose concentrations during the January flight of the Susitna Project. 1975

o Moose □ Caribou ⊙ Sheep

Figure 3 Cont'd.

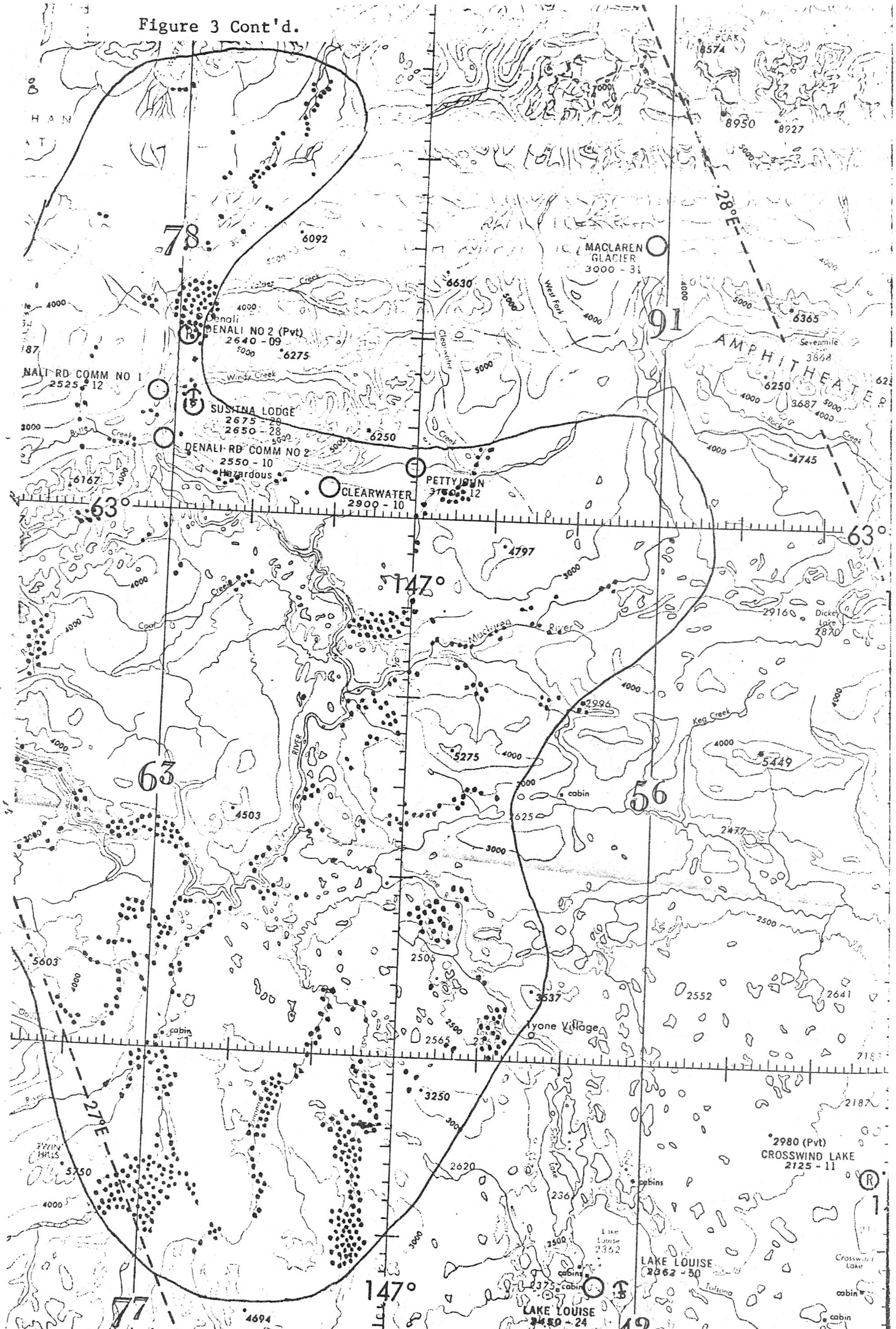


Figure 4. Moose concentrations during the February flight of the Susitna Project. 1975

● Moose, □ Caribou, ⊙ Sheep

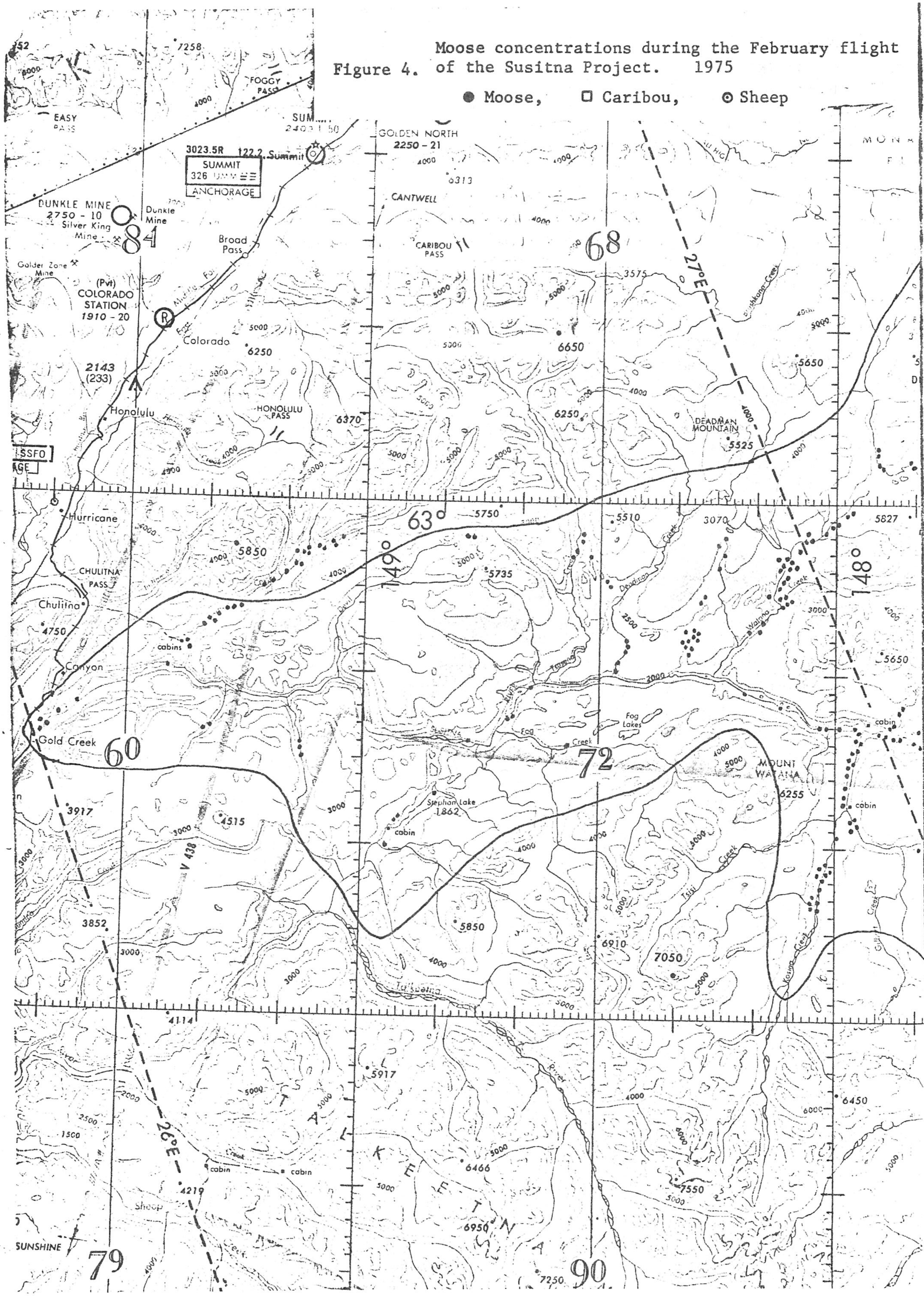
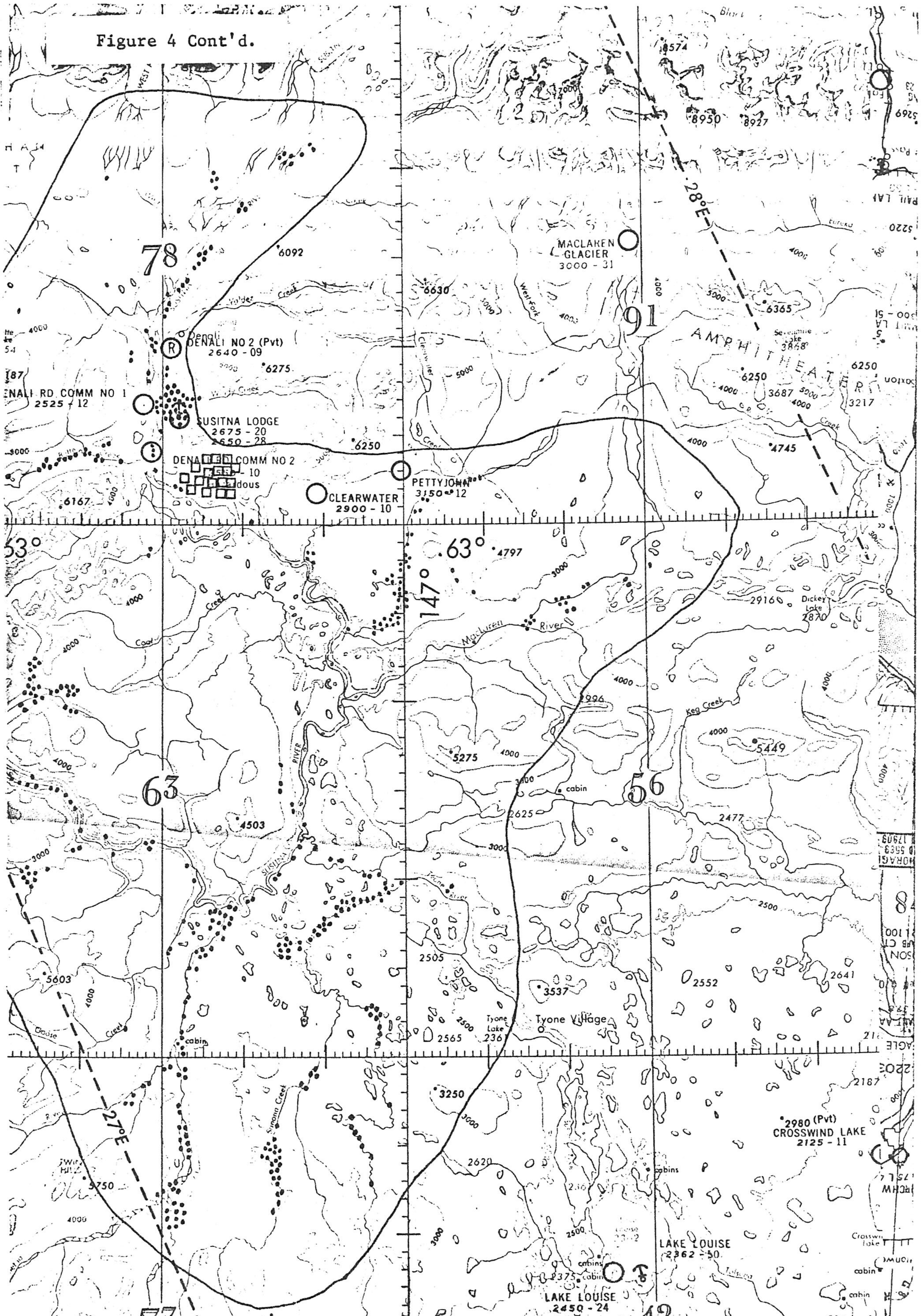


Figure 4 Cont'd.



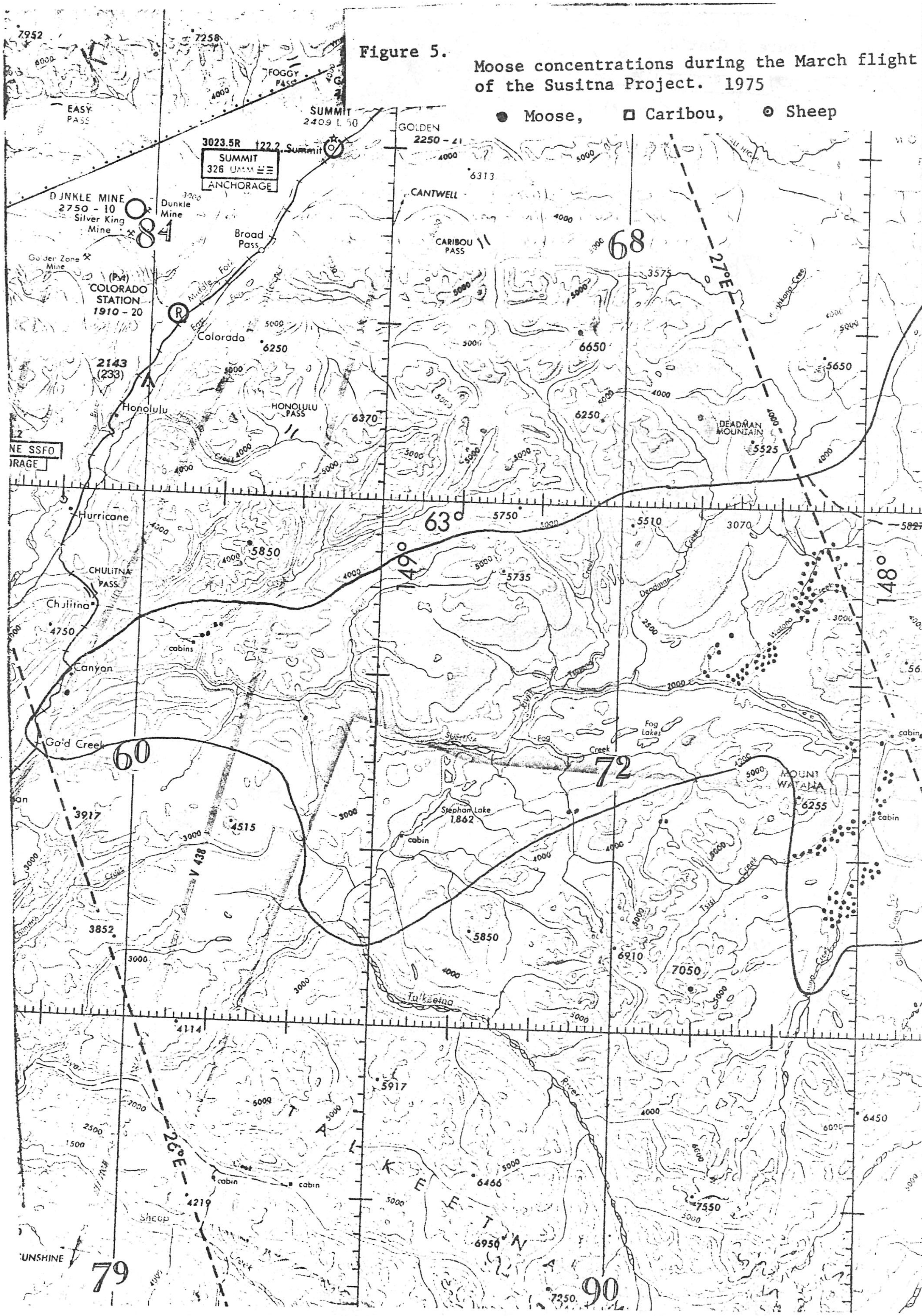


Figure 5. Moose concentrations during the March flight of the Susitna Project. 1975

● Moose, ◻ Caribou, ⊙ Sheep

Figure 5 Cont'd.

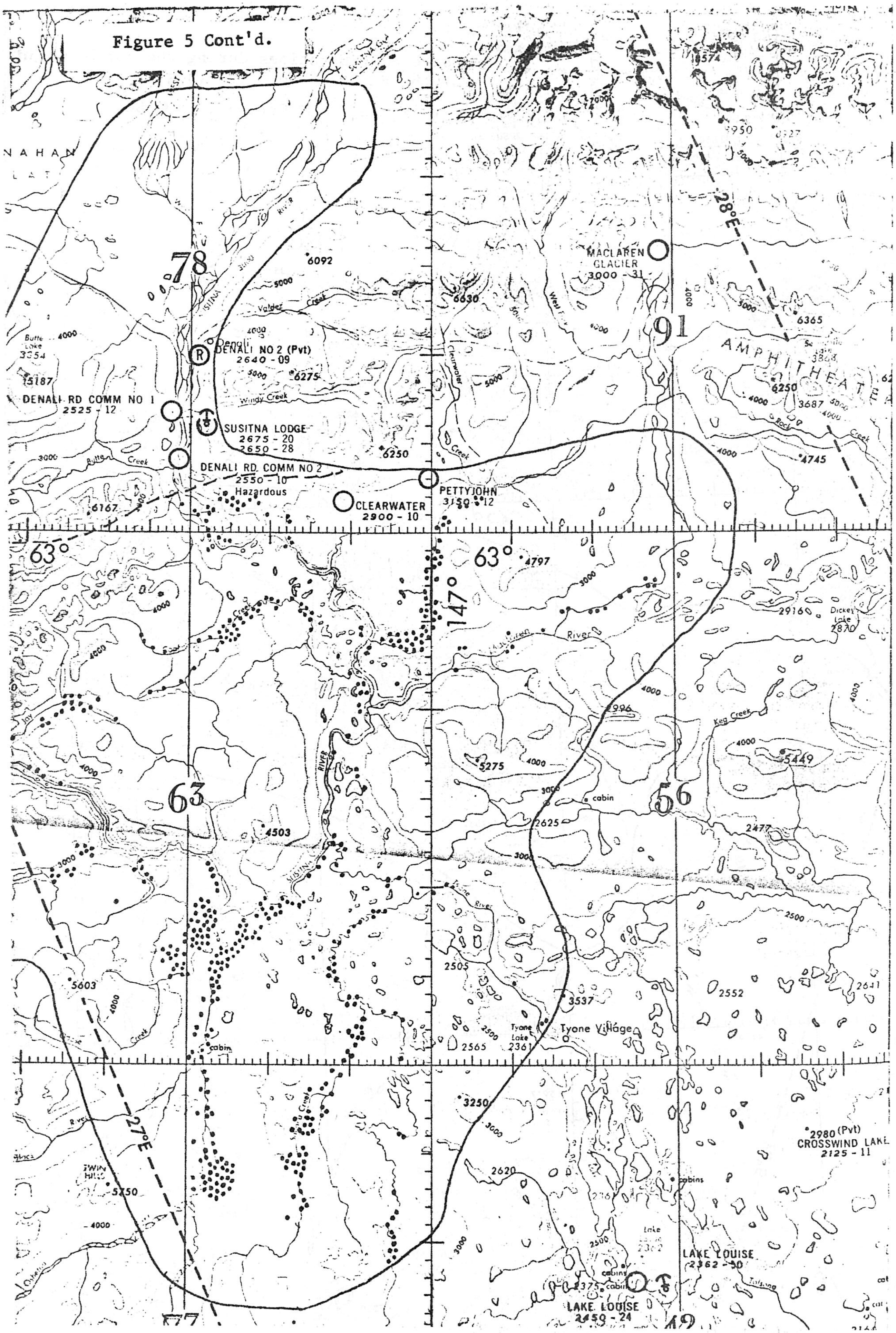


Figure 6. Moose concentrations during the April flight and areas of light, moderate, and heavy utilization by moose. Areas surrounded by the broken lines are the proposed inundated areas. 1975

● Moose, □ Caribou, ⊙ Sheep

Utilization Key:

Light Utilization

Moderate Utilization

Heavy Utilization

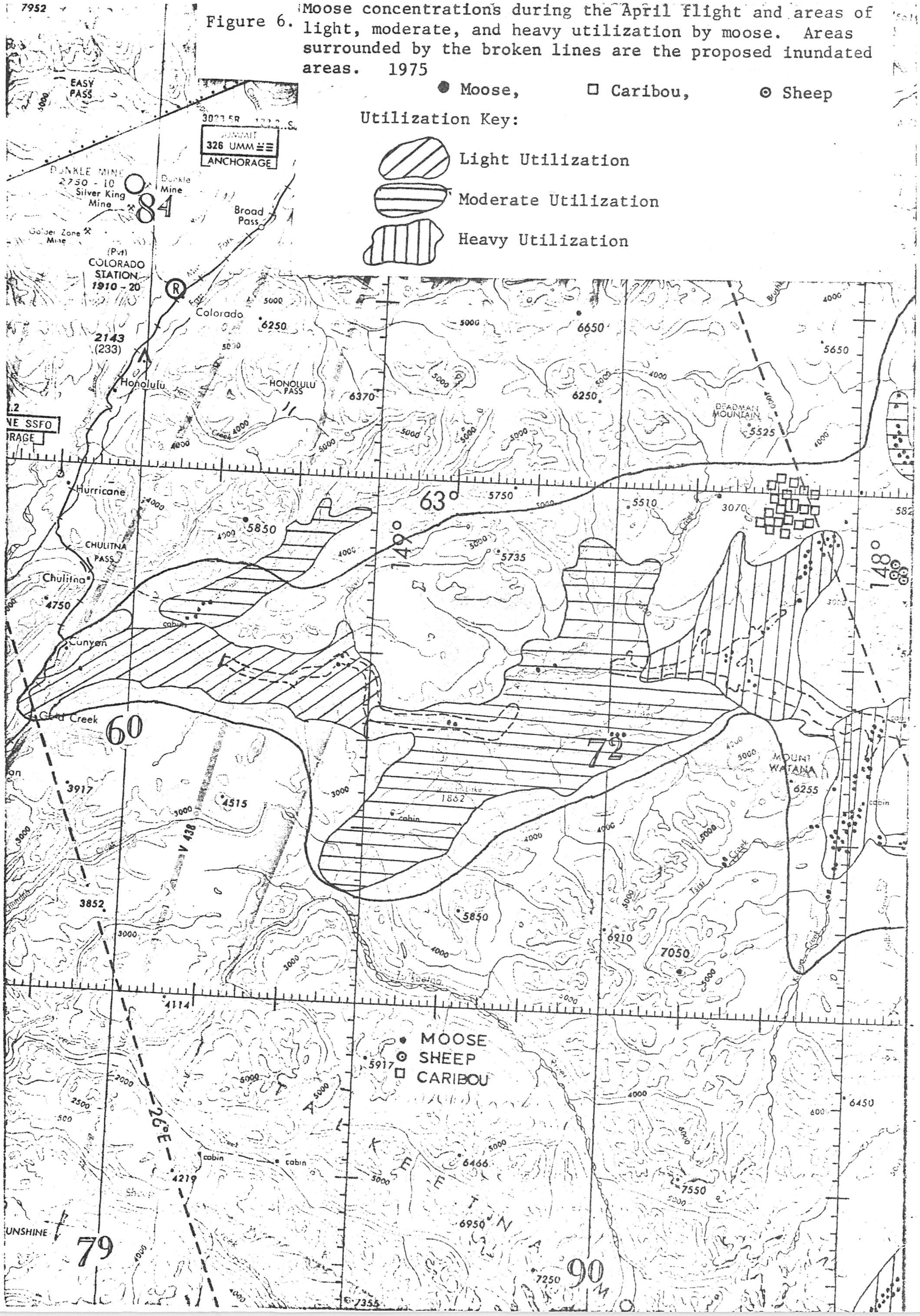


Figure 6 Cont'd.