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GEORGE RIVER WEIR SALMON ESCAPEMENT PROJECT, 1996

By

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ACKNOWLEDGMENTS

The 1996 George River weir project was a cooperative venture in every sense. Individuals from a wide range of organizations, interests and locations converged and worked together to make the project a reality.

It is with great appreciation and enthusiasm that we give recognition and thanks to those who made the development of the George River weir possible in 1996. Dan Senecal-Albrecht of the Bering Sea Fishermen's Association and Tom Kron of the Alaska Department of Fish and Game worked diligently with the U.S. Bureau of Indian Affairs, the Kuskokwim Native Association, and the Alaska Department of Fish and Game to secure funding for the project and nurture a supportive atmosphere among the cooperating groups.

It is with equal appreciation and enthusiasm that we also recognize and thank those whose dedication and commitment during the field season made the George River weir project a success. The 1996 field crew of Stephen Blanchette, Bernard Vaska and Bryon Ward did a commendable job in constructing and maintaining the weir and camp facilities under some very challenging circumstances. Joe Whittom and Chris Schmierbach assisted during the initial start-up of the project and provided valuable training to the field crew. Donna Elliott pitched in to assist with end of season activities including an arduous journey to Bethel. Gary Kyle and Jim Edmundson of the ADF&G Limnology Laboratory in Soldotna coordinated the chemical analysis of water samples and assisted with text describing methods, results and interpretations. Charlie Burkey and Gary Knuepfer did the initial 1995 site survey that laid the ground work for establishment of the weir. Ray Peterson, Johnny Andreanoff, Oscar Andreanoff and Carl Morgan helped with the 1996 reconnaissance trip to identify and mark the project site. Bob and Richard Vanderpool offered endless hospitality and assistance to the field crew which nurtured good morale and contributed to the success of the project. The Vanderpools also allowed materials to be stored over the winter at their facility near the mouth of the George River, a privilege that greatly simplified logistics at the end of the 1996 field season and will equally simplify start-up of the 1997 field season. Thanks is also extended to Dave Ausdahl and Kyle Inman whose concern for the well being of the George River salmon populations drew attention to the George River as a candidate for an escapement assessment project. In addition, Dave helped coordinate the barge transportation of supplies to the George River.

All of these individuals should rightfully take pride and satisfaction that their efforts have furthered our understanding of the salmon populations of the Kuskokwim River. These endeavors will lead towards improving the wise and effective management of Kuskokwim Area salmon fisheries.

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ABSTRACT

A weir was used to collect data about the abundance, run timing and other characteristics of the George River salmon spawning populations in 1996. Counts began 21 June and continued through 26 July when the project ended prematurely due to high water. A total of 7,487 chinook *Oncorhynchus tshawytscha*, 98 sockeye *O. nerka*, 17,570 chum *O. keta*, 644 pink *O. gorbuscha*, and 173 coho salmon *O. kisutch* were estimated to have passed through the weir. Substantial numbers of chinook and chum salmon likely passed upstream of the weir site prior to installation. As such, future counts should begin approximately 10 June. Likewise, chum, pink and particularly coho salmon continued to pass upstream of the project site after the weir was dismantled. Complete enumeration of the chum salmon run will require future weir operations to continue through about 15 August. The current weir design requires some modifications in order to better deal with high water events.

The age, sex and length compositions of chinook and chum salmon varied throughout the season, but the pattern generally conformed to those observed at other locations. The overall age composition of chinook salmon was 7% age 1.2, 21% age 1.3, 39% age 1.4 and 32% age 1.5. Female chinook salmon composed 52% of the passage. The age composition of chum salmon was 2% age 0.2, 55% age 0.3, 41% age 0.4 and 2% age 0.5. Females composed 45% of the chum salmon passage.

In addition to salmon, 3,555 longnose suckers *Catostomus catostomus* were also passed upstream of the weir. The longnose suckers passed primarily in June, and were presumed to be on their spawning migration.

Analysis of water samples showed high levels of iron, primarily associated with the particulate fraction. Most of the trace elements were found to be at or near the analytical detection limit. As such, concentrations are within acceptable water quality standards, and there is no evidence of heavy metal pollution.

INTRODUCTION

This report presents methods and results for the George River weir project in 1996. The project was initiated to contribute towards a better understanding of salmon spawning populations in a region of the Kuskokwim River drainage in which escapements are not currently monitored. This was the first year in which salmon population assessments have been attempted for the George River. This was also the first cooperative project between ADF&G and the Kuskokwim Native Association (KNA).

Except for a small number of tributaries, information is generally deficient regarding the abundance and in-season dynamics of local salmon spawning populations in the Kuskokwim River drainage. The paucity of information is a deterrent to effective management of the subsistence and commercial salmon fisheries. Any addition to the existing inventory of knowledge could make a significant contribution to the salmon management program. The streams whose spawning populations have been studied have tended to be located in the lower Kuskokwim River and drain the southern half of the Kuskokwim Mountains. In contrast, the George River is a tributary of the middle Kuskokwim River and drains the northern half of the Kuskokwim Mountains, so its selection as a project site broadens the geographic distribution of projects monitoring salmon spawning populations.

Historically, the northern region of the Kuskokwim Mountains has supported a relatively high level of mining activity. Mining interest has expanded in recent years with the proposed Donlin Creek project, which borders the George River drainage (Appendix A). The area has also been the subject of queries regarding possible large scale timber harvest. The potential impacts of these proposed resource extraction activities heighten the interest and need for developing a thorough baseline description of the George River salmon spawning populations.

The George River is a known spawning area for chinook *Oncorhynchus tshawytscha*, chum *O. keta* and coho salmon *O. kisutch* (ADF&G 1995). Chinook, in particular, have been observed spawning in the upper reaches of the drainage (Wayne Dolezal, ADF&G Habitat Division, Anchorage, personal communication). Since 1960, biologists from the Commercial Fisheries Management and Development Division (formerly the Commercial Fisheries Division) have periodically flown aerial surveys of the drainage to index the presence of salmon (Table 1); however, the dark tannic color of the water impeded surveying efforts such that the river received little attention throughout the 1980's and early 90's (Burkey and Cappiello 1996). Attention was revived in 1995, when a local sport fishing guide contacted a Department biologist in Bethel about concerns that boat traffic was disturbing the 'hundreds' of chinook salmon spawning in the lower George River. Shortly thereafter a Department biologist conducted an aerial survey of a portion of the George River and reported seeing 1,173 chinook and 420 chum salmon. When the opportunity became available to develop a new escapement monitoring project, in cooperation with KNA and the Bering Sea Fishermen's Association (BSFA), the Department recommended George River as the primary candidate.

Objectives

The objectives of the George River project were to:

1. establish and maintain a salmon weir and support facilities on the lower George River for the purpose of estimating salmon escapement into the drainage;

2. estimate daily and total season escapement of chinook, sockeye, chum, pink and coho salmon into the George River;

3. estimate the age, sex and length (ASL) composition of chinook, chum and coho salmon spawning populations in the George River;

4. examine the mean stream life of spawning chinook and chum salmon in the George River by counting salmon carcasses as they are passed downstream of the weir;

5. collect and preserve tissue samples from 100 chum and 100 coho salmon from the George River for genetic stock analysis;

6. monitor climatological and hydrological conditions at the weir site to provide information relating to potential environmental effects on salmon populations; and

7. collect water chemistry information to serve as a baseline for comparing against future water quality conditions;

Study Area

The George River originates in the mineral rich Kuskokwim Mountains and much of the drainage is steeply sloped. The stream flows south for a distance of about 47 km (75 mi.) to its confluence with the Kuskokwim River at river kilometer (rkm) 507 (river mile, rm. 315) (Figure 1). Tributaries include the East, South and North forks, Michigan Creek and Beaver Creek (Figure 2). The drainage covers 3,626 square kilometers (1,400 square miles or 896,000 acres) of mostly upland spruce-hardwood forest (Selkregg 197?). White spruce with scattered birch or aspen is common on moderate south-facing slopes, while black spruce is more characteristic on northern exposures and poorly drained flat areas. The understory consists of spongy moss and low brush on the cool moist slopes, grasses on dry slopes, and willow and alder in the higher open forest near timber line.

The weir project site is located in a poorly drained area in the lower reaches of the George River, about 6.4 km (4 mi) upstream of its the confluence with the Kuskokwim River (Appendices B and C). The channel profile is very uniform with the central 91 m (300 ft) measuring about 1 m (3 ft) in depth during a 31 May 1996 reconnaissance trip. The channel quickly shallows towards either shore. The substrate is composed of medium sized gravel and surface velocity was estimated at 0.76 to 0.94 m/s (2.5 to 3.1 ft/s) on 31 May 1996, which is a manageable current for weir installation.

METHODS

Facility Construction and Maintenance

Site Selection

An initial survey for suitable weir locations was done on 26 September 1995 when ADF&G biologists conducted a reconnaissance of the lower George River (Appendix B). The most promising site was located approximately 6.4 km (4mi) upstream of the confluence of the George River and the Kuskokwim River (Sleetmute C4 Quadrangle). The camp site is not well drained and is vegetated predominantly by black spruce. A three meter high bank allows for good viewing of the river and weir. On 30 May 1996 a department biologist, accompanied by three staff members from KNA and local guides, did a follow-up reconnaissance trip confirming rkm 6.4 as the project site (Appendix C). On both occasions channel depths were reported at potential sites and velocity estimates were measured by timing objects floating on the surface for a measured distance downstream.

Permitting

Three permits were required to install and operate the weir at rkm 6.4. Habitat Division of ADF&G required a permit for conducting activities within anadromous fish streams, as required under Alaska Statute 16.05.870(d) (Appendix D). The Bureau of Land Management (BLM) required a Land Use Permit for use of the camp site, under 43 CFR 2920 (Appendix E). A land use permit was also obtained from the land owner, The Kuskokwim Corporation (Appendix F).

Logistics

The community of Aniak (rkm 362, rm. 225) was the primary pre-season staging area for equipment storage, boat leasing and hiring KNA crew members. Aniak is located along the

Kuskokwim River approximately 135 km (84 miles) downstream from the confluence of the George River. Aniak is also the headquarters for KNA. Most weir materials were freighted from Anchorage and Bethel to Aniak in the early spring via air cargo services. After winter break-up additional materials were shipped from Bethel to Aniak via commercial barge lines. Materials were kept in storage at the KNA facility in Aniak until 10 June when all items were transported via commercial barge lines to the mouth of the George River. Lumber was loaded from the supplier in Chuathbaluk (rkm 375, rm. 233) while the barge was in route to George River.

The field crew was selected by 5 June. The lead crew person was an ADF&G Fish and Wildlife Technician II. Two crew members were hired by KNA. Additional staff were provided by ADF&G to assist with camp installation, training and dismantling of the camp. The KNA crew members began active duty in Aniak on 10 June. They were joined by two Department staff on that same day. Supplies were purchased, inventoried, and loaded on to the barge which departed Aniak in route to George River on the evening of 10 June. The KNA crew, along with the two Department staff departed Aniak in two skiffs on 11 June and arrived at the George River camp site early that evening, well ahead of the barge. The lead crew person arrived at the site on 17 June.

One of the skiffs used to transport equipment and crew to the project site was leased from a person in Aniak. The leased skiff was a 5.5 m (18 ft) aluminum flat bottomed boat equipped with a 40 hp Yamaha[2] 2-stroke outboard motor. The second skiff, supplied by ADF&G, was a 5.5 m (18 ft) aluminum Alweld boat (slight V-hull with transom tunnel) equipped with a 50 hp Honda 4-stroke outboard with a jet unit. The Alweld remained at camp for the duration of the project. Travel time from Aniak to the weir site in the Alweld skiff with a moderate load was 6.5 hours. and the Honda outboard used about 100 L (26 gal) of gasoline. Both skiffs were used to shuttle weir materials from the mouth of the George River to the weir site. The leased skiff was returned on 16 June and the lease terminated.

Most in-season supply needs were staged through either Crooked Creek (rkm 466, rm. 290) or Red Devil (rkm 526, rm. 327). Crooked Creek is located 31 km (19 mi) downstream of the George River while Red Devil is located 29 km (18 mi) upstream. Each of these communities has scheduled commuter air service with Aniak. Food and most other supplies were shipped from Aniak or Bethel via air carrier to one of these communities, where it was picked up by crew members for transport to camp. Travel time from the weir to Crooked Creek or Red Devil was approximately 1.5 hours. Outboard gasoline was generally purchased from one of these two communities, but it was not always readily available.

Equipment was stored in one of three locations at the end of the season (Appendix G). Weir panels and tripods were stored at the project site. The boat, outboard motor, radios and a few other items were stored at the ADF&G facility in Bethel. Most other materials were placed inside a vacant cabin near the mouth of the George River. The cabin is one of several owned by a local family who maintains a year-round homestead at the location including a very small airstrip. The airstrip was used by the Department on one occasion to transport staff visiting the project. The

[2] Use of company names does not imply endorsement by the State of Alaska.

family was especially hospitable to the weir crew throughout the field season, providing drinking water and a variety of amenities.

Operational Timetable

The project was initially intended to operate from 10 June through 31 July. The first ten days were dedicated to transporting materials to the site, installing the camp, building tripods and installing the weir. Fish passage was monitored from 21 June through 26 July. In mid-July an extension was approved to continue operation through late August, but high water forced a premature end to the project when a section of weir washed out. Following the washout, the crew dismantled and stored the remainder of the weir, recovered panels from the washout, collected genetic tissue samples of coho salmon, dismantled the camp, and stored all the equipment.

Camp Set-Up

The crew arrived on site 11 June and began initial camp construction. The barge arrived at the George River confluence early on 12 June and off loaded supplies to shore. Some of the crew members shuttled materials to the project site while others worked concurrently to fabricate camp facilities. A 3.7 m X 6.1 m (12 ft X 20 ft) Weatherport tent was used for sleeping quarters and office space was set up on a plywood platform The platform included a deck used as a work site during fabrication of tripods. A 4.3 m X 4.9 m (14 ft X 16 ft) canvas wall tent was set up for equipment storage. Other construction included an outdoor cooking area, plywood outhouse and a stair case leading down the cutbank from camp.

Weir Installation

On-site fabrication of the weir began 14 June and was completed on 20 June. At the time of installation, the maximum water depth was approximately 0.9 m (3 ft). The weir consisted of 35 wooden tripods, 70 aluminum weir stringers, 126 aluminum weir panels, sandbags and catwalk planks. At completion the weir formed a 107 meter (350 foot) fence across the stream and was capable of blocking passage of fish as small as pink salmon *O. gorbuscha*. Fish passed through the weir via removal of specially designated panels which served as "fish gates." One section of the weir was modified to allow for boat passage. A fish trap / holding box was also installed in the weir to help with biological sampling.

Tripods. Each tripod was composed of three wooden beams and a sandbag platform (Figure 3). The front leg of each tripod, which was oriented upstream, consisted of a 10.3 cm X 15.4 cm X 3.0 m (4 in X 6 in X 10 ft) beam. The two rear legs were composed of 10.3 cm X 15.4 cm X 2.4 m (4 in X 6 in X 8 ft) beams. The legs were joined at the apex by a steel brace and four 20 cm (8 in) through-bolts (Figure 4). The angle between the front and rear legs was 60 °. The two rear legs were spaced 1.4 m (4.5 ft) apart at the base. Additional bracing of 5.1 cm X 20.3 cm (2 in X 8 in) boards was placed at the mid point of the tripod using 10.3 cm (4 in) lag screws. This bracing also served as the base for a sand bag platform The sandbag platform was made with 2.6 cm X 15.4 cm (1 in X 6 in) boards nailed to the top of the bracing. After the tripod was positioned in the river, several sandbags were placed onto the platform to keep the tripod positioned in the channel. The platform was built high enough on the tripod to keep the platform and sandbags out of the water. The front leg of adjacent tripods were spaced at 2.9 m (9.5 ft) intervals. The tripods were aligned in a straight row and nearly perpendicular to shore in order to avoid scouring.

Stringers. The stringers were 3.0 m (10 ft) lengths of 5.1 cm (2 in) schedule 40 aluminum pipe. They were positioned to span the distance between the front legs of adjacent tripods. One stringer was secured with nails approximately 0.5 m (20 in) from the base of the front leg. The second stringer was secured in the same manner about 1 m (40 in) above the lower stringer. Adjacent stringers overlapped slightly.

Weir Panels and Sandbags. Weir panels were positioned to rest along the upstream surface of the stringers. Each weir panel was constructed of fifteen aluminum pipes, 2.6 cm (1 in) diameter and 2.03 m (6 ft 8 in) in length, welded into place on two pieces of hole punched aluminum T-bar (Figure 5). All welding was done pre-season by a contractor in Anchorage. The spacing between each pipe was 3.49 cm (1-3/8 in). The picket spacing was adequate for blocking passage of pink salmon while still maximizing water passage. The total width of each panel was 85.41 cm (33-5/8 in).

Panels were positioned to rest against the stringers and water current held the panels in place. The base of each panel was firmly seated against the stream bottom. To avoid lateral slippage adjacent panels were bound together by plastic electrician ties. Exceptions were panels used for fish or boat gates. These would need to be periodically removed. Sandbags were placed along the base of the panels to inhibit scouring. The fish gate and boat gate panels were not sandbagged. The stream banks on either side of the weir were reinforced with sandbags to avoid erosion during high water events.

Fish Gates. Fish passed through the weir at points where panel were partially removed. These fish gates were located in areas where the fish naturally congregated. Two such gates were installed in the weir. A light colored 'flash' panel was placed on the stream bottom immediately upstream of each gate to provide a contrasting background for counting fish.

Boat Gate. Residents from nearby communities travel on the George River for sport fishing and other activities. To accommodate the traffic, a 3.0 m (9.5 ft) span of weir was modified as a boat gate. The front leg of the two tripods flanking the boat gate were about 3.0 m (9.5 ft) apart, and the rear legs were angled to maximize the space available for boat clearance. The lower stringer was placed low enough to allowed boat clearance and the upper stringer was removable. When boats needed to pass through the weir, crew members removed the panels and upper stringer from the designated location, which allowed the boat to pass. Salmon passing through the boat gate were tallied and added to the day's fish count.

Catwalk Installation. A catwalk was constructed across the top of the tripods using 5.1 cm X 25.4 cm X 3.7 m (2 in X 10 in X 12 ft) planks. The catwalk allowed access across the weir for maintenance, and it also served as the platform for counting fish.

Weir Maintenance

It was vital that the weir was visually inspected several times a day to detect any breeches that would allow salmon to pass undetected. Breeches included undercut weir panels, gaps between adjacent weir panels or the shore, and holes in the fish trap and holding pen. Inspections were made by patrolling the weir from the catwalk or by using chestwaders to walk along the upstream edge of the panels. Any breech in the weir was immediately repaired. The weir was periodically inspected from a downstream perspective in order to check the bracing, sandbag platforms and the positioning of the upper stringers.

It was also vital that the weir be kept clear of debris in order to maximize water flow through the panels, minimizing pressure against the weir. Panels were cleaned on a daily basis using a rake worked from the catwalk, or by using chestwaders to walk along the upstream edge of the weir and remove debris by hand.

By mid-season, dead and spawned-out fish comprised a substantial portion of the debris load. In addition to blocking water passage, these carcasses attracted bears. All fish carcasses were removed promptly, identified by species, and passed downstream of the weir.

Biological Data

Estimating Fish Passage

One or two fish gates were opened for several hours each day to pass fish upstream. A technician positioned on the catwalk and overlooking the gate, monitored fish passage continually while the gate was open. The technician speciated and enumerated all fish passing through the gate using a multiple tally counter with a separate key labeled for each species. Each counting episode was a minimum of one hour and the passage was recorded in a field log book kept on shore. The log book was summarized each day prior to the morning radio schedule with the Bethel ADF&G office. Daily counts by species were reported to the Bethel office.

On days when substantial breeches were found in the weir, the daily count was estimated as the average of the previous and following days' counts.

Estimating Age-Sex-Length Composition

Throughout the season scale samples and sex and length information were collected from chinook and chum salmon following standard collecting procedures (Molyneaux and DuBois 1996). A pulse sampling design was followed in which intensive sampling was conducted for one or two days followed by a few days without sampling. The goal of each pulse was to collect samples from 210 chinook and 200 chum salmon. These sample sizes were selected so that simultaneous 95% confidence intervals for estimates of age composition proportions would be no wider that 0.10 (α = 0.05, d=0.10; Bromaghin 1993). Recommended sample sizes were increased by 8 to 9% to account for scales whose age could not be determined.

The ASL composition of chinook and chum salmon populations generally change over the course of the season (Molyneaux and DuBois 1996); therefore, efforts were made to collect several temporally distributed pulse samples of each species. Considering the dynamics of the ASL composition, the need for achieving the sample size goals had to be weighed against the need for collecting each pulse sample over a brief period of time. For this reason, the sample size goals serve as general guidelines rather than rigid requirements.

Scales were removed from the preferred area of the fish for use in age determination (INPFC 1963). Three scales were taken from each chinook and one scale was taken from each chum salmon. All scales were mounted on gum cards. Sex was determined by visually examining external morphology, keying on the development of the kype, roundness of the belly and the presence or absence of an ovipositor. Length was measured to the nearest millimeter from mid-eye to the fork of the tail. Sex and length data were recorded along with other pertinent information on computer mark-sense forms. After sampling, each fish was released upstream of the weir. The scale cards and data forms were sent to staff in the Bethel ADF&G office for processing.

In the Bethel and Anchorage ADF&G offices the gum cards were impressed in cellulose acetate using methods described by Clutter and Whitesel (1956). The scale impressions were magnified using of a microfiche reader and the age was deter mined through visual identification of annuli. The ages were recorded on the original computer mark-sense forms containing the sex and length data. Ages were reported using European notation in which two digits, separated by a decimal, refer to the number of freshwater and marine annuli. Total age, from the time the egg was laid, is the sum of the two digits plus one to account for the year prior to when the first annuli was formed.

After the age data was entered on the computer mark-sense forms, the forms were processed by an OPSCAN machine to produce ASCII computer files. The ASCII files were then processed to produce two summaries, one of the age and sex composition of each pulse sample, and another with length statistics.

These summaries were used to estimate the ASL composition of the entire chinook and chum salmon escapement in the George River. To accomplish this the season passage of each species was temporally stratified into several blocks of time referred to as strata. Each stratum consisted of several days of fish passage and one pulse sample. Ideally, the pulse sample was taken towards the central portion of the stratum. The ASL composition of the pulse sample was assumed to be representative of the fish passage during the stratum. The proportion of fish in each age and sex category, by species and stratum, was estimated as the number of fish determined to be in that category (after aging) divided by the total sample size. The number of fish in each age and sex category was estimated as the product of the sample proportion and the sum of the chinook or chum passage during the stratum. The number of fish in each category were summed over all strata to estimate total season passage by age and sex. For each species, seasonal proportions for the age-sex categories were estimated by weighting the stratum proportions by the total weir passage during that stratum.

Length summary statistics (mean, SE, range) for each species were reported by strata and age-sex category. The overall season mean was estimated by weighting the stratum mean lengths by the total weir passage of each species during that stratum.

The original ASL gum cards, acetates and mark-sense forms were archived at the ADF&G office in Anchorage. The computer files, including ASCII and summary files, are archived by ADF&G in the Anchorage and Bethel ADF&G offices.

Stream Life Investigation

Spent fish and carcasses, hereinafter lumped together as carcasses, washed up on the weir were counted, speciated and passed downstream during routine maintenance operations. Cumulative downstream passage of carcasses were compared to cumulative upstream passage of spawners to estimate the duration in which spawners, or their carcasses, were observable on the spawning grounds. The intent was to identify the optimal time interval for conducting peak aerial spawning ground surveys.

Genetic Stock Identification Samples

Chum and coho salmon from the George River were sampled for genetic analysis and included in the statewide baseline. Chum salmon were collected using the fish trap. The weir had washed out before the coho sample was collected, so coho salmon were collected using a gillnet to catch fish from near the weir site. The objective of 100 individuals per species was deemed sufficient estimate allele frequencies from a randomly mating population. Actual sample size varied depending on the availability of fish.

Individual tissues (muscle, liver, eye and heart) were collected from each fish sampled, placed in labeled 2.0 ml cryotubes and frozen as soon as possible in liquid nitrogen. A canister of liquid nitrogen was available on-site during the sampling events. The liquid nitrogen and other sampling supplies were provided by staff from the ADF&G genetics laboratory in Anchorage. Prior to the sampling event, the ADF&G crew members assigned to the George River weir project received training in Bethel on proper genetic sampling technique. They in turn trained the KNA crew members. The tissue samples remained frozen during storage and shipment to the genetics laboratory in Anchorage. Upon arrival in Anchorage, samples were stored at -80° C until subsampled for allozyme or mtDNA analysis.

Hydrological and Climatological Data

Surface water temperature (°C), air temperature (°C), and water level (cm on a staff gauge) were recorded at approximately 1200 hours each day. Measurements were taken at the weir site. A subjective estimate of cloud cover, wind direction and wind speed were also recorded at that time.

Water Chemistry

Water samples were collected from the George River on 1 and 30 July 1996 for the purpose of developing a water quality baseline. Replicate grab samples were collected at the weir site from approximately mid channel and just below the surface. The first sample was placed in a pre-cleaned 500-ml polyethylene (poly) bottle and stored in a cool and dark location. The second sample was placed in a 250-ml polybottle containing 0.5-ml of concentrated ultra-pure nitric acid. Acidified samples had a pH of <2 units. Samples were shipped immediately to the ADF&G limnology laboratory in Soldotna for analysis.

In the laboratory, conductivity (temperature compensated to 25° C) was measured using a YSI conductance meter equipped with a platinum electrode (cell constant = 1.0 cm^{-1}). The pH was measured with a Corning pH/ion meter. Alkalinity was determined by acid titration to pH 4.5 using 0.2 N H_2SO_4 (AHAP 1985). Turbidity, expressed as nephelometric turbidity units (NTU), was measured with a HF DRT-1000 turbidimeter after linear calibration. Color was determined on a filtered (Whatman GFF) sample by measuring the spectrophotometric absorbance at 400 nm and converting to equivalent platinum cobalt (Pt) units (Koenings et al. 1987). Calcium and magnesium were determined from separate EDTA (0.1 N) titrations after Golterman (1969), and total iron was analyzed by reduction of ferric iron with hydroxylamine during hydrochloric acid digestion as described by Strickland and Parsons (1972). Reactive silicon was determined using the method of ascorbic acid reduction to molybdenum blue after Stainton et al. (1977).

Acidified (pH <2) samples were analyzed for multiple trace elements by Elemental Research, Inc., Vancouver, British Columbia, Canada using inductively coupled plasma mass spectrometry (ICP-MS). In essence, samples are converted into an aerosol which is injected into a high temperature argon plasma. The aerosol is vaporized or decomposed into atoms. The concentration of trace elements is determined by measuring the amount of light absorption.

RESULTS

General Operations

The weir was operated from 21 June through 26 July, 1996. The weir remained functional throughout the operating period except for two occasions. The first breech in operation began on 27 June when the water level started to rise following a few days of intermittent rain (Table 2). On 28 June the water level, as recorded from the staff gauge, was 48 cm. The river had risen 18 cm from the previous morning. Increased turbidity made the fish gates inoperable because of poor visibility. Instead, fish were passed manually by netting them out of the fish trap. By the morning of 29 June the staff gauge was at 73 cm; the river had risen another 25 cm. Water was passing around both ends of the weir. At about 0800 hr several sections of weir along the left bank washed back approximately 2 to 3 meters. Approximately 7 meters of weir were affected. Large amounts of debris were floating down the river. Considering the mild spring break-up, this was very likely the highest the water level had been since the previous autumn. The crew repositioned the weir to its original position, and secured both ends of the weir with sandbags. The weir was stabilized by 1230 hr, but the fish trap was submerged and counting was not possible. At 1600 hr the river level crested at 73.5 cm, and the water receded through the evening. The majority of the weir weathered the high water in good form One tripod shifted down stream about 9 cm. Over the course of the day four boats visited the camp with the intention of passing through the weir, but the crew turned them back. All the visitors appeared sympathetic to the situation and none pressed the issue of passing upstream of the weir.

The next morning, 30 June, the water level was at 53 cm, and the crew again passed fish by manually netting them from the fish trap. A lot of fish could be seen behind the weir, but manually passing them through the fish trap was a slow process. A small hole was found where a tripod had shifted downstream a few centimeters. The hole was immediately repaired. Two boaters again aborted efforts to pass the weir, instead they sport fished a couple hundred meters downstream of the weir.

On 1 July the water level was steady at 53 cm, but poor visibility still prevented use of the fish gate. The crew passed some fish through the trap, then rigged an incline on the fish gate to direct fish to within view of the surface. The endeavor was very successful at improving visibility during turbid conditions, but the design was rough and awkward to use.

On the morning of 2 July the water level had receded to 49 cm and visibility had improved. A large hole was found beneath the fish gate. The crew suspected that many fish had passed through the hole during the night and early morning, so fish passage for the day was estimated and the crew re-worked the fish gate and incline.

The weir remained in excellent working condition until the last week of July. On a few occasions small breaches were found in the weir, but they were inconsequential. The crew surveyed the weir frequently and the beginning of any holes were addressed before they became problematic. Water level and weir operations were uneventful until 26 July when steady rains began to fall. The water gauge was at 41 cm on the morning of 26 July. By the morning of 27 July the water level was up to 67 cm and counts were suspended. Two large holes were found in the weir and repaired by 0915 hr, but the water level was still rising. Large amounts of debris were coming down the river, including increased numbers of spawned out salmon. At 1330 hr two panels fell from the stringers on the south end of the weir. The water gauge was at 77 cm. At 1430 hr the water level was up to 79 cm, 81 cm at 1500 hr and 85 at 1830 hr. It was still raining. Some panels were removed, but it was a difficult process because of the placement of cable ties at the base of most adjoining panels. At 2200 hr the water level was up to 93 cm.

The next day, 28 July, the water level continued to rise. The crew worked through much of the early morning removing debris from the weir. At 0300 hr the river gauge was at 95 cm. At 0600 hr. one tripod had drifted 8 meters downstream of the weir. Panel and stringers were falling into the water. The crew salvaged what they could and continued clearing debris from the weir.

On 29 July the water level was 101 cm at 1230 hr. Stringers, panels and even tripods were being washed downstream. Several tripods were found as far downstream as the confluence with the Kuskokwim River. One was even found bobbing in the water near Crooked Creek. Outboard problems hindered recovery efforts. The crew began to remove remaining panels, stringers and tripods from the water and stack them on shore. Larry DuBois relieved Steve Blanchette during a scheduled change on 29 July. The next several days were dedicated to recovering weir materials from the river, and stacking materials for winter storage, breaking down camp and collecting genetic samples of coho salmon. On 3 August Donna Elliott relieved Larry DuBois. Bryon Ward departed camp on 8 August. Bernard Vaska and Donna Elliott finalized closing the camp. By 9 August 123 of the 126 weir panels were recovered and stored on shore. Only 34 of the original 70 stringers were found, but all 35 tripods were recovered.

Biological Data

Five species of Pacific salmon were counted passing upstream through the George River weir. Estimated passage for the period 21 June through 26 July included: 7,487 chinook, 98 sockeye *O. nerka*, 17,570 chum, 644 pink and 173 coho salmon (Table 3). In addition, 3,555 longnose suckers (*Catostomus catostomus*) and 1 Dolly Varden (*Salvelinus malma*) were counted passing upstream of the weir.

Chinook Salmon

Passage and Run Timing. Chinook salmon were passed through the weir every day of operation, including 27 fish on the first day of counts (Table 3). Peak daily passage of 1,034 fish occurred on 1 July, thereafter counts dropped off sharply with the exception of a few daily spikes of passage (Figure 6). During the final week of operation, chinook salmon were passing the weir at a rate of 15 to 60 fish a day.

ASL Composition. From 24 June through 9 July, 191 chinook salmon were sampled for scales, sex and length information (Table 4 and 5). The samples were collected in four pulses with sample sizes ranging from 25 to 90 fish. The season was partitioned into four temporal strata each centered around one pulse sample. The ASL composition of each pulse sample was used to characterize the composition of chinook passage during the associated stratum. Reabsorption of scale margins appeared to be minimal, therefore reliability of aging is believed to be good. As applied to total chinook passage, age 1.4 was the most abundant age class (39%), followed by age 1.5 (32%), 1.3 (21%), 1.2 (7%) and 2.2 (<1%) (Table 4). The proportion of older age classes (1.4 and 1.5) was greatest during the third and fourth strata. The mean length by age class for males was 932 mm (1.5), 848 mm (1.4), 713 mm (1.3), and 598 mm (1.2) (Table 5). For females the mean length by age class was 902 mm (1.5), 856 mm (1.4) and 746 mm (1.3). No females occurred as age 1.2.

Females composed 52% of the total chinook escapement (Table 4). The proportion of females was greatest in the first strata (59%), declining thereafter. Males dominated the younger age classes (1.2 and 1.3) while females were in greater proportion among older fish.

Stream Life. On 25 June the first chinook salmon carcass was passed downstream of the weir (Table 6). Thereafter chinook carcasses were observed sporadically until 9 July when they began to occur daily. A peak of 36 carcasses was observed on 21 July. The cumulative downstream passage of carcasses for the season was 196.

Sockeye Salmon

Of the five species of salmon returning to the George River, sockeye salmon were the least abundant with a season cumulative passage of only 98 (Table 3). The first sockeye was observed on 26 June, peak daily passage of 18 fish was on 3 July, and the last sockeye was observed on 25 July. Most of the fish passed the weir between 2 and 9 July. Sockeye salmon were not sampled for ASL information. One sockeye carcass was found on the weir on 20 July, twenty-four days after the first fish was reported passing upstream (Table 6).

Chum Salmon

Passage and Run Timing. Chum salmon were the most abundant species of fish enumerated through the weir and they dominated counts on nearly every day (Table 3). Sixty-five chum salmon were counted on the first day of weir operations. Peak daily passage of 1,314 fish occurred on the third day of operation, 23 June, and passage remained high throughout the season. Daily passage of chum salmon fell below 300 on only eight days; three of those days occurred during the high water event of 28 - 30 June. On 26 July, the final day of operations, 508 chum salmon passed through the weir.

ASL Composition. A total of 765 chum salmon were sampled for ASL data (Table 7 and 8). The samples were collected in six pulses with sample sizes ranging from 47 to 203 fish. The season was partitioned into six temporal strata each centered around one pulse sample. The ASL composition of each pulse sample was used to characterize the composition of chum passage during the associated stratum. The sample sizes of each pulse sample ranged from about 1 to 10 percent of the weir passage to which it was applied.

Reabsorption of scale margins appeared to be minimal, therefore accuracy of the aging is believed to be high. As applied to total chum passage, age 0.3 was the most abundant (55.2%), followed by age 0.4 (41.0%), 0.2 (2.0%) and 0.5 (1.8%) (Table 7). The proportion of older age classes, 0.4 and 0.5, was greatest early in the season and steadily decreased as the season progressed. This pattern occurred for both males and females.

Overall, females were estimated to have comprised 45% of the chum salmon escapement (Table 7). The proportion of females tended to increase slightly as the season progressed. The length of female chum salmon was consistently less than males of the same age. For both sexes the average length at age generally diminished through the season (Table 8). The mean length by age class for males was 632 mm (0.5), 616 mm (0.4), 599 mm (0.3), and 592 mm (0.2). For females the mean length by age class was 571 mm (0.4), 554 mm (0.3) and 560 mm (0.2). No females occurred as age 0.5.

Stream Life. Chum salmon carcasses began to occur at the weir on 25 June (Table 6). Thereafter, carcasses were observed and passed downstream almost daily. The number of carcasses steadily increased throughout the season, peaking at 143 chum carcasses on 22 July.

Stock Identification.. Tissue samples from 100 chum salmon were collected between 21 and 23 July for genetic stock identification. All samples were taken from fish caught and held in the fish trap. The samples were transported to the ADF&G genetics laboratory in Anchorage for processing. When processing and analysis are completed, the information will be archived in a statewide database.

Pink Salmon

Pink salmon were observed at the George River, mostly during the second half of the season (Table 3). The first pink was seen on 2 July and daily occurrence began on 12 July. The largest daily passage of pink salmon, 90 fish, occurred on 19 July, but counts continued to be relatively strong through the last day the weir was operated. Pink salmon were not sampled for ASL information. A total of 55 pink salmon carcasses were passed downstream of the weir (Table 6). The first pink carcass was found on 10 July, eight days after the first pink salmon was counted passing upstream of the weir. Daily occurrence pink salmon carcasses began 20 July, with a peak of 30 fish being passed downstream on 25 July, the last day such records were kept.

Coho Salmon

Coho salmon were just beginning to enter the George River during the last few days of weir operation (Table 3). The first coho was reported on 16 July and by 23 July coho salmon were being counted on a daily basis. The peak count of 93 fish occurred on the last day of operation, 26 July. Coho salmon were not sampled for ASL information and no carcasses were observed.

Tissues from 26 coho salmon were collected between 31 July through 8 August as part of the genetic stock identification study. Gillnets and rod and reel were employed to catch coho salmon near the weir. The samples were transported to the ADF&G genetics laboratory in Anchorage for processing. These are among the first baseline samples collected of coho salmon from the Kuskokwim Area, and they will enter a developing statewide database.

Resident Freshwater Species

Other species observed passing through the weir included 3,555 longnose suckers (Table 3) and one Dolly Varden. The majority of the longnose suckers were passed during the first few days of weir operation. As the season progressed, passage was erratic, ranging from 0 to nearly 150 a day. No information was collected to characterize the ASL composition of freshwater species of fish. Carcasses of 97 longnose suckers were passed downstream of the weir along with 5 northern pike (*Esox lucius*), 4 whitefish (*Coregonus* sp.), and one Arctic grayling (*Thymallus arcticus*) (Table 6). The condition of these fish was not reported.

Climatological and Hydrological Conditions

At the onset of the season the maximum water depth at the weir site was about 90 cm (3 feet). This corresponded with a staff gauge water level measurement of 30 cm on 23 June (Table 2).

Two rain events resulted in sharp increases in water depth. On 29 June the staff gauge measurement crested at 73 cm (approximately 133 cm total depth) following a period of steady rainfall. On 29 July another rain event pushed the staff gauge readings in excess of 100 cm (160 cm total depth) after which the weir washed out.

Water temperature averaged 14 °C (range 9 to 17 °C) and air temperature average 19 °C (range 9 to 26 °C) for the season.

Water Chemistry

Water samples were collected from the George River on 21 June, 1 July and 30 July. Collections from the first two dates included samples used for general processing at the ADF&G Limnology Laboratory. The collections made on 21 June and 30 July included samples for heavy metals. Results from all the samples are presented in Table 9.

DISCUSSION

Biological Data

Chinook Salmon

Passage and Run Timing. The season passage estimate of 7,487 chinook salmon at the George River weir does not account, strictly speaking, for the entire George River spawning population. Some fraction of the population spawned below the weir, but the relative proportion is likely small given the short distance to the mouth. It is also likely that some unknown number of fish passed though the occasional holes that occurred under, between or around weir panels. However passage was estimated for periods of time in which substantial holes in the weir were known to have existed. Chinook were observed passing the weir on the last day of operation, but the daily passage was declining. Perhaps 200 additional chinook salmon passed upstream of the site after 26 July, assuming the rate of decline was consistent during the waning portion of the run (Figure 7). In addition, some number of chinook passed the site prior to weir installation. The magnitude of these unenumerated early chinook may be relatively substantial. Awareness of the presence of adult chinook salmon in the George River prior to weir installation is based upon confirmed reports from a local sportfisher catching chinook at the confluence of the East Fork George River a number of days prior to installation of the weir, as well as passage counts on the first few days of operation. Future operations should begin by about 10 June in order to assess for the early portion of the chinook escapement.

Despite these considerations, the overall run timing of chinook passage at the George River weir was markedly similar to other escapement projects in the Kuskokwim River drainage (Figure 8). The median passage date of chinook at George River was 3 July, about four days earlier than the median passage dates at both Kwethluk River tower and Kogrukluk River weir. These three projects are approximately 507, 298, and 725 rkm (315, 185 and 450 rm.) from the mouth of the Kuskokwim River, respectively. The timing difference between the three projects was generally consistent through most of the season. Both the Kwethluk and Kogrukluk projects had nearly complete temporal coverage of the chinook run.

The similarity in timing of the chinook populations arrival on the spawning grounds in these three spacially distant spawning streams can be accounted for through one or more of three mechanisms. First, populations with the farthest to travel may be entering the Kuskokwim River earlier than those traveling to lower river tributaries. A second is that the time of entry into the Kuskokwim River is similar, but that fish going farther swim faster. A third is that milling time is inversely proportional to the distance chinook salmon need to travel to their spawning grounds. The brief reports which summarize the tagging studies conducted by ADF&G in the 1960's are of very limited use in addressing this phenomenon (ADF&G 1961, 1962 and 1966). Results from the 1966 study, however, do show that the travel rate of tagged chinook salmon increased from 4.8 to 32.2 km (3 to 20 mi) per day with increasing travel distance (ADF&G 1966). Still, the author concluded that chinook spawning stocks could not be identified by run timing. Marino and Otis (1989) did a similar tagging study and had similar results; however, they concluded that chinook salmon entering the Kuskokwim River early in the season migrated greater distances, and at greater travel rates, than fish entering later in the season. This suggests a mechanism for managing stock aggregates by means of their time of entry into the lower Kuskokwim River. Of the 80 tag recoveries reported by Marino and Otis, two were found on the spawning grounds, one was recovered from the Eek River at rkm 86.9 (rm. 54), and one from the Kogrukluk River at rkm 718 (rm. 446).[3] These fish traveled 5.8 km/d and 27.3 km/d respectively; nearly a 5 fold difference in travel rate. However, there was an 11 fold difference in the distance the two fish traveled. In order for these two fish to arrive on the spawning grounds at the same time, which they did not, the Kogrukluk fish would have had to enter the Kuskokwim River 12 days sooner than the Eek River fish.

It should be noted that the run timing of chinook salmon was generally early throughout the Kuskokwim River in 1996. The median passage date at Kogrukluk River weir was five days earlier than normal (Cappiello and Burkey 1997). Similarly, the median chinook passage in the Bethel test fishery was eight days earlier than normal (Burkey et al. 1997). For each of these projects the 1996 chinook run timing was among the earliest on record. In contrast, Kwethluk tower median passage was only a day earlier than in 1992, the only other year in which escapement data is available for that system (Harper, in press).

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[3] Both chinook were tagged on 18 June, however the chinook recovered from the Kogrukluk River was tagged at rkm 145 whereas the chinook recovered from the Eek River was tagged at rkm 35.

ASL Composition. The ASL data collected on George River chinook was limited with respect to sample size, but the four pulse samples were fairly well distributed over the course of the run (Table 4). While the small sample sizes of 44, 25, 32 and 90 chinook are far from optimal, they do represent 3.3, 6.7, 1.2 and 2.8 percent of the chinook passage during their respective strata. These percentages are comparable to those collected by the Department at Kogrukluk River weir in recent years (Molyneaux and DuBois 1996).

The observation of older age classes (1.4 and 1.5) becoming more prominent as the season progresses was also observed in the 1996 Kogrukluk River data (Molyneaux and DuBois, in press). Historically, this pattern has been seen with some regularity at other escapement projects in the Kuskokwim drainage, but not consistently. The inconsistency between years may be more a function of the reliability of the aging, than to a true disparity in the population dynamics. The phenomenon has also been documented on the East Fork Andreafsky (Tobin and Harper 1995) and Gisasa (Melegari 1996) rivers in the Yukon drainage. Given the subjectivity of determining chinook ages from scales, the historical age data should be evaluated to confirm it's consistency. The initials of the person doing the aging should also be added to the historic database in order to better track between reader variability.

Age 1.4 and 1.5 chinook composed 72% of the overall chinook age composition at George River, whereas only 32% of the passage at Kogrukluk River was attributed to the older age classes (Molyneaux and DuBois, in press). The lower percentage of older aged chinook at Kogrukluk River in 1996 was comparable to the historic average for that project. A low proportion of older age classes was also characteristic in data from Tuluksak River (1991 - 1994) and Kwethluk River (1992) weirs. Within this context, George River appears to be the outlier. There was no indication of any irregularity in the methods used at the George River weir that would suggest the results were biased towards older age classes. One point supporting the validity of the George River age composition is that returns from the 1989 brood year have been strong during the past few years, and that year class returned as age 1.5 fish in 1996 (Burkey et al. 1996). Never-the-less, future operations at George River weir should include improvements such as a fish trap designed to better ensure that all fish are retained in the holding pen with equal probability of being sampled. A larger sample size is also recommended.

The estimated sex ratio of chinook salmon in the George River is also a bit of an anomaly. Overall the ratio of males to females was about even (Table 4), but that has rarely been the case at other Kuskokwim River escapement projects (Molyneaux and DuBois 1996). At Kogrukluk River weir, females composed 24% of the run in 1996, and the historic average is only 32%. The percentage of females rarely even approaches 50%. At Tuluksak River the females average 19% of the passage, and during the one year of data from Kwethluk River females composed 25% of the passage. Again, George River was the outlier. There is no indication that the George River weir crew had any difficulty in determining the sex of the chinook salmon they handled. But since the younger age classes, which are also smaller in size, are traditionally dominated by males, there is some question as to whether the fish trap was as effective at holding small male chinook as it was larger fish. Incorporating the additional improvements discussed above would help avoid any potential bias and improve overall confidence in the data.

The length frequency composition of the George River chinook samples appear to be fairly well partitioned by age class (Figure 9). The lengths at age also appears to be comparable to the historic grand averages reported for the Kogrukluk River (Molyneaux and DuBois, in press). Any further assessment is hindered by the small sample size.

Stream Life. Analysis of the carcass data is confounded by the lack of upstream passage data from the early portion of the run, coupled with the lack of carcass passage from late in the season. An estimated stream life for chinook salmon at the mid point of the run was about 17 days at George River (Figure 10). Harper reported 21 and 26 days at Tuluksak River weir in 1992 (Harper 1995a) and 1993 (Harper 1995b). The carcass data from George River suggests the optimal time for aerial surveys was between about 10 July and 20 July, however no aerial surveys were flown in the drainage.

Sockeye Salmon

The passage of 98 sockeye at the weir probably accounts for nearly the entire spawning population. The first sockeye was not observed until 26 June, the run peaked on 3 July, and only an occasional sockeye was seen during the final two weeks of operation (Figure 11). As expected, the George River does not appear to be a sockeye producing system. While substantial numbers of sockeye salmon do occur in the Kuskokwim drainage, they are most abundant in river systems with lakes as is characteristic of the species (Burgner 1991). The George River drainage does not have the requisite lake habitat to support a significant sockeye population. Many of the sockeye salmon observed in the George River may well strays from other tributaries.

Chum Salmon

Passage and Run Timing. The 17,570 chum salmon that were counted through George River weir between 21 June and 26 July does not account for the entire spawning population. As was discussed for chinook, some fraction of the chum population spawns below the weir, but the relative proportion is likely small given the short distance to the mouth of the George River. It is also likely that some unknown number of fish passed through the intermittent holes that occurred in the weir, but estimates were used to account for the most obvious of these events. More significantly, substantial numbers of chum salmon likely passed the weir site both before and after the operational period.

Adult chum salmon occurred in the George River prior to weir installation. Sport reported catching three chum, as well as 12 sheefish (*Stenodus leucichthys*) at the outlet of Bear Creek, about 1.6 km (1 mi) downstream of camp on 19 June. In addition, 65 chum salmon were passed through the weir on the first day of counts, and the highest daily count of 1,314 occurred on the third day of operation (Figure 12). It is likely that a substantial, but unknown, number of chum salmon passed the weir site prior to 21 June.

Chum salmon passage remained relatively high through the last day of counts, which suggests that a substantial number of spawners may have passed the site after the weir was removed (Figure 12). Conservative trend analysis of the tail portion of the chum run suggests that about 3,700 additional chum salmon may have passed the site following 26 July (Figure 7). But without knowing the typical timing curve such an estimate is especially speculative.

By missing some of the early and late portions of the chum salmon escapement the objective of estimating the size of the spawning population was not completed. To address this, future weir operations should begin by about 10 June and continue through about 15 August.

Despite these considerations, the run timing for George River chum salmon was similar to other escapement projects in the Kuskokwim River drainage (Figure 13). The median passage date of chum at George River was 7 July, and the median at other projects was within 2 days of that date. The significance of this similarity is in the fact that these projects are so widely dispersed geographically: Kwethluk River tower, rkm 298 (rm. 185); Aniak River, rkm 386 (rm. 240); George River weir, rkm 507 (rm. 315); Kogrukluk River weir, rkm 725 (rm. 450); and Takotna River tower, rkm 926 (rm. 575).

Possible causes of this similar timing were discussed in the section on chinook. ADF&G conducted chum tagging studies in the 1960's, however the brief reports which summarize that work are of limited usefulness in determining temporal differences in the entry pattern of various populations or population aggregates (ADF&G 1961, 1962 and 1966). Results from the 1966 study do show that the travel rate of tagged chum salmon increased from 5.1 miles per day to 9.5 miles per day with increasing travel distance (ADF&G 1966). Still, the author concluded that spawning stocks of chum salmon could not be identified by run timing.

Findings from a radiotelemetry study conducted by the Bering Sea Fishermen's Association in 1995 suggested very course temporal differentiation between some stock aggregates in the Kuskokwim River (Parker and Howard 1995). Fish tracked to the George (rkm 349, n = 1), Holitna (rkm 393, n = 3) and Stony (rkm 436, n = 1) Rivers were predominantly tagged early in the season, 16 June to 6 July. Fish found in the Kwethluk (rkm 31, n = 6), Kisaralik (rkm 53, n = 6), Kasigluk (rkm 53, n = 8), Tuluksak (rkm 90, n = 5), Swift Creek (rkm 200, n = 1), Aniak (rkm 213, n = 22) and Holokuk (rkm 267, n = 3) Rivers were mostly tagged at Bethel over a broad period ranging from 22 June to 30 July. Tagging effort in the study was unintentionally greater in the later portion of the season. There was no evidence of fish milling between Bethel and the spawning grounds in which they were found.

Overall, run timing of chum salmon to the Kuskokwim River in 1996 was a few days earlier than historic averages. Median passage at both Aniak River sonar and Kogrukluk River weir was about 3 days earlier than average (Vania and Huttunen 1997, Cappiello and Burkey 1997). The median passage date at Kwethluk River tower was six days earlier than in 1992, the only other year for which daily escapement data is available for that system (Harper, in press).

ASL Composition. The ASL data collected on George River chum salmon was limited with respect to sample size, but the six pulse samples were well distributed over the course of the run (Table 7). The sample sizes of 47, 177, 91, 203, 69, and 178 were not all optimal, but they do represent 1.2, 3.0, 4.0, 9.0, 4.2, and 9.9 percent of the chum passage during each respective stratum. These percentages are comparable to those collected by the Department at Kogrukluk River weir in recent years (Molyneaux and DuBois 1996).

The overall age composition of chum salmon at George River was typical of other local chum populations in the Kuskokwim River. The 0.3 age class was most abundant, comprising 55% of the escapement, while the 0.4 age class made up 41% (Table 7). The 0.2 and 0.5 age classes were minor contributors, as is common throughout the Kuskokwim River drainage (Molyneaux and DuBois 1996). Chum populations at the Kogrukluk and Aniak Rivers had higher proportions of age 0.3 fish in 1996, 68% and 65% respectively, but the percentages observed at all three locations were well within historic ranges.

The observation of age 0.4 chum salmon being most abundant at the onset of the season, and age 0.3 chum becoming progressively more abundant through the course of the season, is a common pattern in the Kuskokwim (Molyneaux and DuBois 1996) and Yukon drainages (Tobin and Harper 1995, Melegari 1996). The pattern has been documented in populations from south-central Alaska (Helle 1979), southeast Alaska (Clark and Weller 1986), British Columbia (Beacham and Starr 1982; and Beacham 1984), and Washington (Salo and Noble 1953). The occasional inconsistencies seen in the historic database for the Kuskokwim drainage may be more a function of accuracy in age determination from year to year, than to any real disparity in the population dynamics. At a minimum, databases which seem to violate this common dynamic should be spot checked to confirm the reliability of the aging. The initials of the person doing the aging should also be added to the historic database in order to better track between-reader variability.

The nearly even sex ratio of chum salmon observed in the George River is typical of most other chum populations in the Kuskokwim drainage (Molyneaux and DuBois 1996). At the Aniak River, females composed 59% of the escapement in 1996 and 52% in 1995. The proportion of females observed at the Tuluksak and Kwethluk Rivers has, historically, ranged from 47 to 58 percent. In contrast, the proportion of females at the Kogrukluk River is chronically low; in 1996 for example, females only composed 15% of the passage and the historic average over the past twenty-three years is only 30% (range of 13 to 42%). Clearly, the Kogrukluk River chum salmon population is outside the norm The cause for the disparity is unknown, but there is some speculation that it is a result of the location of the project in the far upper reaches of the Holitna drainage, coupled with a possible behavioral tendency for males to continually move upstream through the spawning season while females remain more stationary on the spawning ground.

The length frequency of George River chum salmon overlap broadly by age and sex (Figure 14). However the average length of females is consistently smaller than that of males of the same age (Table 7). The same tendency is seen at the Kogrukluk, Aniak, Tuluksak and Kwethluk Rivers (Molyneaux and DuBois 1996). The average length at age for male chum salmon at the Kogrukluk, George and Aniak Rivers were nearly identical in 1996; however, females from

Kogrukluk River were consistently 20 to 30 mm larger than those from the other populations (Figure 15). The same methods were used to measure fish at all three locations.

Stream Life. Analysis of the carcass data is, to a large extent, confounded by the lack of upstream passage data prior to startup of the weir, and the lack of carcass count data from late in the season after weir operations ended. An estimate of stream life for chum salmon at the mid point of the run was about 12 days at George River; i.e., spawners or their carcasses, were observable on the spawning grounds. (Figure 10). Harper reported 13 and 10 days at Tuluksak River weir in 1992 (Harper 1995a) and 1993 (Harper 1995b).

Stock Identification. Tissue samples collected from George River chum salmon have not as of yet been processed. To date, allozyme analysis has identified two broad groupings of chum salmon in the Kuskokwim Area (Lisa Seeb and Penny Crane, ADF&G geneticists, Anchorage, personal communication). One group, referred to as "early spawners", are found in baseline samples collected from the Middle Fork Goodnews River to the Takotna River. These fish spawn mostly in July and early August. The second group of chum salmon spawn from late summer through autumn and are referred to as "late spawners". Late spawners have only been found in the baseline samples collected from tributaries upstream of McGrath, and they are genetically distinct from the fall chums of the Yukon River. The George River chum salmon will likely be grouped in the early spawning component. Early spawning chum salmon of the Kuskokwim Area are also part of the 'Northwest Alaska complex' described by Seeb et al. (1995).

Pink Salmon

Operation of the George River weir ended before the pink salmon escapement had been completed, so the 644 pink salmon counted through the weir do not account for the entire spawning population (Table 3). As was discussed for other species, some pink salmon likely spawn below the weir and others may have passed undetected through small intermittent breaches in the weir. However, the majority of the unenumerated fish likely passed after 26 July when weir operations ended. The first pink salmon was counted on 2 July and daily occurrence began 12 July (Figure 16). Passage peaked on 19 July and thereafter generally declined. Spikes in passage did occur on 24 and 25 July, for reasons unknown. Pink salmon do not seem to be in great abundance in the George River, especially considering that pink salmon in the Kuskokwim Area are in greatest abundance during even years (Burkey et al. 1997).

Pink salmon are not of direct importance in the commercial or subsistence fisheries of the Kuskokwim River. As a result, biological data has not generally been collected for pink salmon beyond their incidental inclusion in escapement counts. This perspective may be short sighted. Salo (1991) discusses many interactions between pink and chum salmon which influence the abundance of chum salmon in some years. While pink salmon are not as abundant in the Kuskokwim River as they are in the systems discussed by Salo, their influence in the future should not be entirely dismissed.

The weir used at George River was intentionally designed to allow enumeration of pink salmon. In addition to passage estimates, other biological information may prove insightful in addressing future investigations. As such, it is recommended that efforts be made to collect a number of pulse samples each year to estimate pink salmon sex ratios and perhaps lengths. Given the limitation of resources, it is not recommended that these efforts be exhaustive or done to the detriment of other data collection efforts.

Coho Salmon

The George River weir was intended to operate through much of the coho salmon run, but the premature termination on 26 July precluded achievement of that objective. Coho first began to appear in the counts on 16 July. Daily occurrence began on 23 July, and passage steadily increased through the end of the operational period (Figure 17). Total passage was 173 fish. While it is thought that the George River may support significant spawning population of coho salmon, the data collected in 1996 does not provide any information as to the magnitude of the escapement.

Beginning in 1984, commercial salmon fishery management in the Kuskokwim Area shifted from a guideline harvest strategy to an escapement objective approach (Burkey et al. 1997). The shift applied to all species, although data are extremely limited for coho salmon. Since that time coho harvests have increased markedly in the Kuskokwim River. The average guideline harvest in 1984 was 150,000 to 250,000 fish (Francisco and Schultz 1984), whereas the actual commercial harvest in 1996 was a record 935,510 fish (unpublished). Coho salmon have accounted for the majority of the overall cash value of the Kuskokwim Area commercial salmon fisheries in recent years and the outlook is for that trend to continue.

Despite their economic importance, assessment of coho salmon escapement in the Kuskokwim Area is extremely limited. Indeed, the Kogrukluk River weir is the only coho escapement project regularly operated in the entire Kuskokwim Area. Data collected from this one tributary stream are used to make broad assumptions regarding the adequacy of coho salmon escapements throughout the Kuskokwim River drainage. The shortage of coho escapement information prevents adequate assessment of the effectiveness of the fishery management plan and in-season management actions. Given the trend of increasing commercial harvests, coupled with the concurrent growth of public expectations for continued large harvests, the likelihood of over exploitation is high. Ideally, the problem should be addressed by focusing additional resources at a well distributed array of new escapement monitoring projects, including the proposed resumption of Kuskokwim River sonar. If long term funding allows, the George River weir project could contribute to such an effort, and possibly provide escapement information in a manner timely enough for in-season management needs. Any future plans to operate the George River weir should include funding through the middle of September in order to reasonably assess coho escapement into that system.

Resident Freshwater Species

The only abundant non-salmon species observed at the George River weir was longnose suckers. The passage of 3,555 suckers through the weir was unexpected. Although the species has been reported at other escapement projects, the number of fish has never been as large as reported from George River. Most of the passage occurred during the first week of operation, peaking on 22 June and dissipating rapidly thereafter (Figure 18). Smaller individuals may have been able to pass between the weir pickets, but occurrence of such passage was not reported.

The upstream passage of longnose suckers was likely part of a spawning migration. According to Morrow (1980) the species spawns in shallow gravel bottom streams in the spring, as early as May in the southern part of their range (Columbia River) and as late as July in the northern limit (Arctic Slope). Mid to late June is a likely time to expect this species to spawn in the Kuskokwim Area.

A total of 97 longnose sucker carcasses were passed downstream of the weir, but the number may be incomplete (Table 6). Most of the carcasses were reported during the last few days of June. The mortalities are likely a result of spawning. Morrow (1980) reported that post-spawning mortality occurs in 10 to 30 percent of spawning adults.

There were no observations noted of live longnose suckers attempting to move back downstream during the operational period of the weir. River-resident fish reportedly stay on or near the spawning area for much of the summer whereas suckers that are lake resident return to the lake a few days after spawning (Morrow 1980). Assuming the fish seen in the George River are a stream resident population, the lack of downstream migrants is to be expected.

The longnose suckers are of no direct commercial value, and their use for subsistence is limited. Never-the-less, there may be some merit in continuing to gather information about the species on an opportunistic basis. It is recommended that efforts be made to collect a number of pulse samples of this species each year, and that length and sex information be recorded. Measuring the length of carcasses washed up on the weir might be useful in determining whether some fraction of the population is able to pass between the weir pickets. Morrow (1980) describes the sexual dimorphism in spawning adults to be pronounced. Males have prominent tubercles on the head and rays of the anal and caudal fins, while these are lacking in females. Dorsal coloration in males is also darker than in females, and the reddish lateral strip is more prominent in males. Given the limitation of resources, it is not recommended that sampling efforts be exhaustive, or done to the detriment of other data collection activities.

Climatological and Hydrological Conditions

Low water level was a defining feature of the 1996 season (Appendix H). Spring snow pack measurements throughout the Kuskokwim River drainage were generally well below average (USDA 1996). This was followed by below normal precipitation in May, June and early July (Appendix I). As a result spring break-up in the Kuskokwim drainage was very mild and water levels remained well below average in May, Jüne and early July. Steady precipitation in the second half of July brought the water level of the Kuskokwim River to above average. The effect of the rain in the George River was a near doubling of the water depth at the weir site (Table 2). The terrain of the George River drainage is steeply sloped and dramatic increases in water level are characteristic. A local resident reported that water level increases of 80 cm (2 ft) over a period of a few days is not unusual. The crew should be prepared in future years to remove the weir when the maximum depth at the weir site approaches 130 cm total depth in order to avoid damaging wash outs. Some steps should also be taken to help improve the integrity of the weir structure. Such improvements include the use of additional sandbags on the tripod platforms, replacing the smaller make-shift tripods with full size tripods, ensuring that the full crew is on duty for cleaning debris from the weir during rain events, and reducing the distance between tripods to add strength and reduce the likelihood of stringers slipping out of place.

Water Chemistry

General Water Chemistry

The George River is a highly turbid waterway. Turbidity, caused by both inorganic and organic suspended sediments ranged from 20 NTU in early July to 60 NTU in late July. In comparison, normally clear systems have a turbidity of less than 5 NTU (Lloyd et al. 1987; Koenings and Edmundson 1991). Samples also exhibited appreciable amounts of color (38 Pt units), which indicates allochthonous inputs of organic material (e.g., humic and tannic acids). In contrast, non-stained systems typically exhibit color less than 15 Pt units (Koenings and Edmundson 1991). Samples had a circumneutral pH and relatively low alkalinity (50 mg L^{-1}). Conductivity, an index of dissolved solids or electrolytes, averaged 112 µmhos cm^{-1}. Calcium and magnesium concentration was relatively low. In contrast, total iron was quite high (>2,000 µg L^{-1}). This is not unexpected in that inorganic particles such as glacial silt or sediment contain large amounts of iron. Hence, much of the total iron is contained within the particulate fraction, rather than dissolved in solution.

Trace Elements

Many of the trace elements are considered heavy metals and essential for aquatic biota at low concentration, but are toxic at higher levels. Some important trace elements occurring in natural waters and as a byproduct of mining are arsenic, cadmium, chromium, lead, nickel and mercury.

Sediments added to rivers and streams by mining activity can have associated heavy metals adsorbed to particle surfaces. Metals bound in particulate form can dissolve into the water under acidic conditions. Most of the trace elements in the George River samples were found to be at or near the analytical detection limit. As such, concentrations are within acceptable water quality standards (Thurston et al. 1979, USEPA 1986).

The heavy metals analyses were conducted on unfiltered water; i.e., the concentration reflects both the particulate and dissolved forms of the elements. Metals in dissolved form (ions), not as particulates, are what is harmful to aquatic life in high levels. Samples taken for future metals analysis should be filtered, and then preserved in acid. In any event, the trace element concentrations in the unfiltered water samples were less than detection limit, so there is no evidence of heavy metal pollution.

General Operations

Overall the George River weir project operated well during its first year. Materials and crew arrived on time and construction and operation of the camp and weir generally proceeded in good order. Crew members were dedicated and maintained a good work attitude throughout the season. Although experience and training were limited, the crew succeeded in achieving the project objectives within the restraints of the operational period of the weir. Building on the experience of the 1996 season, expectations in 1997 will be greater. The following are a number of suggested operational improvements that are being considered for the 1997 field season:

A. Pre-season meeting with all involved staff to discuss operations and expectations

B. Better prepare the weir for high water events.
   1. full sized tripods
   2. place tripods at 9.0 ft instead of 9.5 feet apart to avoid stringers slipping from place
   3. more sandbags on each tripod; approximately 6 instead of 3
   4. installation of "grabbers" on rear legs to avoid tripods slipping down stream
   5. Set high water criteria to trigger the removal of weir panels / tripods to avoid damaging washout

C. Improvements in passing fish
   1. Begin counts by about June 10 and continue through at least August 15 to span the entire chum salmon run
   2. install inclines on fish gates / trap to allow for counting during muddy water conditions
   3. paint panels on either side of fish gates dark green to better attract fish to the fish gates for passage

D. ASL Sampling
   1. improve trap design to insure small salmon are not escaping

2. raise the walls of the fish trap
3. include some length and sex data of the suckers (measured tip of snout to fork of tail)
4. collect length and sex data for pink salmon

E. Collection of Hydrological, Climatological and Water Chemistry information
   1. standardize method for reporting water level so that information is comparable interannually.
   2. collect turbidity and settleable solids information on a daily basis
   3. determine stream discharge two to three times over the course of the season (preferably under different water level conditions)

F. Safety
   1. Take additional bear safety measures
   2. A spare outboard motor should be kept in the boat when making trips away from camp

The successful implementation of these improvements will likely increase the degree to which objectives are realized in 1997.

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TABLES

Table 1. History of aerial spawning ground surveys of the George River drainage (Burkey and Cappiello 1996).

Location	Date of Survey	Observer	Survey Conditions	Species			Comments
				Chinook	Chum	Coho	
Main Stem	Jul 28 1995	Charlie Burkey	Good	1173	420	0	surveyed mouth to 25 miles upstream
	Jul 30 1993	Charlie Burkey	Fair	75	0	0	surveyed confluence of the East Fork to 20 miles upstream
	Jul 16 1960		Excellent	526	470		
	Jul 18 1976	Gary Schaefer	Good	199	1298	0	surveyed mouth to 40 miles upstream of the North Fork confluence
	Oct 1 1976	Gary Schaefer	Good	0	0	0	
	Aug 1 1975	Fritz Kuhlman	Fair	28	717		surveyed mouth to 5 miles upstream of the North Fork confluence
East Fork	Jul 24 1980	Dan Schniederha	Fair	89	3479	0	surveyed mouth to headwaters
	Jul 18 1976	Gary Schaefer	Fair	a few	a few		
North Fork	Jul 18 1976	Gary Schaefer	Good	a few	200	0	
	Aug 1 1975	Fritz Kuhlman	Fair	0	123	0	
	Aug 1 1975	Fritz Kuhlman	Good	3	20	0	unnamed tributary

Table 2. Daily water conditions and weather at the George River weir, 1996.

Date	Osevation Time	Water Level (cm)	Temperature (°C) Water	Air	Water Color	Sky [a] (a.m.)	Precip. [b] (a.m.)	Wind Vel. (knotts)
6/21						3	0	0
6/22	1930		14			3	0	0
6/23	2100	30	14	20		1	0	15
6/24	2100	30	15	10		4	A	10
6/25	2230	30	13	15		4	A	5
6/26	2230	31	14	20		4	A	5
6/27	1200	34	14	24		4	0	0
6/28	1200	48	15	16		4	B	0
6/29	2000	73	9	16		4	0	0
6/30	1200	56	9	9		4	0	0
7/01	1200	53	11	18		4	0	0
7/02	1230	49	13	20		4	0	0
7/03	1200	46	13	21		1	0	0
7/04	1200	43	14	22		1	0	0
7/05	1200	36	16	25		2	0	0
7/06	1200	35	17	26		1	0	0
7/07	1230	34	17	15		2	0	0
7/08	1230	34	17	22		2	0	0
7/09	1230	34	16	20		4	B	0
7/10	1200	34	15	17		4	B	0
7/11	1200	40	15	17		4	A	30
7/12						0	A	0
7/13						0	A	0
7/14						0	A	0
7/15	1700	35	17	25		1	0	0
7/16	1700	35	9	11		3	A	5
7/17	1200	39	12	25		4	A	5
7/18	1200	40	13	19		4	0	0
7/19	1200	43	13	18		4	0	0
7/20	1200	45	13	17		4	0	0
7/21	1200	49	16	23		3	0	0
7/22	1200	45	16	23		2	A	5
7/23	1200	41	17	26	33	1	0	5
7/24	1500	39	17	23	33	4	0	5
7/25	1200	39	16	22	31	2	0	15
7/26	1230	41	14	14		4	B	5
7/27	800	67						
7/28	1500	95						
7/29	730	110						
7/30		100 +						
7/31		100 +						
8/01		100 +						
8/02		100 +						
8/03		100 +						
8/04		100 +						
8/05	1715	100 +						

[a] Sky condition codes:
- 0 = no observation
- 1 = < 1/10 cloud cover
- 2 = partly cloudy; < 1/2 cloud cover
- 3 = mostly cloudy; > 1/2 cloud cover
- 4 = complete overcast
- 5 = thick fog

[b] Precipitation Codes:
- A = intermittaent rain
- B = continuous rain
- C = snow
- D = snow and rain
- E = hail
- F = thunder

Table 3. Daily fish passage at the George River weir, 1996.

Date	Daily Passage						Cumulative Passage						Percent Passage					
	Chinook	Sockeye	Chum	Pink	Coho	Suckers	Chinook	Sockeye	Chum	Pink	Coho	Suckers	Chinook	Sockeye	Chum	Pink	Coho	Suckers
6/21	27	0	65	0	0	519	27	0	65	0	0	519	0	0	0	0	0	15
6/22	17	0	613	0	0	832	44	0	678	0	0	1,351	1	0	4	0	0	38
6/23	269	0	1,314	0	0	703	313	0	1,992	0	0	2,054	4	0	11	0	0	58
6/24	762	0	692	0	0	238	1,075	0	2,684	0	0	2,292	14	0	15	0	0	64
6/25	214	0	49	0	0	285	1,289	0	2,733	0	0	2,577	17	0	16	0	0	72
6/26	41	5	376	0	0	62	1,330	5	3,109	0	0	2,639	18	5	18	0	0	74
6/27	183	2	508	0	0	296	1,513	7	3,617	0	0	2,935	20	7	21	0	0	83
6/28	98	1	167	0	0	2	1,611	8	3,784	0	0	2,937	22	8	22	0	0	83
6/29 *	91	3	191	0	0	1	1,702	11	3,975	0	0	2,938	23	11	23	0	0	83
6/30	84	4	215	0	0	0	1,786	15	4,190	0	0	2,938	24	15	24	0	0	83
7/01	1,034	1	498	0	0	1	2,820	16	4,688	0	0	2,939	38	16	27	0	0	83
7/02 *	712	10	730	1	0	15	3,532	25	5,418	1	0	2,954	47	26	31	0	0	83
7/03	389	18	961	1	0	29	3,921	43	6,379	2	0	2,983	52	44	36	0	0	84
7/04	320	8	1,074	0	0	0	4,241	51	7,453	2	0	2,983	57	52	42	0	0	84
7/05	280	6	326	2	0	25	4,521	57	7,779	4	0	3,008	60	58	44	1	0	85
7/06	579	9	606	1	0	43	5,100	66	8,385	5	0	3,051	68	67	48	1	0	86
7/07	180	3	575	0	0	19	5,280	69	8,960	5	0	3,070	71	70	51	1	0	86
7/08	122	0	629	0	0	2	5,402	69	9,589	5	0	3,072	72	70	55	1	0	86
7/09	436	15	852	12	0	149	5,838	84	10,441	17	0	3,221	78	86	59	3	0	91
7/10	127	0	241	0	0	2	5,965	84	10,682	17	0	3,223	80	86	61	3	0	91
7/11	376	0	446	0	0	6	6,341	84	11,128	17	0	3,229	85	86	63	3	0	91
7/12	53	4	343	4	0	1	6,394	88	11,471	21	0	3,230	85	90	65	3	0	91
7/13	60	2	394	9	0	3	6,454	90	11,865	30	0	3,233	86	92	68	5	0	91
7/14	127	0	489	11	0	0	6,581	90	12,354	41	0	3,233	88	92	70	6	0	91
7/15	324	0	556	34	0	21	6,905	90	12,910	75	0	3,254	92	92	73	12	0	92
7/16	78	1	232	18	1	15	6,983	91	13,142	93	1	3,269	93	93	75	14	1	92
7/17	67	0	462	34	0	15	7,050	91	13,604	127	1	3,284	94	93	77	20	1	92
7/18	107	0	514	44	0	15	7,157	91	14,118	171	1	3,299	96	93	80	27	1	93
7/19	63	3	667	90	1	0	7,220	94	14,785	261	2	3,299	96	96	84	41	1	93
7/20	49	0	322	68	3	8	7,269	94	15,107	329	5	3,307	97	96	86	51	3	93
7/21	58	0	387	61	0	146	7,327	94	15,494	390	5	3,453	98	96	88	61	3	97
7/22	26	0	273	45	0	102	7,353	94	15,767	435	5	3,555	98	96	90	68	3	100
7/23	29	2	321	39	6	0	7,382	96	16,088	474	11	3,555	99	98	92	74	6	100
7/24	54	0	525	68	22	0	7,436	96	16,613	542	33	3,555	99	98	95	84	19	100
7/25	34	2	449	74	47	0	7,470	98	17,062	616	80	3,555	100	100	97	96	46	100
7/26	17	0	508	28	93	0	7,487	98	17,570	644	173	3,555	100	100	100	100	100	100
7/27	High Water; partial washout																	

* estimated fish passage.

Table 4. Estimated age and sex composition of the 1996 chinook salmon escapement to the George River.

Year	Sample Dates (Stratum Dates)	Sample Size	Sex	Age Class 1.2 Esc.	1.2 %	1.3 Esc.	1.3 %	2.2 Esc.	2.2 %	1.4 Esc.	1.4 %	1.5 Esc.	1.5 %	Total Esc.	Total %
1996	6/24 - 25	44	M	91	6.8	272	20.5	30	2.3	121	9.1	30	2.3	544	40.9
	(6/21 - 6/26)		F	60	4.5	212	15.9	0	0.0	302	22.7	212	15.9	786	59.1
			Subtotal	151	11.4	484	36.4	30	2.3	423	31.8	242	18.2	1,330	100.0
	6/28	25	M	0	0.0	15	4.0	0	0.0	119	32.0	30	8.0	164	44.0
	(6/27 - 29)		F	15	4.0	89	24.0	0	0.0	45	12.0	60	16.0	208	56.0
			Subtotal	15	4.0	104	28.0	0	0.0	164	44.0	89	24.0	372	100.0
	7/2	32	M	0	0.0	317	12.5	0	0.0	476	18.8	476	18.8	1,270	50.0
	(6/30 - 7/4)		F	0	0.0	0	0.0	0	0.0	555	21.9	714	28.1	1,270	50.0
			Subtotal	0	0.0	317	12.5	0	0.0	1,031	40.6	1,190	46.9	2,539	100.0
	7/7, 9	90	M	289	8.9	541	16.7	0	0.0	469	14.4	289	8.9	1,587	48.9
	(7/5 - 26)		F	36	1.1	144	4.4	0	0.0	866	26.7	613	18.9	1,659	51.1
			Subtotal	325	10.0	685	21.1	0	0.0	1,334	41.1	902	27.8	3,246	100.0
	Season [a]	191	M	380	5.1	1,145	15.3	30	0.4	1,185	15.8	825	11.0	3,564	47.6
			F	111	1.5	445	5.9	0	0.0	1,768	23.6	1,598	21.3	3,923	52.4
			Total	491	6.6	1,590	21.2	30	0.4	2,953	39.4	2,423	32.4	7,487	100.0

[a] 'Season' escapement estimates are the sum of the 'strata' escapement estimates, percentages are derived from those sums.

Table 5. Estimated mean length (mm) of the 1996 chinook salmon escapement to the George River.

Year	Sample Dates (Stratum Dates)	Sex		Age Class 1.2	1.3	2.2	1.4	1.5
1996	6/24 - 25 (6/21 - 6/26)	M	Mean Length	565	674	600	823	955
			Std. Error	50	18	0	27	0
			Range	505- 664	575- 734	600- 600	742- 860	955- 955
			Sample Size	3	9	1	4	1
		F	Mean Length	518	722		894	849
			Std. Error	18	25		17	45
			Range	500- 535	648- 848		812- 963	659- 986
			Sample Size	2	7	0	10	7
	6/28 (6/27 - 29)	M	Mean Length		775		908	992
			Std. Error		0		20	7
			Range		775- 775		805- 970	985- 998
			Sample Size	0	1	0	8	2
		F	Mean Length	620	735		856	859
			Std. Error	0	27		41	53
			Range	620- 620	664- 848		805- 938	710- 952
			Sample Size	1	6	0	3	4
	7/2 (6/30 - 7/4)	M	Mean Length		723		843	919
			Std. Error		18		47	22
			Range		684- 766		669- 981	824- 976
			Sample Size	0	4	0	6	6
		F	Mean Length				852	926
			Std. Error				16	14
			Range				785- 919	860- 987
			Sample Size	0	0	0	7	9
	7/7, 9 (7/5 - 26)	M	Mean Length	609	726		845	945
			Std. Error	36	21		21	24
			Range	520- 775	595- 885		741- 972	812- 1010
			Sample Size	8	15	0	13	8
		F	Mean Length	542	790		844	898
			Std. Error	0	38		12	16
			Range	542- 542	669- 879		640- 925	714- 1000
			Sample Size	1	4	0	24	17
	Season [a]	M	Mean Length	598	713	600	848	932
			Range	505- 775	575- 885	600- 600	669- 981	812- 1010
			Sample Size	11	29	1	31	17
		F	Mean Length		746		856	902
			Range		664- 879		640- 963	659- 1000
			Sample Size	4	17	0	44	37

[a] 'Season' mean lengths are weighted by the chinook salmon passage in each stratum.

Table 6. Daily record of fish carcasses passed downstream of the George River weir, 1996.

Date	Daily Passage								
	Chinook	Sockeye	Chum	Pink	Coho	Suckers	N. Pike	Whitefish	Grayling
Date									
6/21	0	0	0	0	0	0	0	0	0
6/22	0	0	0	0	0	0	0	0	0
6/23	0	0	0	0	0	0	0	0	0
6/24	0	0	0	0	0	0	0	0	0
6/25	1	0	4	0	0	4	0	0	0
6/26	0	0	1	0	0	0	0	0	0
6/27	0	0	0	0	0	0	0	0	0
6/28	0	0	1	0	0	2	1	0	0
6/29	3	0	5	0	0	61	1	0	0
6/30	0	0	4	0	0	17	0	0	1
7/01	0	0	6	0	0	0	0	0	0
7/02	1	0	10	0	0	0	0	0	0
7/03	1	0	8	0	0	0	0	0	0
7/04	2	0	13	0	0	0	0	0	0
7/05	2	0	11	0	0	3	0	0	0
7/06	0	0	23	0	0	0	1	1	0
7/07	2	0	25	0	0	1	0	0	0
7/08	0	0	19	0	0	0	0	0	0
7/09	6	0	40	0	0	0	0	0	0
7/10	10	0	53	1	0	0	1	0	0
7/11	10	0	44	0	0	1	0	0	0
7/12	8	0	55	0	0	4	0	0	0
7/13	3	0	33	0	0	2	0	0	0
7/14	3	0	50	0	0	0	1	0	0
7/15	5	0	45	1	0	0	0	0	0
7/16	7	0	69	0	0	0	0	1	0
7/17	8	0	73	0	0	0	0	0	0
7/18	10	0	65	5	0	0	0	0	0
7/19	5	0	56	0	0	0	0	0	0
7/20	14	1	130	2	0	0	0	0	0
7/21	36	0	126	2	0	0	0	0	0
7/22	29	0	143	4	0	0	0	0	0
7/23	11	0	108	5	0	0	0	0	0
7/24	9	0	72	5	0	2	0	0	0
7/25	10	0	126	30	0	0	0	2	0
7/26	No carcasses recorded								
7/27	High Water; partial washout								
Total	196	1	1,418	55	0	97	5	4	1
Live Passage	7,487	98	17,570	644	173	3,555			
% of Live	3	1	8	9	0	3			

Table 7. Estimated age and sex composition of the 1996 chum salmon escapement to the George River.

Year	Sample Dates (Stratum Dates)	Sample Size	Sex	Age Class 0.2 Esc.	0.2 %	0.3 Esc.	0.3 %	0.4 Esc.	0.4 %	0.5 Esc.	0.5 %	Total Esc.	Total %
1996	6/22 - 23	47	M	0	0.0	403	10.6	1,288	34.0	242	6.4	1,932	51.1
	(6/21 - 28)		F	81	2.1	805	21.3	966	25.5	0	0.0	1,852	48.9
			Subtotal	81	2.1	1,208	31.9	2,254	59.6	242	6.4	3,784	100.0
	7/5 - 6	177	M	0	0.0	1,804	31.1	1,968	33.9	33	0.6	3,804	65.5
	(6/29 - 7/8)		F	0	0.0	1,115	19.2	886	15.3	0	0.0	2,001	34.5
			Subtotal	0	0.0	2,919	50.3	2,853	49.2	33	0.6	5,805	100.0
	7/11	91	M	50	2.2	700	30.8	375	16.5	25	1.1	1,151	50.5
	(7/9 - 13)		F	75	3.3	725	31.9	325	14.3	0	0.0	1,125	49.5
			Subtotal	125	5.5	1,426	62.6	700	30.8	25	1.1	2,276	100.0
	7/16 - 17	203	M	11	0.5	744	33.0	388	17.2	0	0.0	1,143	50.7
	(7/14 - 18)		F	55	2.5	744	33.0	311	13.8	0	0.0	1,110	49.3
			Subtotal	67	3.0	1,487	66.0	699	31.0	0	0.0	2,253	100.0
	7/20	69	M	0	0.0	645	39.1	143	8.7	0	0.0	789	47.8
	(7/19 - 22)		F	72	4.3	574	34.8	215	13.0	0	0.0	860	52.2
			Subtotal	72	4.3	1,219	73.9	358	21.7	0	0.0	1,649	100.0
	7/25 - 26	178	M	0	0.0	699	38.8	152	8.4	20	1.1	871	48.3
	(7/23 - 26)		F	0	0.0	750	41.6	182	10.1	0	0.0	932	51.7
			Subtotal	0	0.0	1,448	80.3	334	18.5	20	1.1	1,803	100.0
	Season [a]	765	M	61	0.3	4,994	28.4	4,315	24.6	320	1.8	9,690	55.2
			F	283	1.6	4,712	26.8	2,885	16.4	0	0.0	7,880	44.8
			Total	344	2.0	9,707	55.2	7,200	41.0	320	1.8	17,570	100.0

[a] 'Season' escapement estimates are the sum of the 'strata' escapement estimates and the percentages are derived from those sums.

Table 8. Estimated mean length (mm) of the 1996 chum salmon escapement to the George River.

Year	Sample Dates (Stratum Dates)	Sex		Age Class 0.2	0.3	0.4	0.5
1996	6/22 - 23	M	Mean Length		616	625	644
	(6/21 - 28)		Std. Error		26	6	37
			Range		553- 702	589- 675	573- 698
			Sample Size	0	5	16	3
		F	Mean Length	598	556	590	
			Std. Error	0	6	8	
			Range	598- 598	516- 589	544- 623	
			Sample Size	1	10	12	0
	7/5 - 6	M	Mean Length		601	616	613
	(6/29 - 7/8)		Std. Error		5	5	0
			Range		509- 703	526- 689	613- 613
			Sample Size	0	55	60	1
		F	Mean Length		553	562	
			Std. Error		5	8	
			Range		494- 619	459- 657	
			Sample Size	0	34	27	0
	7/11	M	Mean Length	595	608	609	577
	(7/9 - 13)		Std. Error	6	8	8	0
			Range	589- 601	521- 702	548- 656	577- 577
			Sample Size	2	28	15	1
		F	Mean Length	561	558	551	
			Std. Error	19	7	14	
			Range	537- 598	498- 639	443- 624	
			Sample Size	3	29	13	0
	7/16 - 17	M	Mean Length	580	596	611	
	(7/14 - 18)		Std. Error	0	5	6	
			Range	580- 580	442- 689	522- 679	
			Sample Size	1	67	35	0
		F	Mean Length	550	563	578	
			Std. Error	15	4	6	
			Range	500- 576	474- 635	499- 640	
			Sample Size	5	67	28	0
	7/20	M	Mean Length		590	595	
	(7/19 - 22)		Std. Error		6	21	
			Range		548- 653	548- 689	
			Sample Size	0	27	6	0
		F	Mean Length	525	552	551	
			Std. Error	21	8	7	
			Range	496- 565	460- 618	523- 597	
			Sample Size	3	24	9	0

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Table 8. (page 2 of 2)

Year	Sample Dates (Stratum Dates)	Sex		Age Class 0.2	0.3	0.4	0.5
	7/25 - 26	M	Mean Length		585	589	583
	(7/23 - 26)		Std. Error		4	10	41
			Range		522- 651	523- 678	542- 623
			Sample Size	0	69	15	2
		F	Mean Length		545	561	
			Std. Error		4	8	
			Range		483- 614	506- 641	
			Sample Size	0	74	18	0
	Season	M	Mean Length	592	599	616	632
			Range	580- 601	509- 703	522- 689	542- 698
			Sample size	3	251	147	7
		F	Mean Length	560	554	571	
			Range	496- 614	460- 639	443- 657	
			Sample size	12	238	107	0

[a] 'Season' mean lengths are weighted by the chum salmon passage in each stratum.

Table 9. Chemical analysis of water samples collected from George River in 1996.

Parameter	EPA Std. [a] (μg/L)	Lab	Date of Sample 06/21	07/01	07/30
Depth			Surface	Surface	Surface
Location			RM 4	RM 4	RM 4
Relative Water Level			V. Low	Moderate	Bank Full
Specific Conductance (μmhos/cm)		ADFG [b]		122	102
pH	6.5 to 9.0 [d]	ADFG [b]		7	7.5
Alkalinity (mg/L)		ADFG [b]		55.2	47.6
Turbidity (NTU)		ADFG [b]		20.1	59.8
Color (Pt units)		ADFG [b]		n.a.	38
Calcium (mg/L)		ADFG [b]		16	13.2
Magnesium (mg/L)		ADFG [b]		4.8	5.4
Iron (μg/L)	1000 [d]	ADFG [b]		1157	2621
Reactive silicon (μg/L Sil)		ADFG [b]		2788	3280
Aluminum (μg/L)		ER [c]	31		1800
Antimony (μg/L)	1600 [d]	ER [c]	<0.1		<0.1
Arsenic (μg/L)	48 [d]	ER [c]	<1		1
Barium (μg/L)	1000 [e]	ER [c]	55.1		88.7
Beryllium (μg/L)	5.3 [d]	ER [c]	<0.1		0.3
Bismuth (μg/L)		ER [c]	<0.05		<0.05
Boron (μg/L)		ER [c]	4		4
Buropium (μg/L)		ER [c]	<0.05		<0.05
Cadmium (μg/L)	1.1 [d]	ER [c]	<0.1		<0.1
Caesium (μg/L)		ER [c]	<0.05		<0.05
Calcium (μg/L)		ER [c]	19900		15500
Cerium (μg/L)		ER [c]	0.06		1.85
Chromium (μg/L)		ER [c]	<0.5		2.0
Cobalt (μg/L)		ER [c]	0.2		1.5
Copper (μg/L)	12 [d]	ER [c]	1.2		5.1
Dysprosium (μg/L)		ER [c]	<0.05		0.23
Erbaim (μg/L)		ER [c]	<0.05		<0.05
Gadolinium (μg/L)		ER [c]	<0.05		0.13
Gallium (μg/L)		ER [c]	<0.1		0.5
Germanium (μg/L)		ER [c]	<0.5		<0.5
Gold (μg/L)		ER [c]	<0.1		<0.1
Hafnium (μg/L)		ER [c]	<0.05		<0.05
Holmium (μg/L)		ER [c]	<0.05		0.08
Iridium (μg/L)		ER [c]	<0.05		<0.05
Iron (μg/L)	1000 [d]	ER [c]	1280		3340
Krypton (μg/L)		ER [c]	<1		2
Lanthanum (μg/L)		ER [c]	<0.1		0.6
Lead (μg/L)	3.2 [d]	ER [c]	<0.1		1.5
Lithium (μg/L)		ER [c]	2.8		4.4
Lutetium (μg/L)		ER [c]	<0.1		<0.1
Magnesium (μg/L)		ER [c]	6500		4940

- continued -

Table 9. (page 2 of 2)

Parameter	EPA Std. [a] (μg/L)	Lab	Date of Sample 06/21	07/01	07/30
Manganese (μg/L)	:	ER [c]	86.8		170
Mercury (μg/L)	0.012 [d]	ER [c]	<0.05		<0.05
Molybdenum (μg/L)		ER [c]	<0.1		<0.1
Neodymium (μg/L)		ER [c]	<0.05		0.8
Nickel (μg/L)	160 [d]	ER [c]	0.7		3.0
Niobium (μg/L)		ER [c]	<0.1		<0.1
Palfadium (μg/L)		ER [c]	<0.1		<0.1
Phosphorous (μg/L)		ER [c]	<50		<50
Pladium (μg/L)		ER [c]	<0.05		<0.05
Potassium (μg/L)		ER [c]	670		470
Praseodymium (μg/L)		ER [c]	<0.05		0.23
Rhenaium (μg/L)		ER [c]	<0.1		<0.1
Rhodium (μg/L)		ER [c]	<0.05		<0.05
Rubidium (μg/L)		ER [c]	0.2		1.0
Ruthenium (μg/L)		ER [c]	<0.1		<0.1
Samarium (μg/L)		ER [c]	<0.05		0.29
Scandium (μg/L)		ER [c]	0.5		1.9
Silicon (μg/L)		ER [c]	1990		6120
Silver (μg/L)	0.12	ER [c]	<0.05		<0.05
Sodium (μg/L)		ER [c]	2280		1840
Strontium (μg/L)		ER [c]	89.9		62.7
Tantalum (μg/L)		ER [c]	<0.1		<0.1
Tellurium (μg/L)		ER [c]	<0.5		<0.5
Terbium (μg/L)		ER [c]	<0.05		<0.05
Thallium (μg/L)	40	ER [c]	0.11		0.11
Thorbium (μg/L)		ER [c]	<0.05		<0.05
Thutium (μg/L)		ER [c]	<0.05		<0.05
Tin (μg/L)		ER [c]	<0.1		<0.1
Titanium (μg/L)		ER [c]	1.80		18.0
Tungsten (μg/L)		ER [c]	<0.1		<0.1
Uranium (μg/L)		ER [c]	0.10		0.13
Vanadium (μg/L)		ER [c]	<1		5
Yuerbium (μg/L)		ER [c]	<0.05		<0.05
Yurium (μg/L)		ER [c]	0.12		1.26
Zinc (μg/L)	110	ER [c]	1		12
Zirconium (μg/L)		ER [c]	<0.1		0.4

[a] United States Environmental Protection Agency (EPA 1986).

[b] Alaska Department of Fish and Game, Limnology Unit, Soldotna, AK.

[c] Elemental Reseach Inc., North Vancouver, B.C., Canada.

[d] freshwater chronic criteria

[e] drinking water criteria

FIGURES

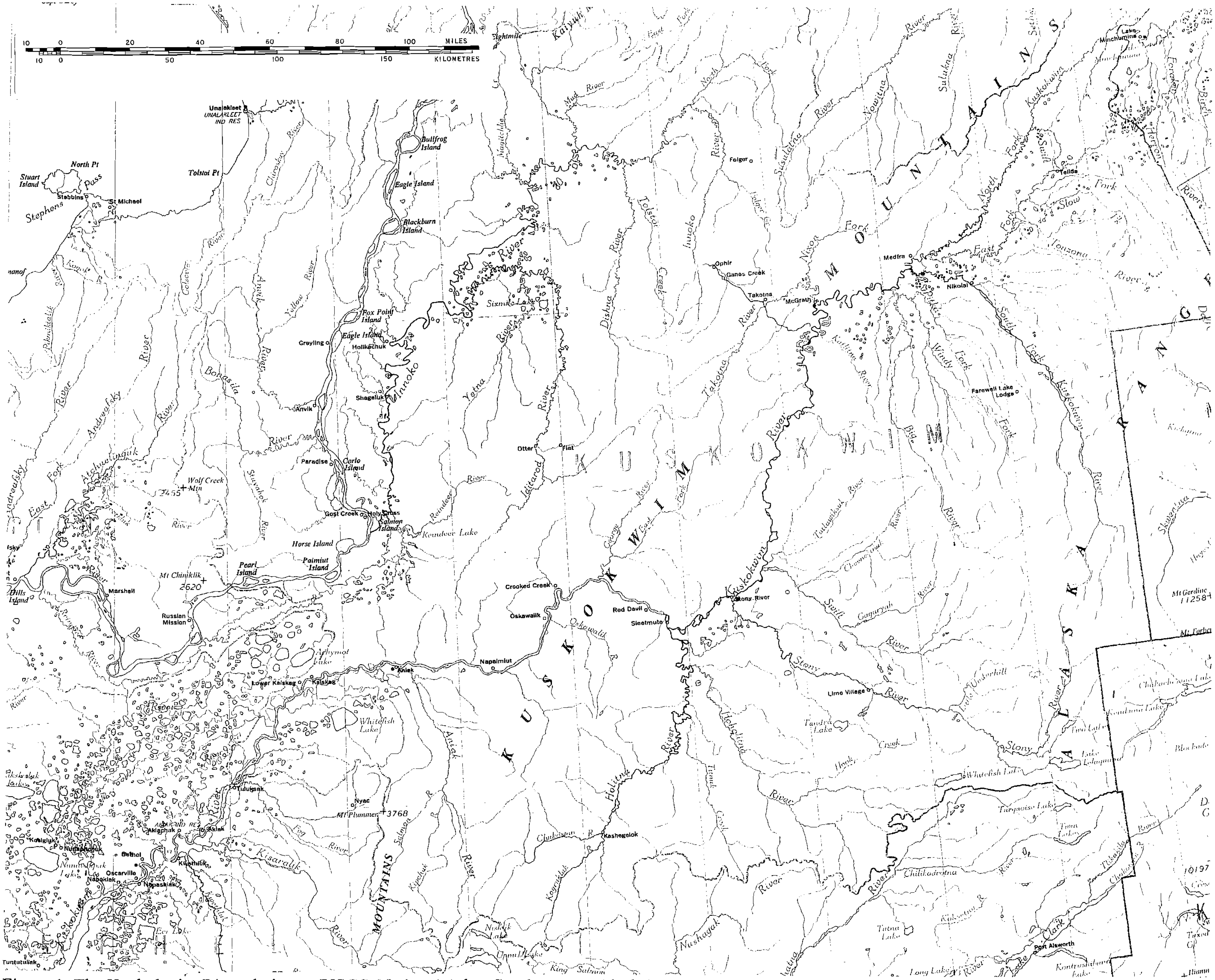


Figure 1. The Kuskokwim River drainage (USGS, National Atlas, Southwestern Alaska).

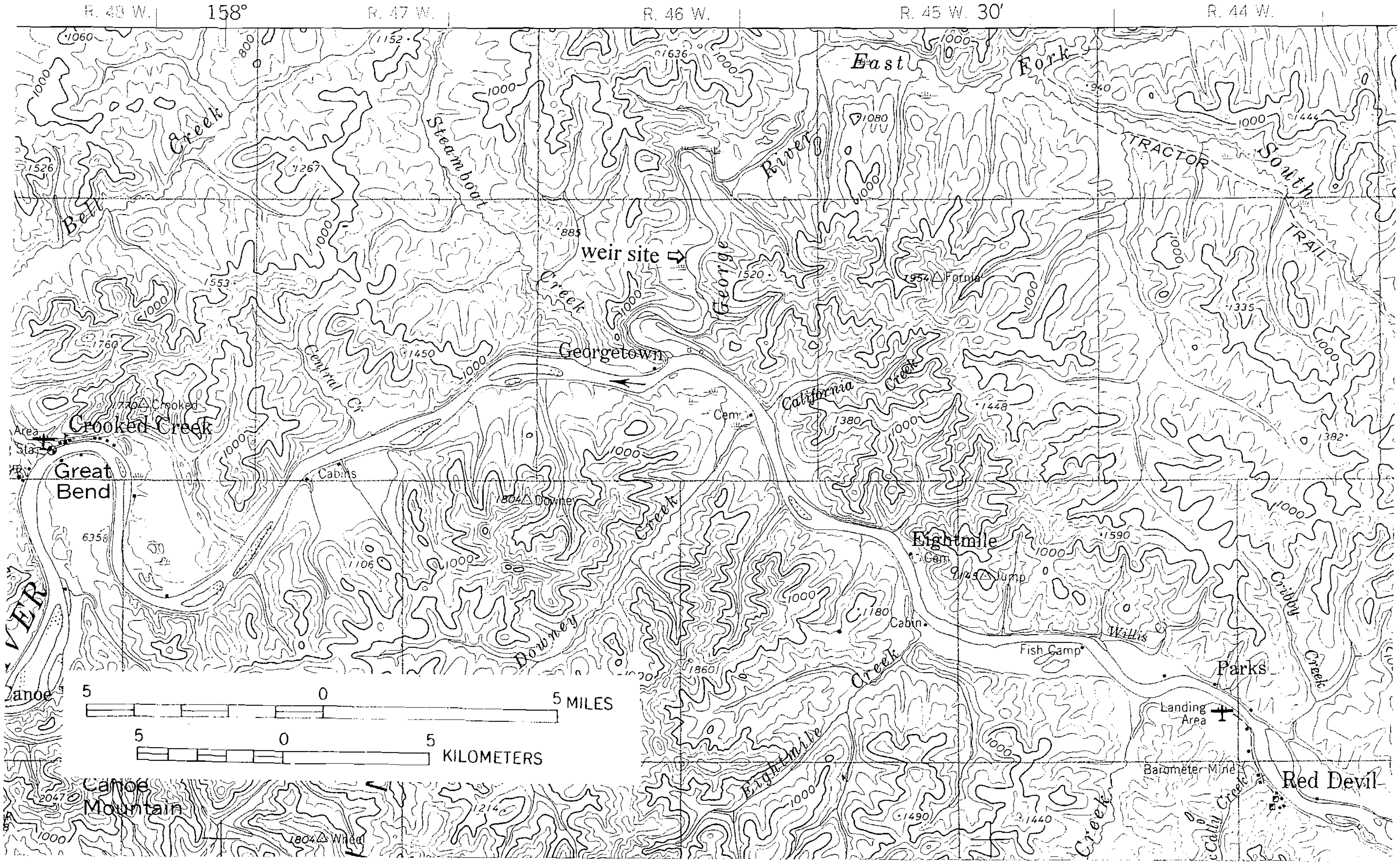


Figure 2. The Kuskokwim River between Crooked Creek and Red Devil (USGS, Sleetmute quadrangle).

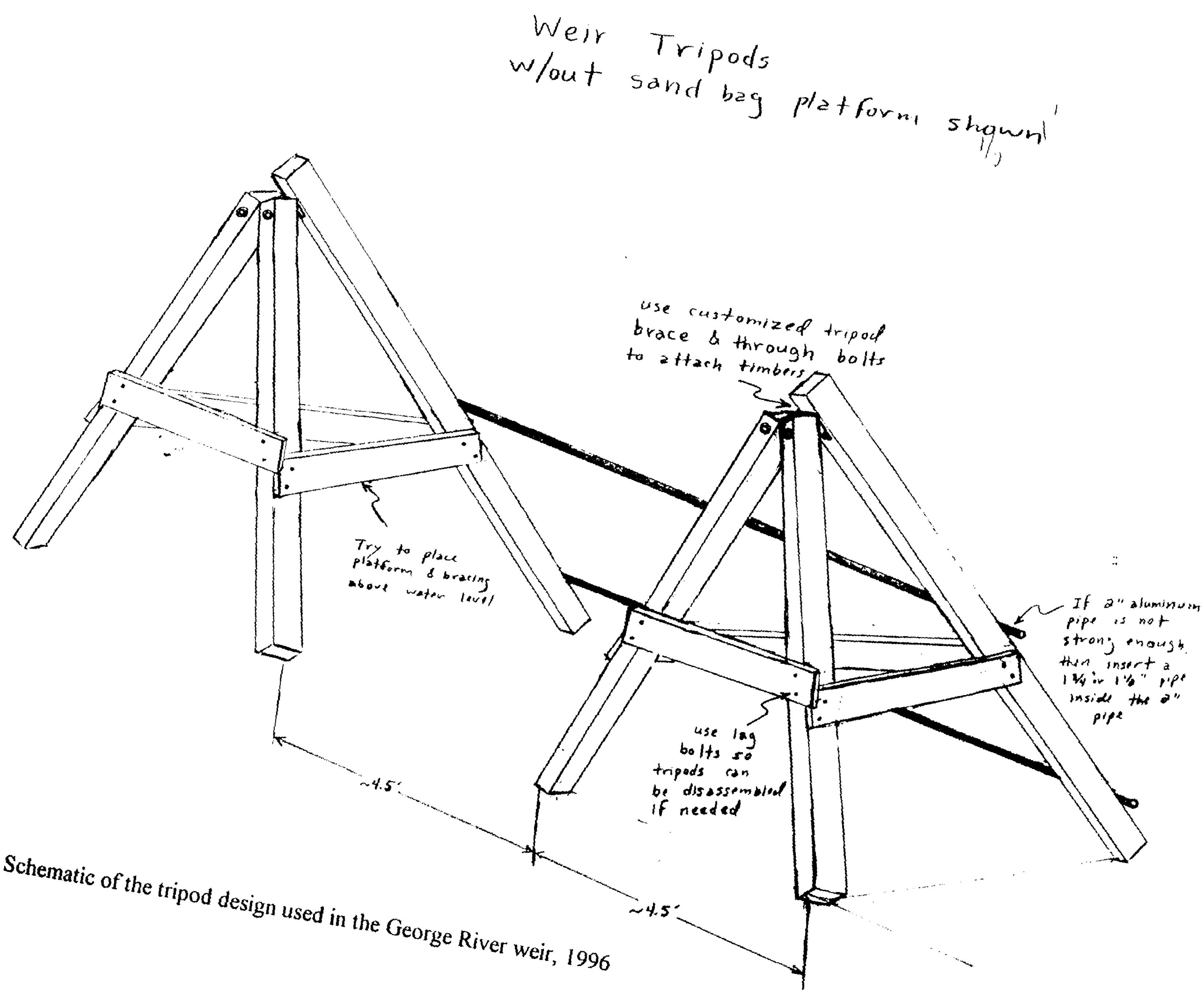


Figure 3. Schematic of the tripod design used in the George River weir, 1996

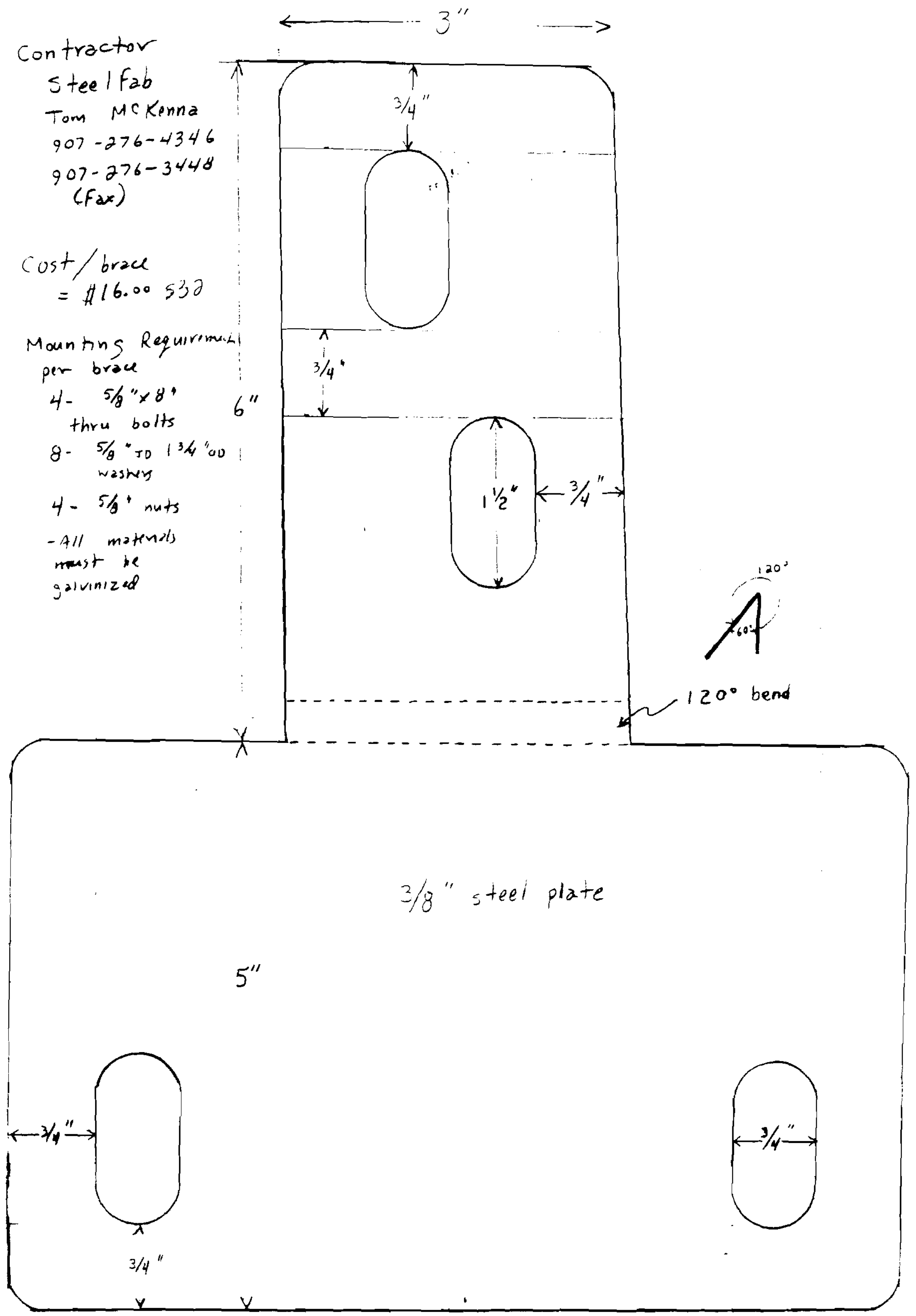


Figure 4. Schematic of the tripod brace design used in the George River weir, 1996.

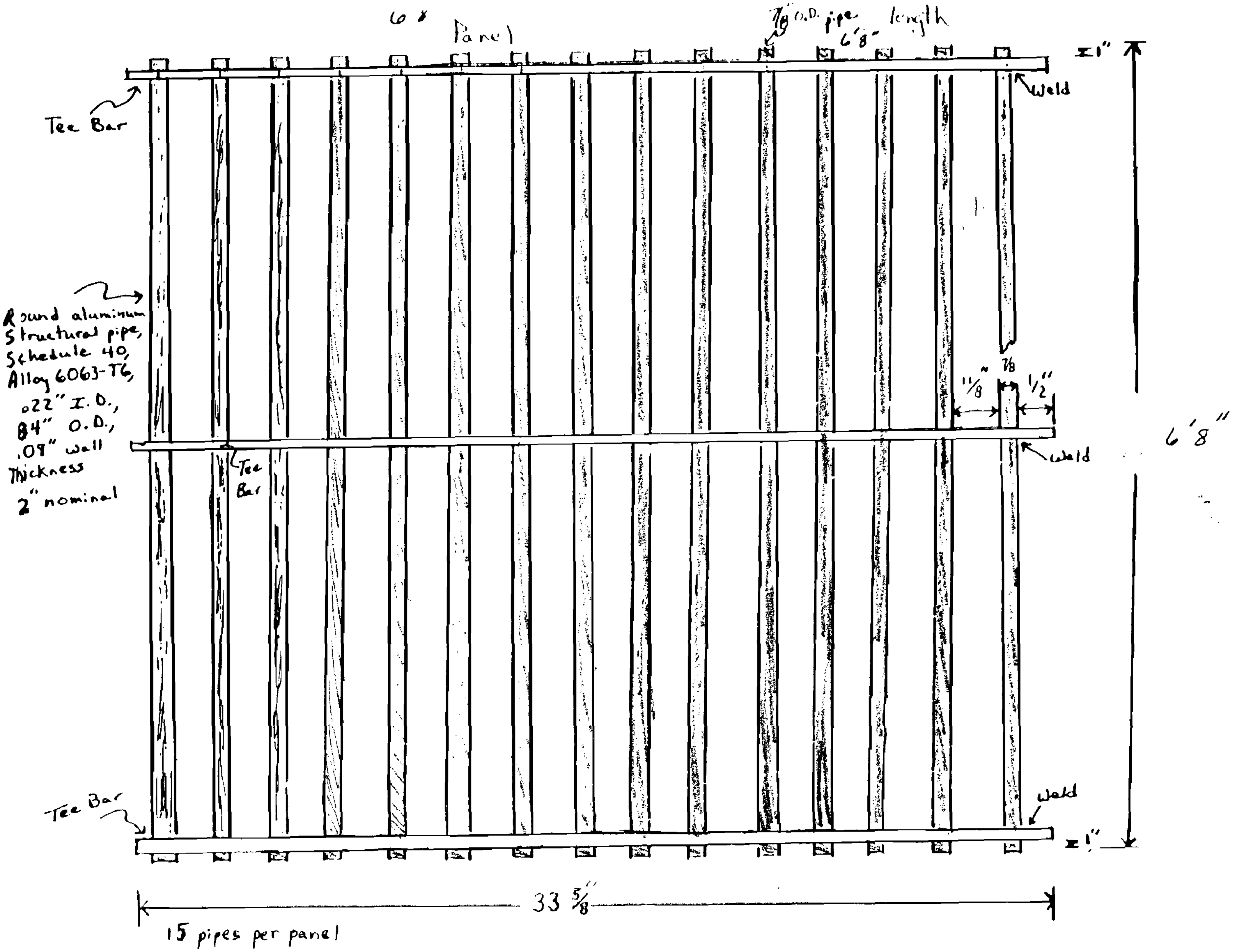


Figure 5. Schematic of the weir panel design used in the George River weir, 1996.

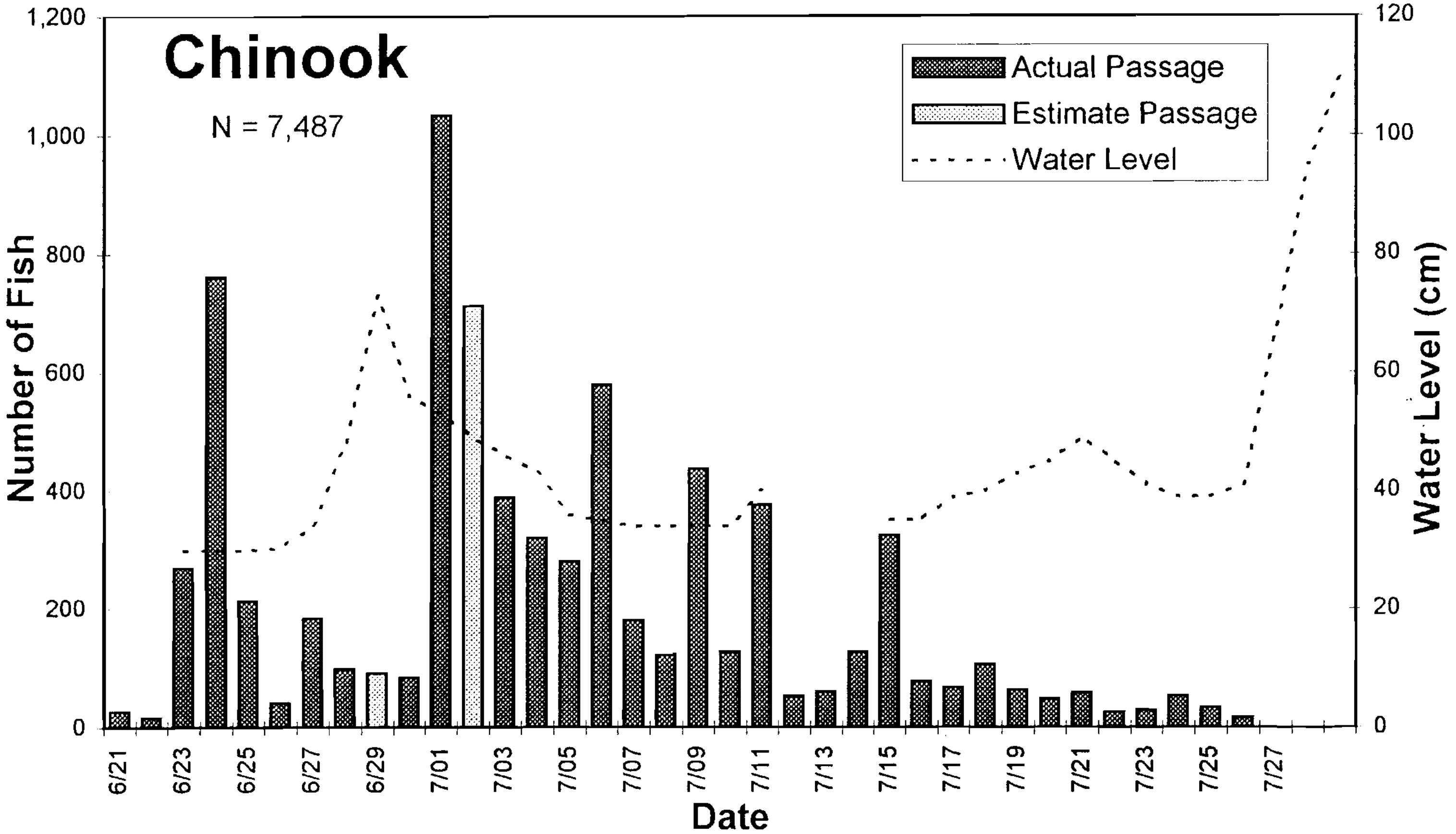


Figure 6. Daily chinook salmon passage at George River weir relative to changes in water level, 1996.

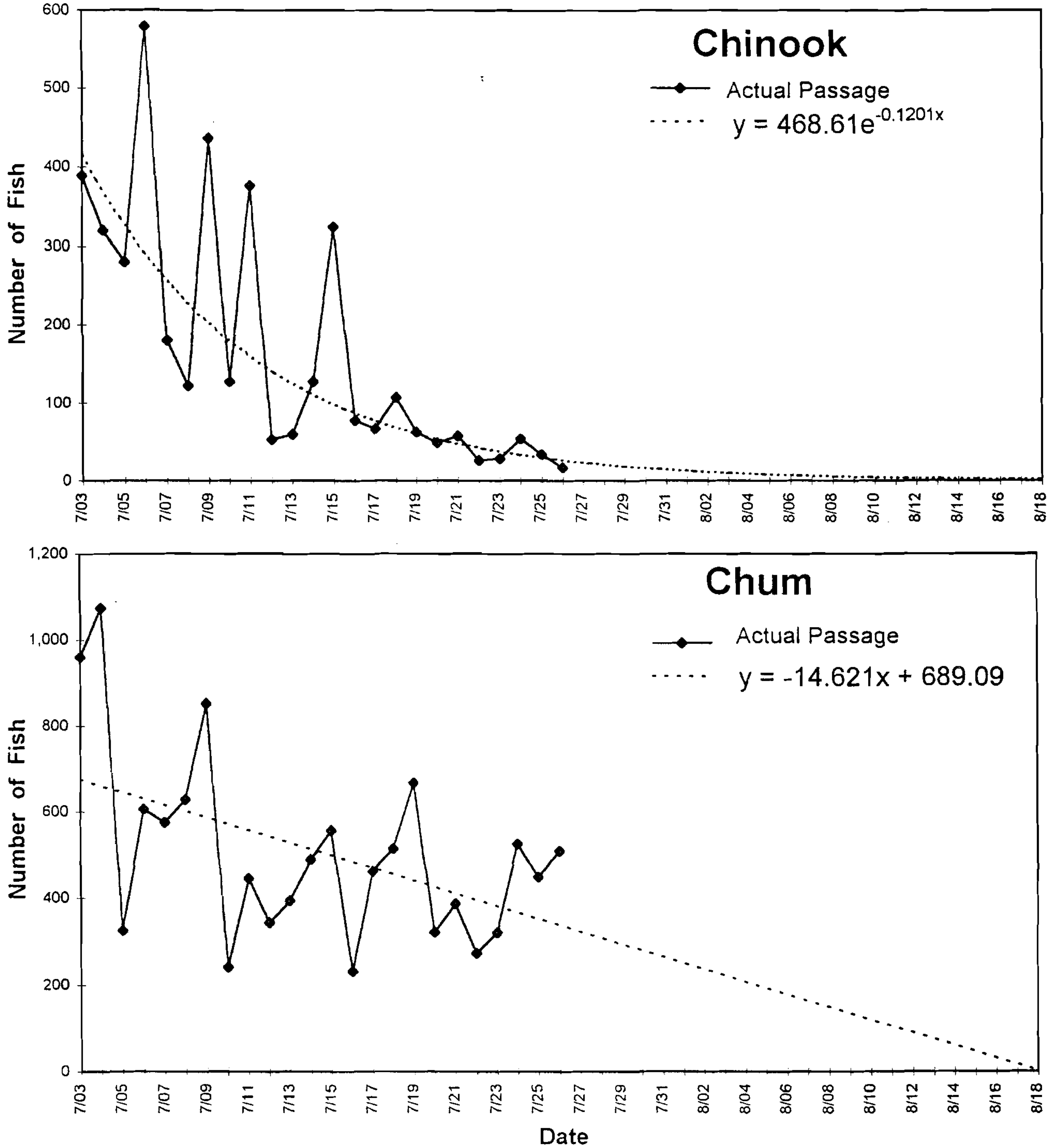


Figure 7. Daily passage of chinook and chum salmon at George River weir for the period 3 July through 26 July with trendline through 18 August.

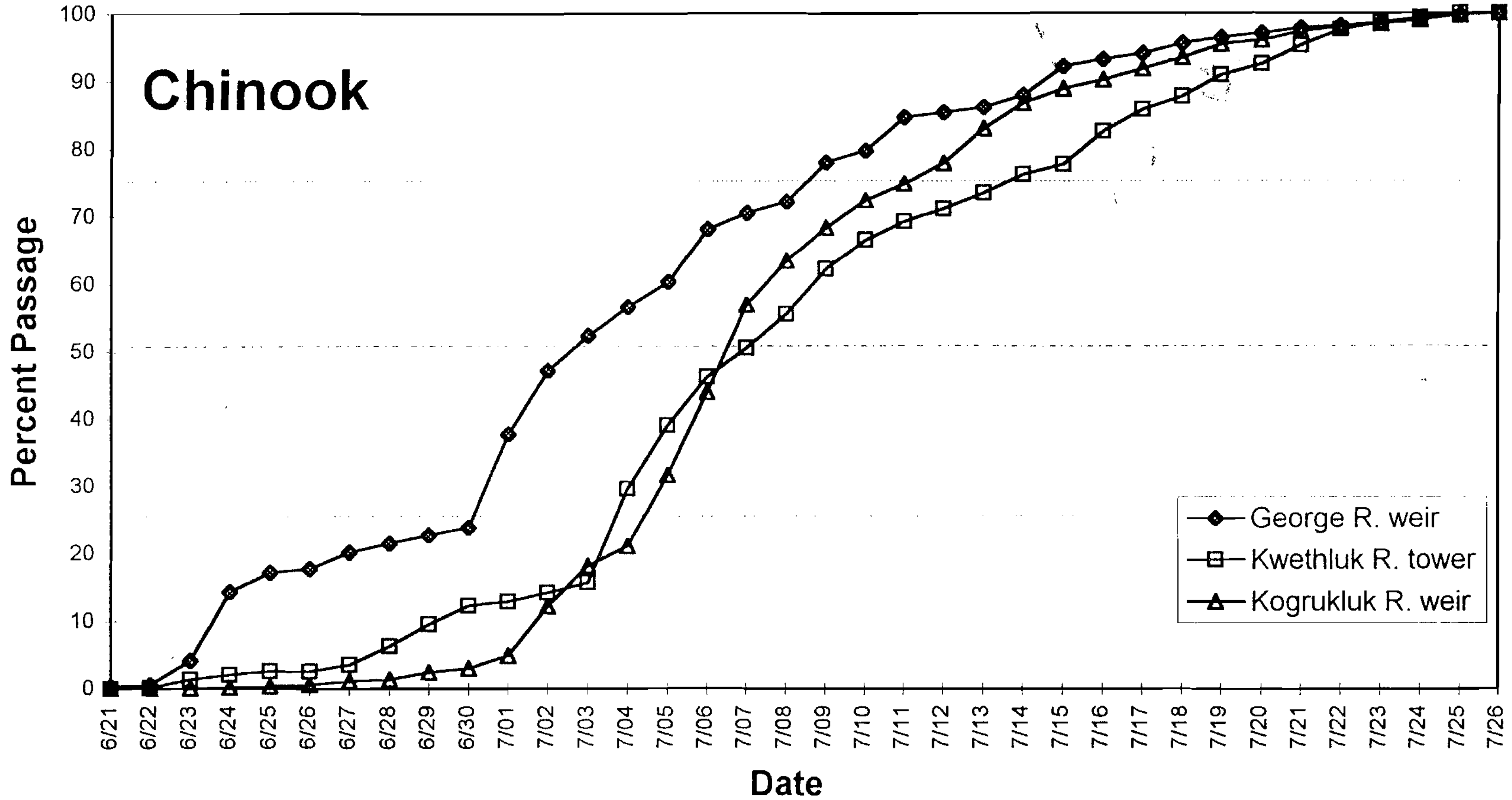


Figure 8. Cumulative percent passage of chinook salmon at three Kuskokwim River escapement projects in 1996.

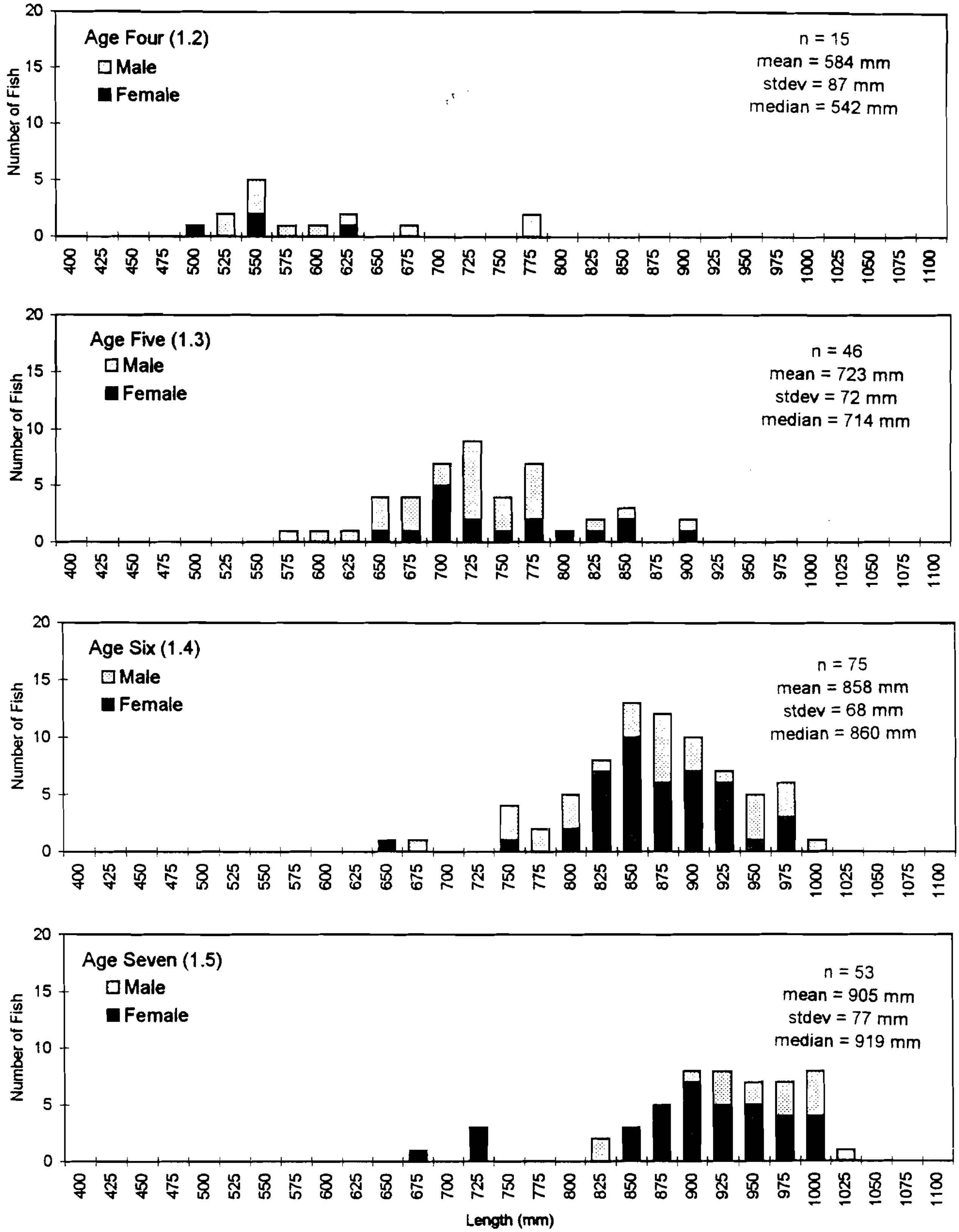


Figure 9. Length frequency of George River chinook salmon, 1996

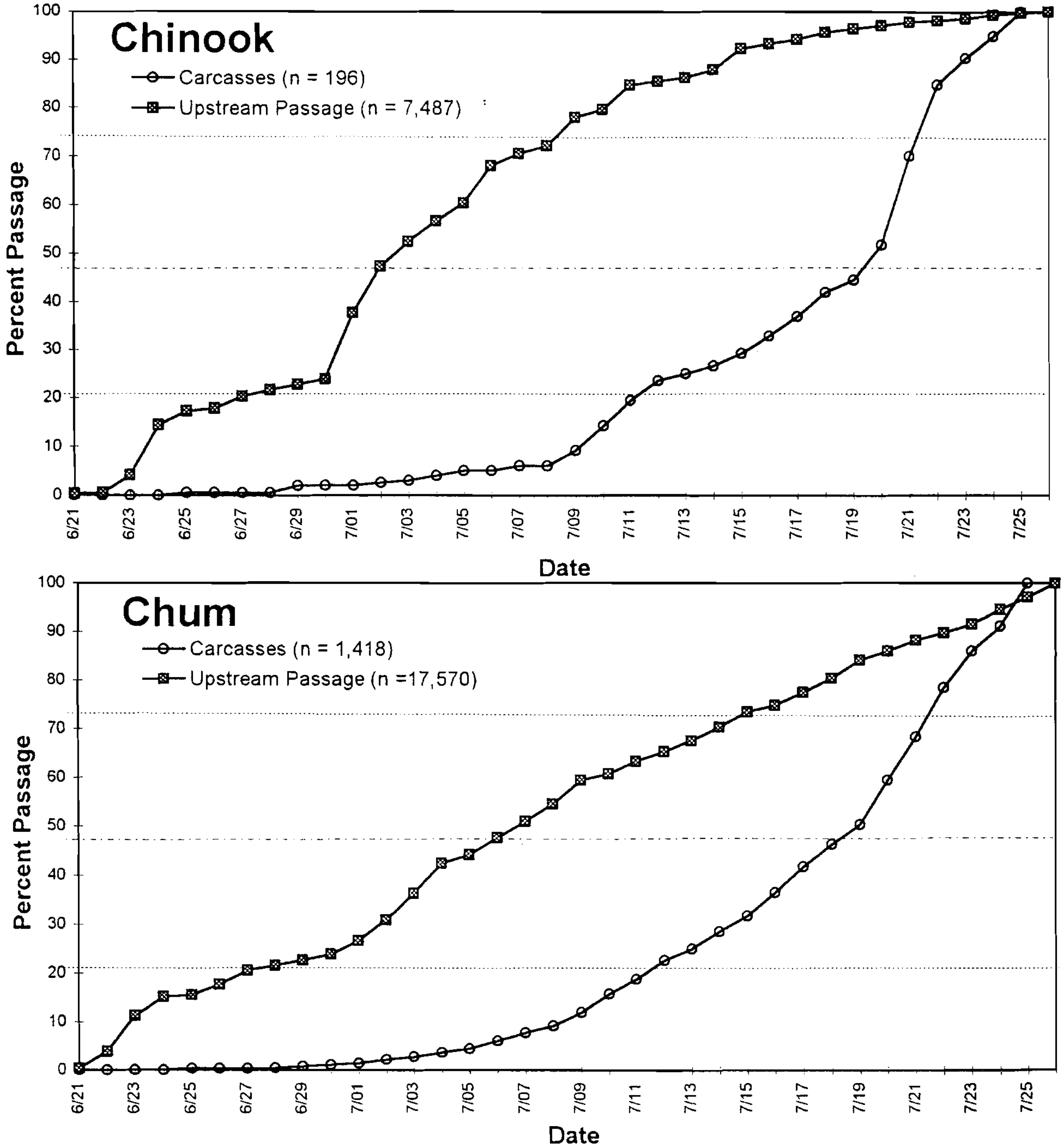


Figure 10. Cumulative percent upstream passage of chinook and chum salmon, and cumulative percent downstream carcass passage at George River weir in 1996.

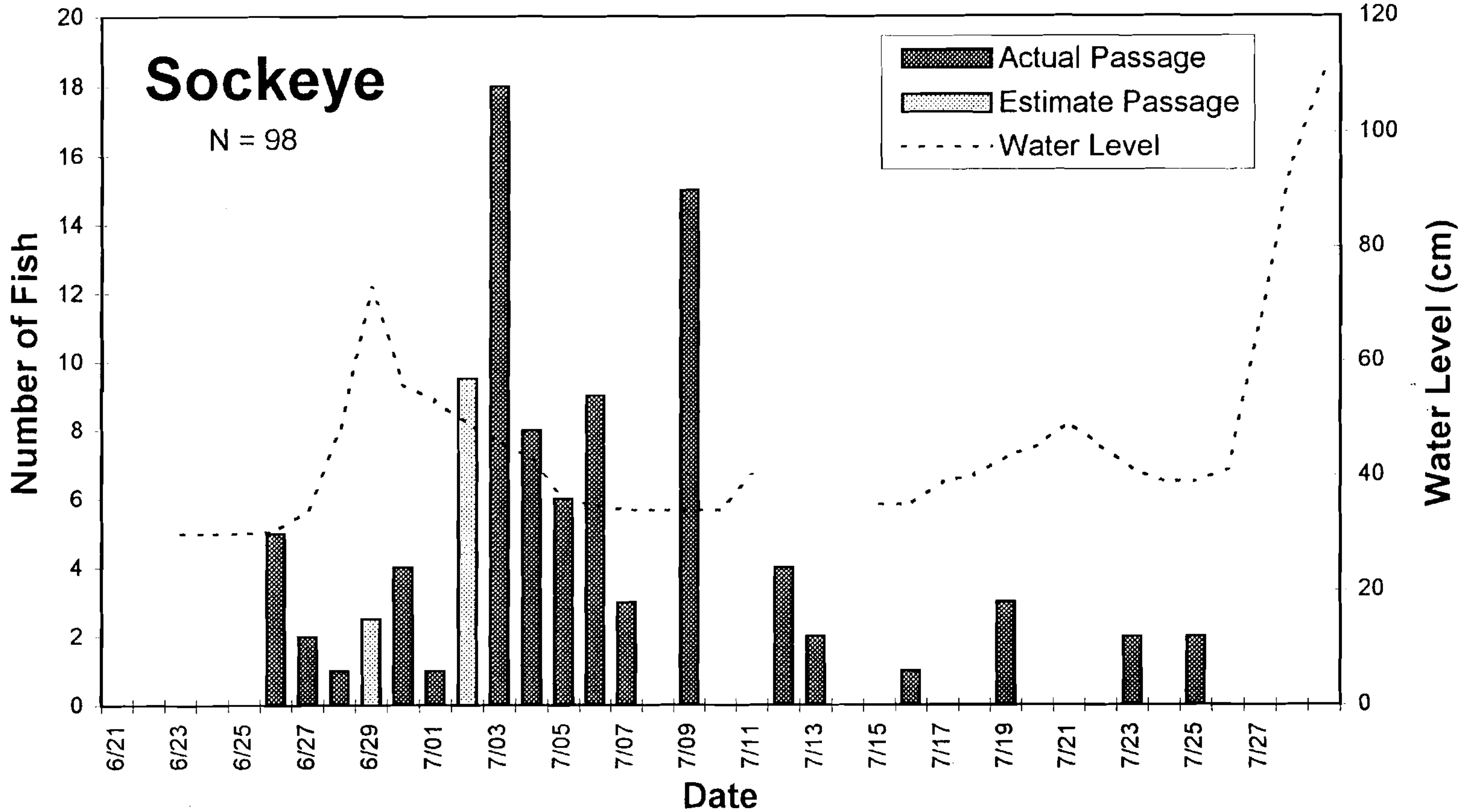


Figure 11. Daily sockeye salmon passage at the George River weir relative to changes in water level, 1996.

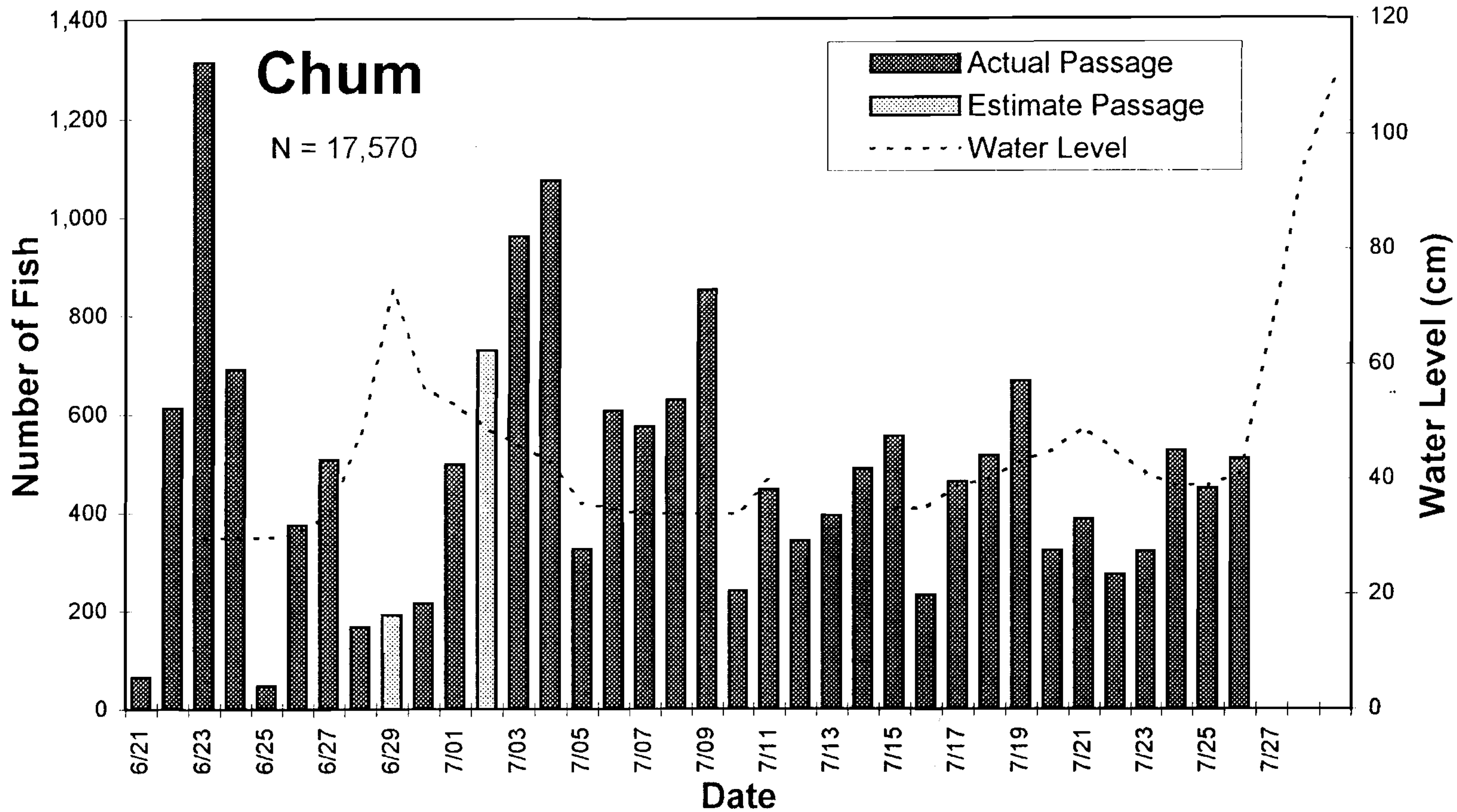


Figure 12. Daily chum salmon passage at the George River weir relative to changes in water level, 1996.

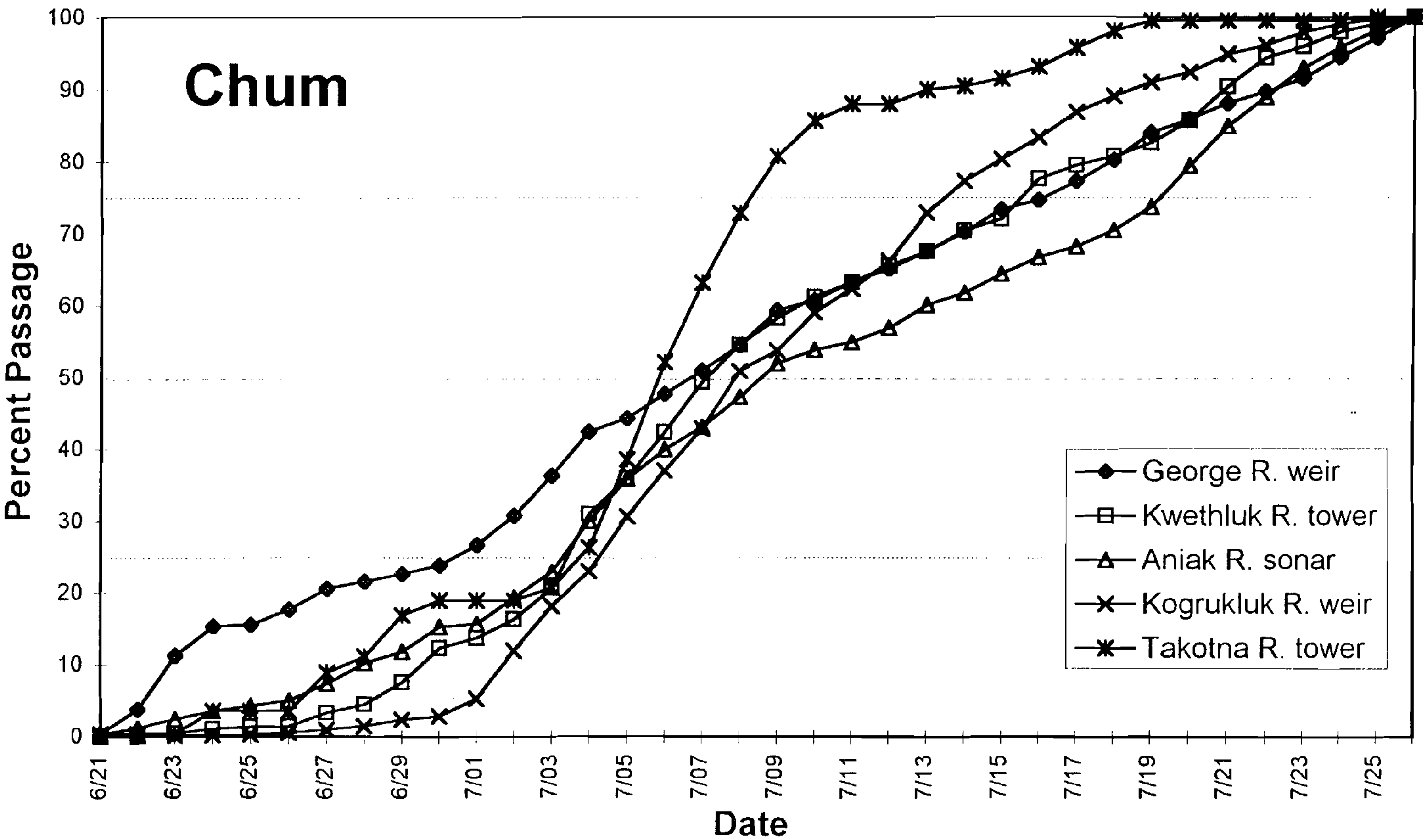


Figure 13. Cumulative percent passage of chum salmon at five Kuskokwim River escapement projects in 1996.

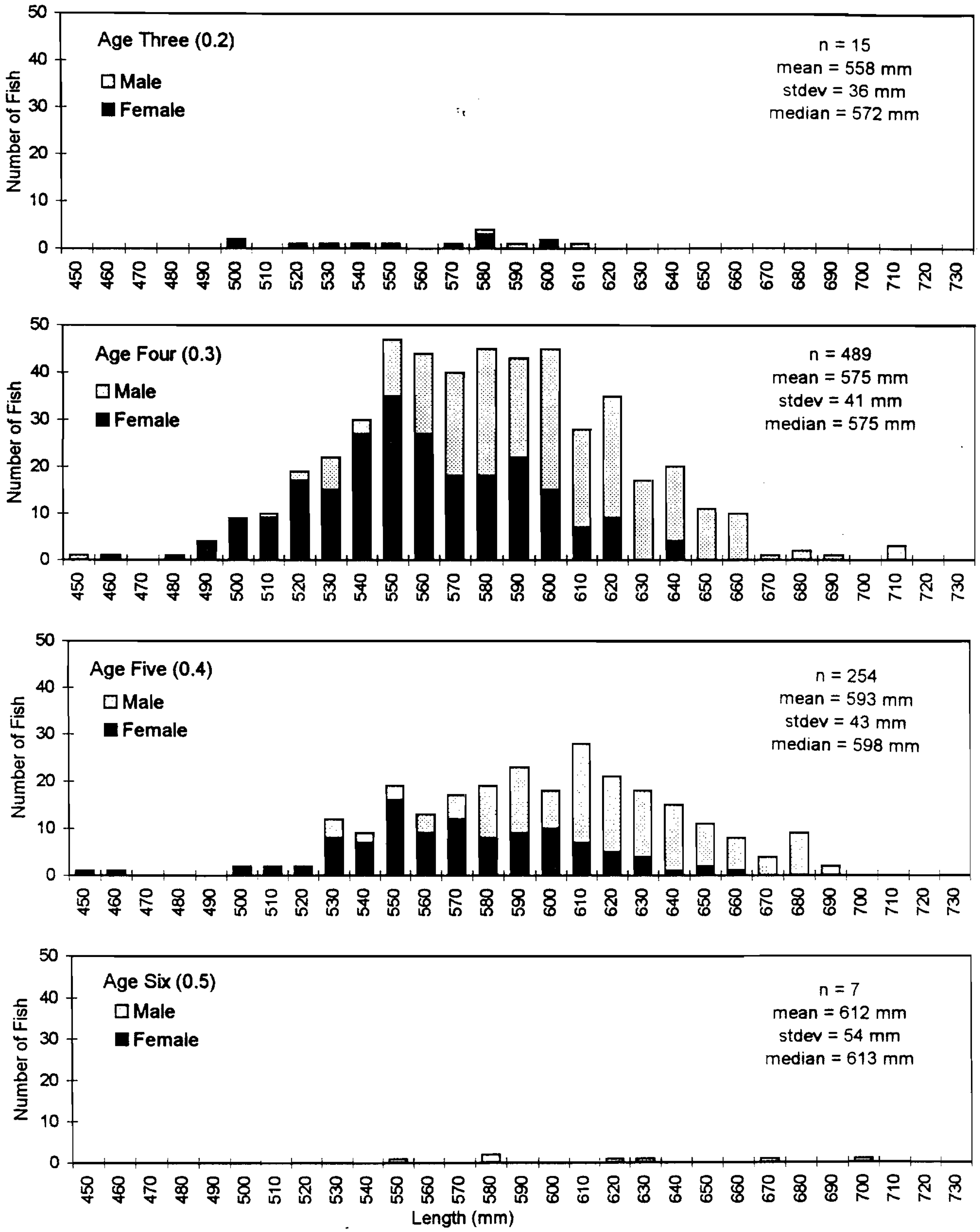


Figure 14. Length frequency of George River chum salmon, 1996

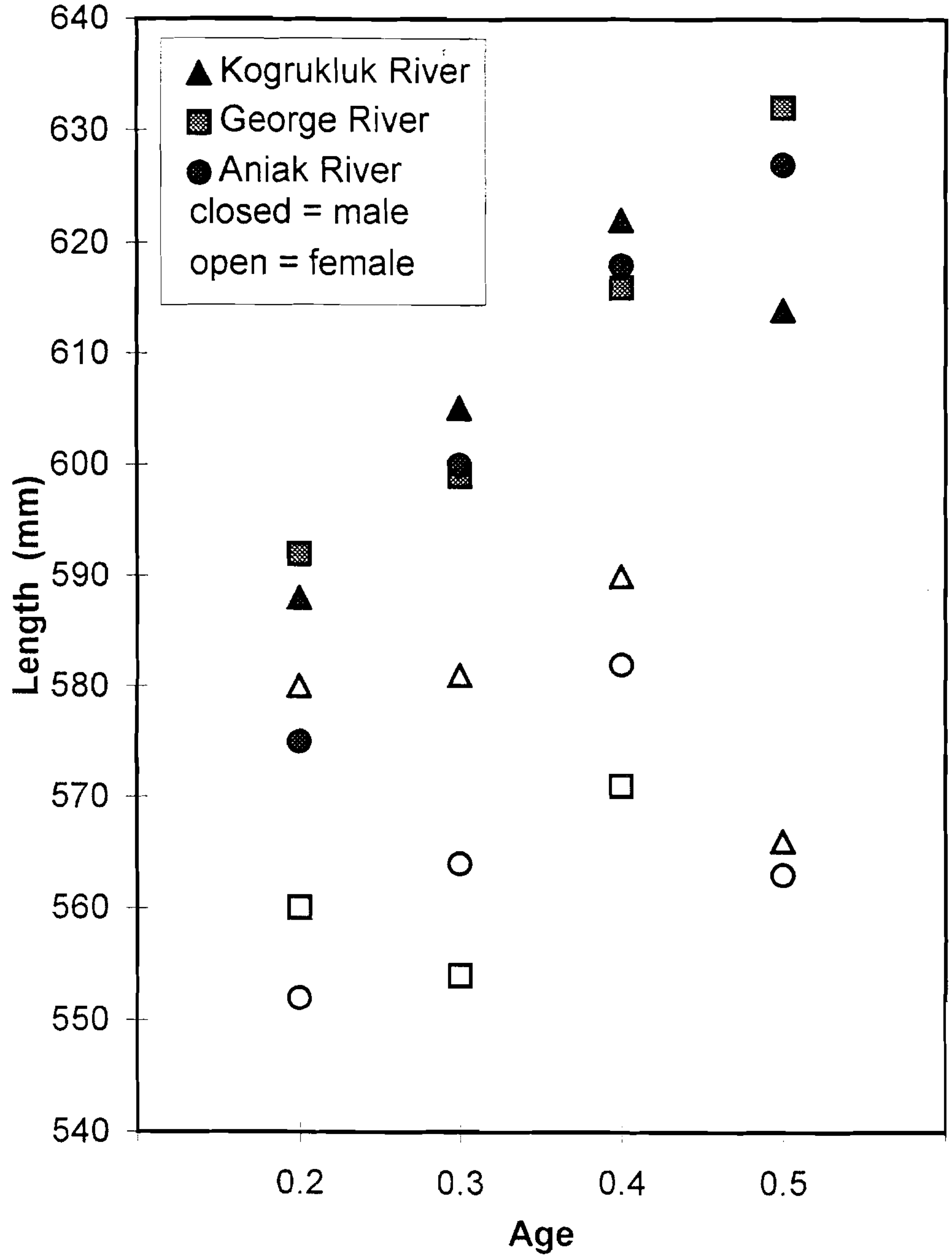


Figure 15. Average length, by age and sex, for three chum salmon populations in the Kuskokwim River drainage in 1996.

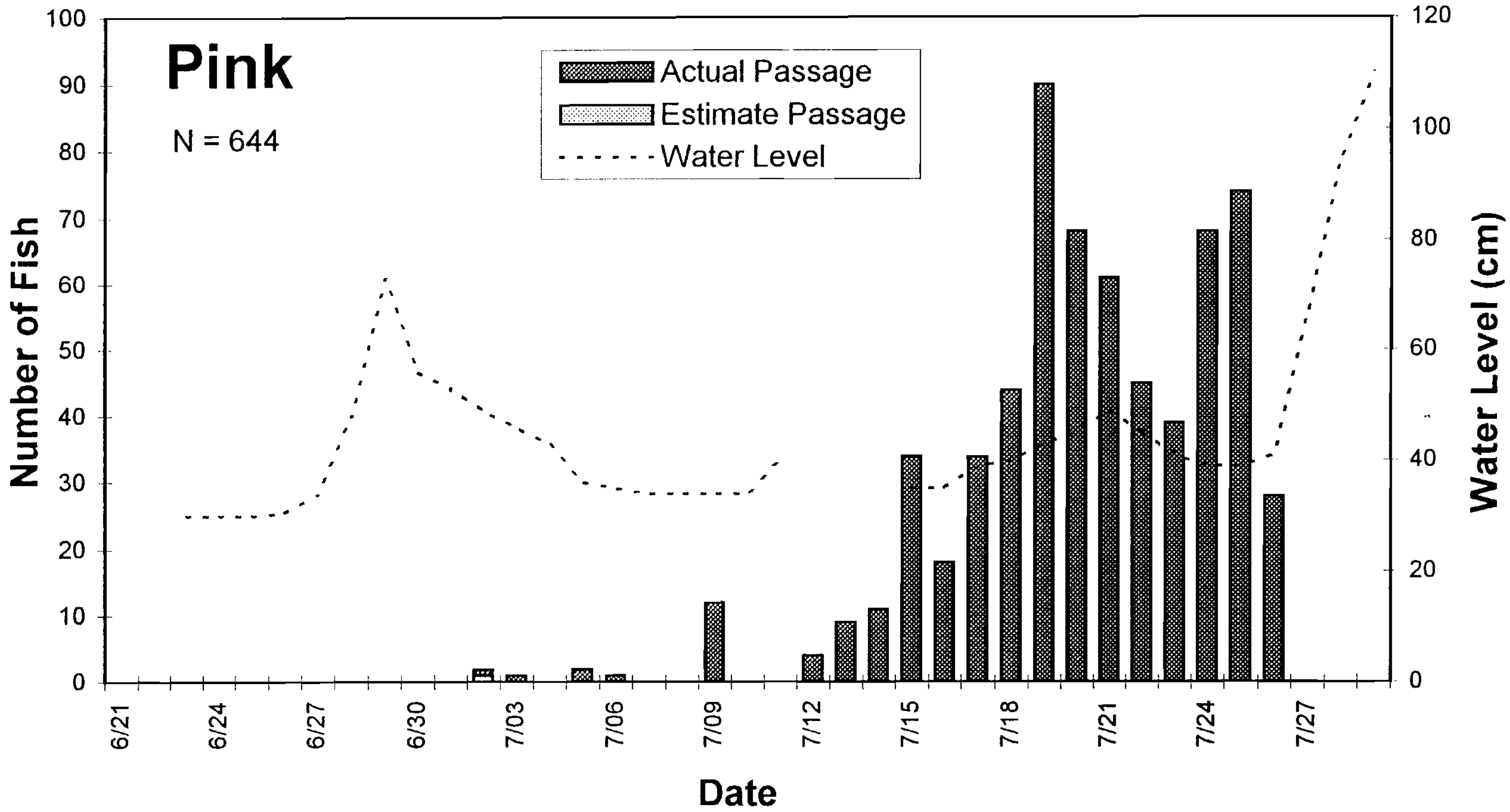


Figure 16. Daily pink salmon passage at the George River weir relative to changes in water level, 1996.

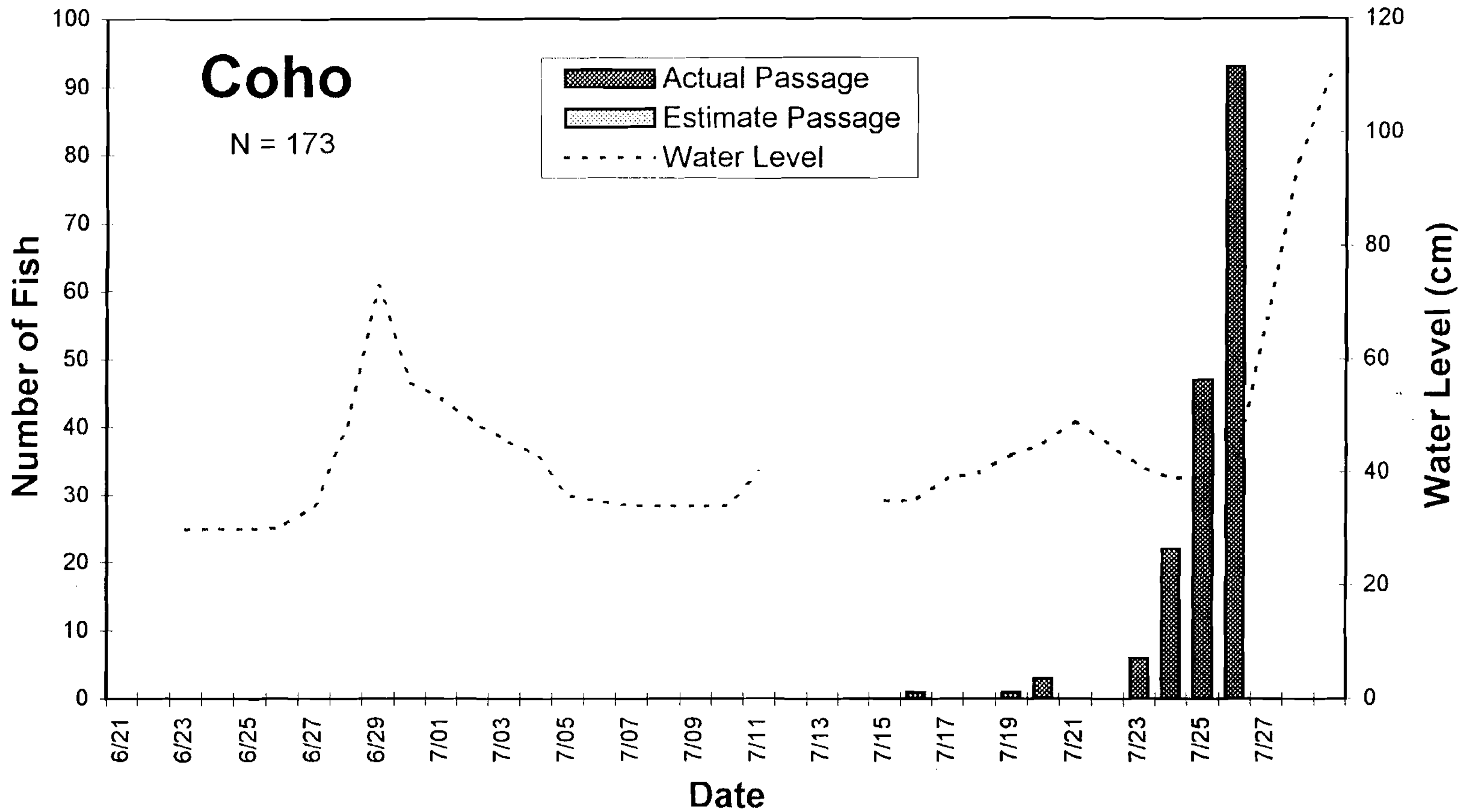


Figure 17. Daily coho salmon passage at the George River weir relative to changes in water level, 1996.

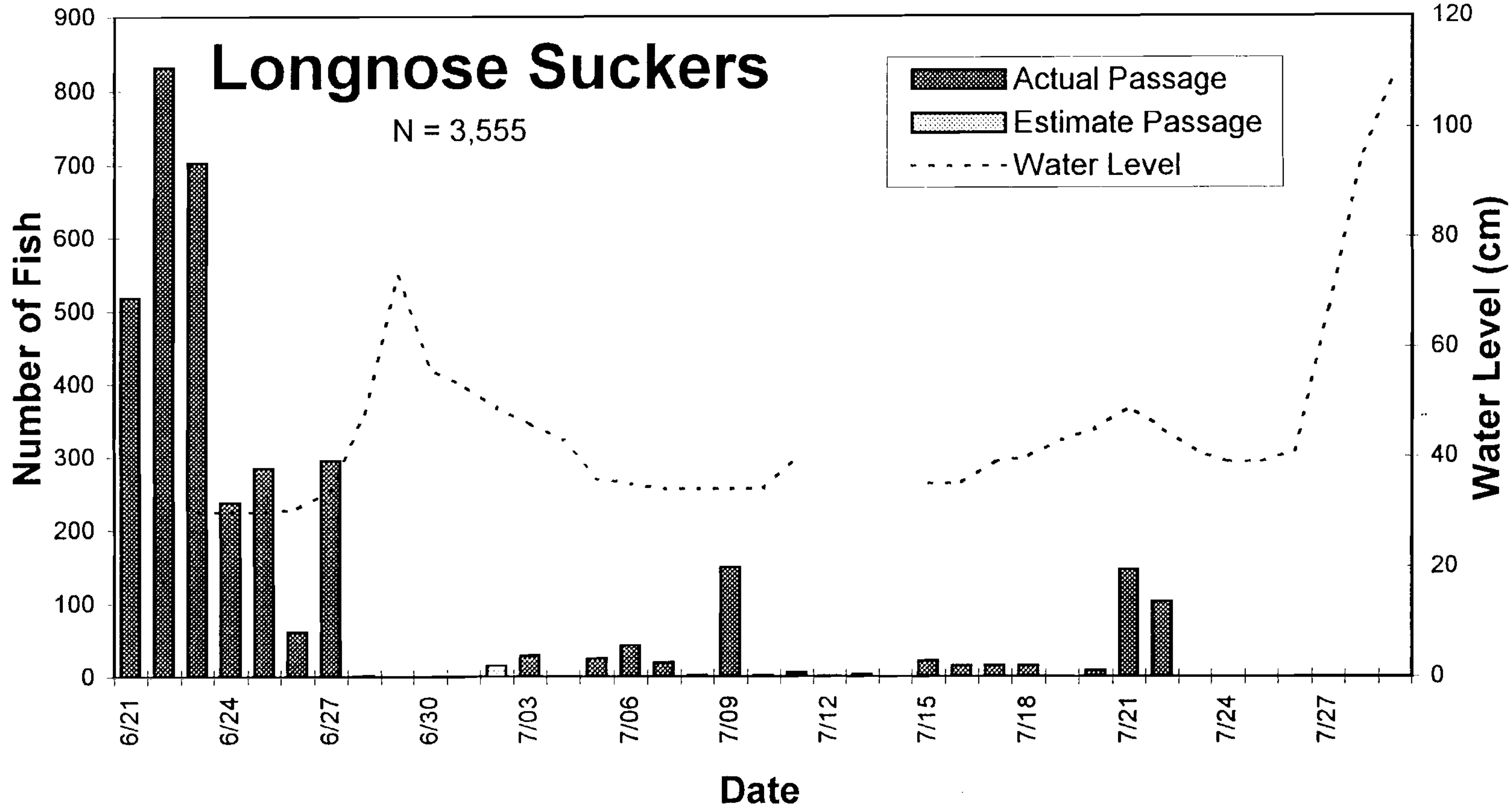


Figure 18. Daily longnose sucker passage at the George River weir relative to changes in water level, 1996.

APPENDICES

Appendix A. ADF&G permit for Donlin Creek mine exploration.

US Army Corps
of Engineers

Alaska District

Regulatory Branch (1145b)
Post Office Box 898
Anchorage, Alaska 99506-0898

Public Notice of Application for Permit

PUBLIC NOTICE DATE: 7 FEBRUARY 1997

EXPIRATION DATE: 8 MARCH 1997

REFERENCE NUMBER: Q-950120

WATERWAY NUMBER: Donlin Creek 1

Interested parties are hereby notified that an application has been received for a Department of the Army (DA) permit for certain work in waters of the United States (U.S.) as described below and shown on the attached plan.

APPLICANT: Placer Dome U.S. Inc., 240 South Rock Boulevard, Reno, Nevada 89502.

LOCATION: Sections 1, 2 and 3, T. 22 N., R. 49 W.; sections 13, 12, 23, 24, 25, 26, 27, 34, 35 and 36, T. 23N., R. 49 W.; and sections 17, 18, 19, 20, 29, 30, and 31, T. 23 N., R. 48 N., Seward Meridian. USGS Map Iditarod (A-5), Alaska. Approximately 12 air miles north of the village of Crooked Creek, Alaska.

WORK: Excavate 27 trenches cumulatively measuring 23.3 miles long with widths between four (4) and 20 feet. The cumulative trench footprint would be between 11.3 and 56.4 acres. Trench depth would range between three (3) and 12 feet. The excavated material would be side cast along each side of the trench within 30 feet of the trench's center. The amount of excavated material would range between 0.6 and 4.7 cubic yards/linear trench foot or 73,700 and 577,000 cubic yards. The maximum width of the trench and sidecast areas would be 60 feet.

Sixteen of the 27 trenches would occur wholly or partially in wetlands; the remaining would be in upland areas. The cumulative length of the 16 wetland trenches would be 5.1 miles. The cumulative wetland trench footprint would be between 2.5 and 12.4 acres. The proposal involves the excavation of between 16,200 and 127,000 cubic yards from wetlands and the discharge of this material into adjacent wetlands. The total footprint of these trenches and discharge areas would be 37.3 acres.

PURPOSE: The purpose of this proposal is to continue the gold exploration program that began in 1995. The trenches would be used to map the surface geology of mineralized areas.

ADDITIONAL INFORMATION: Only the work described above that involves the excavation of and/or the discharge of fill material into waters of the U.S. including wetlands, requires a DA permit. Trenches located in uplands do not require DA authorization. The proposal involves work in six (6) small drainages which are all apart of the larger, Crooked Creek drainage. Beginning in 1998, selected trenches would be backfilled and seeded, others would be backfilled with bedrock material and reclaimed into access roads, the remaining trenches would remain open for further testing. Additional information as to which trenches would be retained as roads, fully reclaimed or left open would most likely be available the summer of 1998. Placer Dome's representative for the permit application is Mr. Dave Parker, 240 South Rock Boulevard, Reno, Nevada 89502; telephone (702) 856-2552.

MITIGATION: As a result of early project planning, the applicant has incorporated into the proposed project the following mitigation efforts to reduce impacts to the aquatic environment: The original 1997 trench plan is shown on sheet 9 of 9. Wetland impacts on this plan exceed 100 acres, the applicant has reduced this amount to the current proposal by; 1) Eliminating or slightly re-routing trench routes, 2) using helicopter support in less accessible areas, 3) using longer upland routes to access areas which could be more directly approached by crossing wetlands, and, 4) Postponing construction of access roads to remote areas until additional information concludes that access is warranted. Furthermore, the applicant would install erosion control devises when trenches are near drainages and to the extent practicable, excavated materials would be placed up-slope of trenches located within 50 feet of drainage channels.

WATER QUALITY CERTIFICATION: A permit for the described work will not be issued until a certification or waiver of certification as required under Section 401 of the Clean Water Act (Public Law 95-217), has been received from the Alaska Department of Environmental Conservation.

PUBLIC HEARING: Any person may request, in writing, within the comment period specified in this notice, that a public hearing be held to consider this application. Requests for public hearings shall state, with particularity, reasons for holding a public hearing.

CULTURAL RESOURCES: The latest published version of the Alaska Heritage Resources Survey (AHRS) has been consulted for the presence or absence of historic properties, including those listed in or eligible for inclusion in the National Register of Historic Places. This worksite is not a registered or eligible property. Consultation of the AHRS constitutes the extent of cultural resource investigations by the District Engineer at this time, and he is otherwise unaware of the presence of such resources. This application is being coordinated with the State Historic Preservation Office (SHPO). Any comments SHPO may have concerning presently unknown archeological or historic data that may be lost or destroyed by work under the requested permit will be considered in our final assessment of the described work.

ENDANGERED SPECIES: The project area is within the known or historic range of the American peregrine falcon. Preliminarily, the described activity will not affect threatened or endangered species, or their critical habitat designated as endangered or threatened, under the Endangered Species Act of 1973 (87 Stat. 844). This application is being coordinated with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. Any comments they may have concerning endangered or threatened wildlife or plants or their critical habitat will be considered in our final assessment of the described work.

FEDERAL SPECIES OF CONCERN: The following Federal species of concern may use the project area: Chinook Salmon, Coho Salmon, Lesser Canada Goose, Bald Eagle, Tundra Swan, Canvasback Duck, Sandhill Crane, American Peregrine Falcon.

FLOOD PLAIN MANAGEMENT: Evaluation of the described activity will include conformance with appropriate State or local flood plain standards; consideration of alternative sites and methods of accomplishment; and weighing of the positive, concentrated and dispersed, and short and long-term impacts on the flood plain.

SPECIAL AREA DESIGNATION: None.

EVALUATION: The decision whether to issue a permit will be based on an evaluation of the probable impacts including cumulative impacts of the proposed activity and its intended use on the public interest. Evaluation of the probable impacts which the proposed activity may have on the public interest requires a careful weighing of all those factors which become relevant in each particular case. The benefits which reasonably may be expected to accrue from the proposal must be balanced against its reasonably foreseeable detriments. The decision whether to authorize a proposal, and if so, the conditions under which it will be allowed to occur, are therefore determined by the outcome of the general balancing process. That decision should reflect the national concern for both protection and utilization of important resources. All factors which may be relevant to the proposal must be considered including the cumulative effects thereof. Among those are conservation, economics, aesthetics, general environmental concerns, wetlands, cultural values, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shore erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership, and, in general, the needs and welfare of the people. For activities involving 404 discharges, a permit will be denied if the discharge that would be authorized by such permit would not comply with the Environmental Protection Agency's 404(b)(1) guidelines. Subject to the preceding sentence and any other applicable guidelines or criteria (see Sections 320.2 and 320.3), a permit will be granted unless the District Engineer determines that it would be contrary to the public interest.

The Corps of Engineers is soliciting comments from the public; Federal, State, and local agencies and officials; Indian Tribes; and other interested parties in order to consider and evaluate the impacts of this proposed activity. Any comments received will be considered by the Corps of Engineers to determine whether to issue, modify, condition or deny a permit for this proposal. To make this decision, comments are used to assess impacts on endangered species, historic properties, water quality, general environmental effects, and the other public interest factors listed above. Comments are used in the preparation of an Environmental Assessment and/or an Environmental Impact Statement pursuant to the National Environmental Policy Act. Comments are also used to determine the need for a public hearing and to determine the overall public interest of the proposed activity.

Comments on the described work, with the reference number, should reach this office no later than the expiration date of this Public Notice to become part of the record and be considered in the decision. Please contact Dave Casey at (907) 753-2716 or toll free in Alaska at (800)-478-2712, if further information is desired concerning this notice.

AUTHORITY: This permit will be issued or denied under the following authorities:

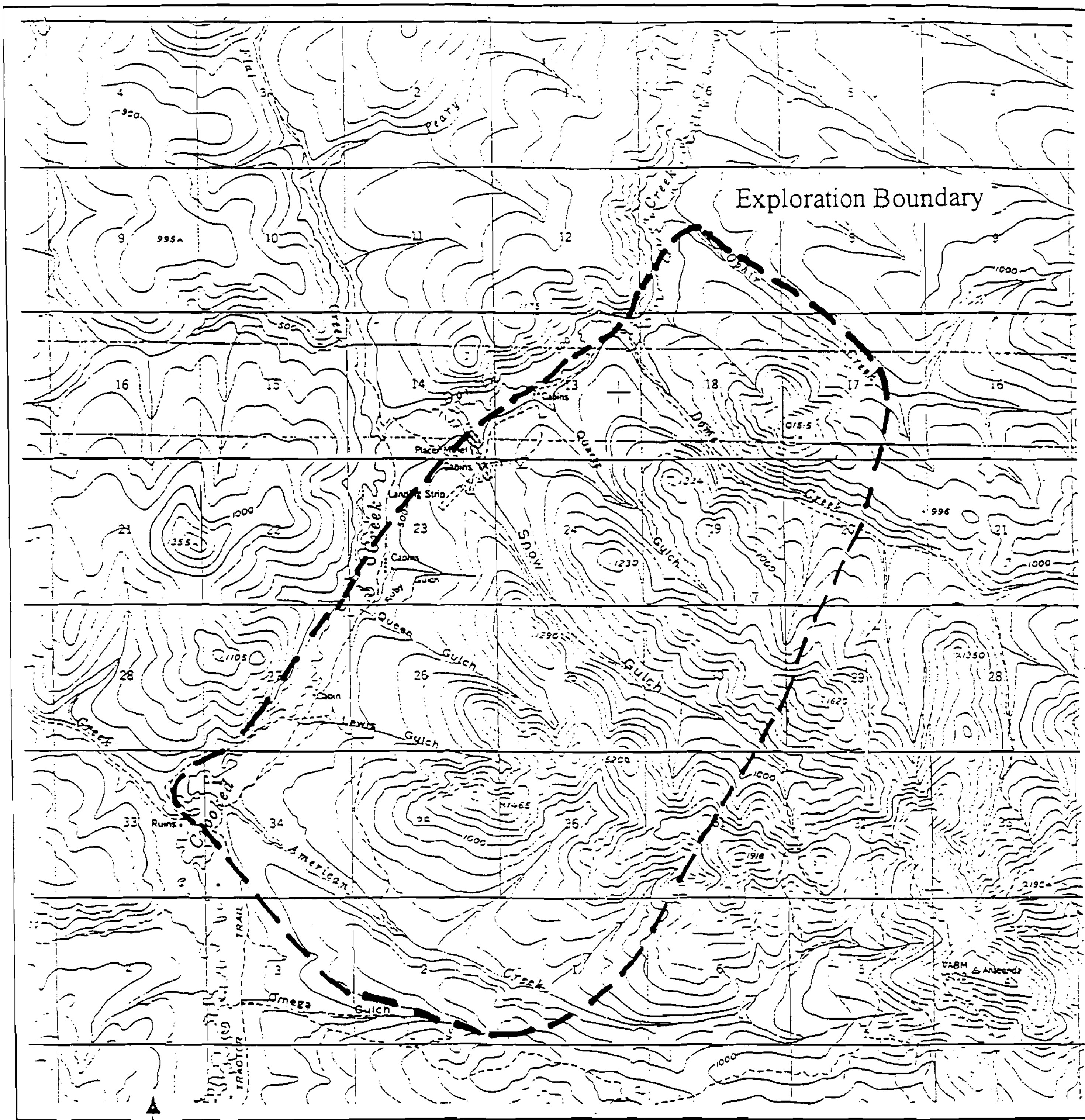
(X) Discharge dredged or fill material into waters of the United States - Section 404 Clean Water Act (33 U.S.C. 1344). Therefore, our public interest review will consider the guidelines set forth under Section 404(b) of the Clean Water Act (40 CFR 230).

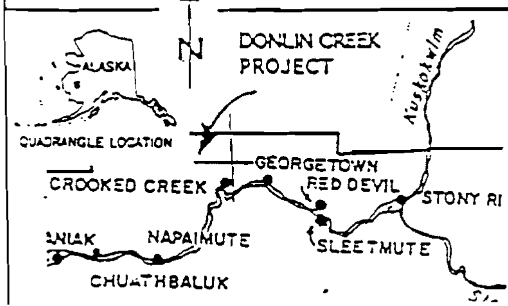
A plan, Notice of Application for State Water Quality Certification are attached to this Public Notice.

District Engineer
U.S. Army, Corps of Engineers

Attachments

Q-950120 DONLIN CREEK 1
Sheet 1 of 9



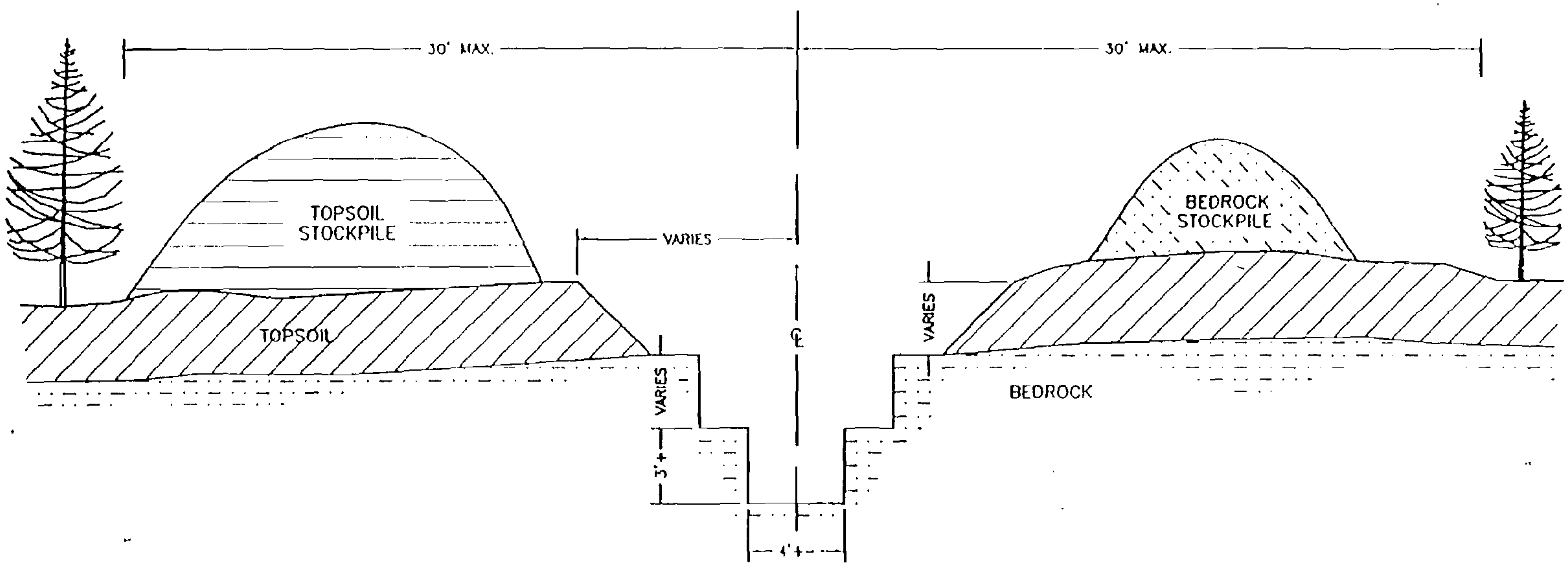


1 inch = 1 mile

1:63,360 (1954) Contours and Elevations in Feet
Portion of USGS Iditarod (A-5) Alaska

Vicinity Map
Donlin Creek Project
Southwest, Alaska

Placer Dome U.S., Inc.



NOTES:

TRENCH DEPTH MAY VARY FROM 3 TO 12 FEET.

TRENCH WIDTH AT SURFACE WILL VARY FROM 4 TO 20 FEET, DEPENDING ON DEPTH AND ROCK OR SOIL TYPE.

EXCAVATED SURFACE SOILS (TOPSOIL) WILL BE STOCKPILED FOR POSSIBLE USE AS FINAL COVER DURING FUTURE TRENCH RECLAMATION.

TRENCH SIDE WALL SLOPES SHALL CONFORM TO APPLICABLE SAFETY STANDARDS.

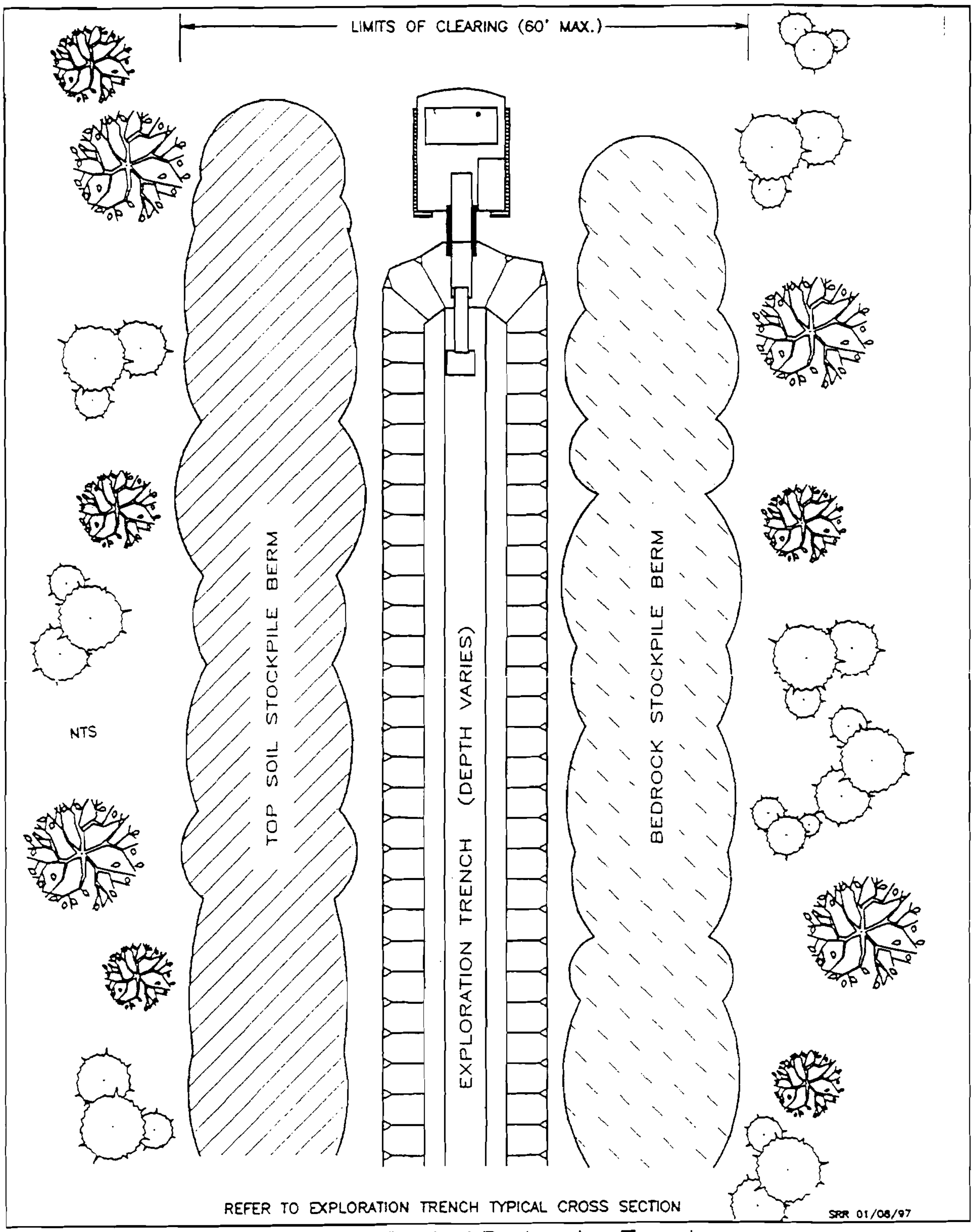
TRENCH ALIGNMENTS MAY BE USED AS ACCESS ROUTES FOR EXPLORATION DRILLING SUPPORT.

EXPLORATION TRENCH TYPICAL CROSS SECTION

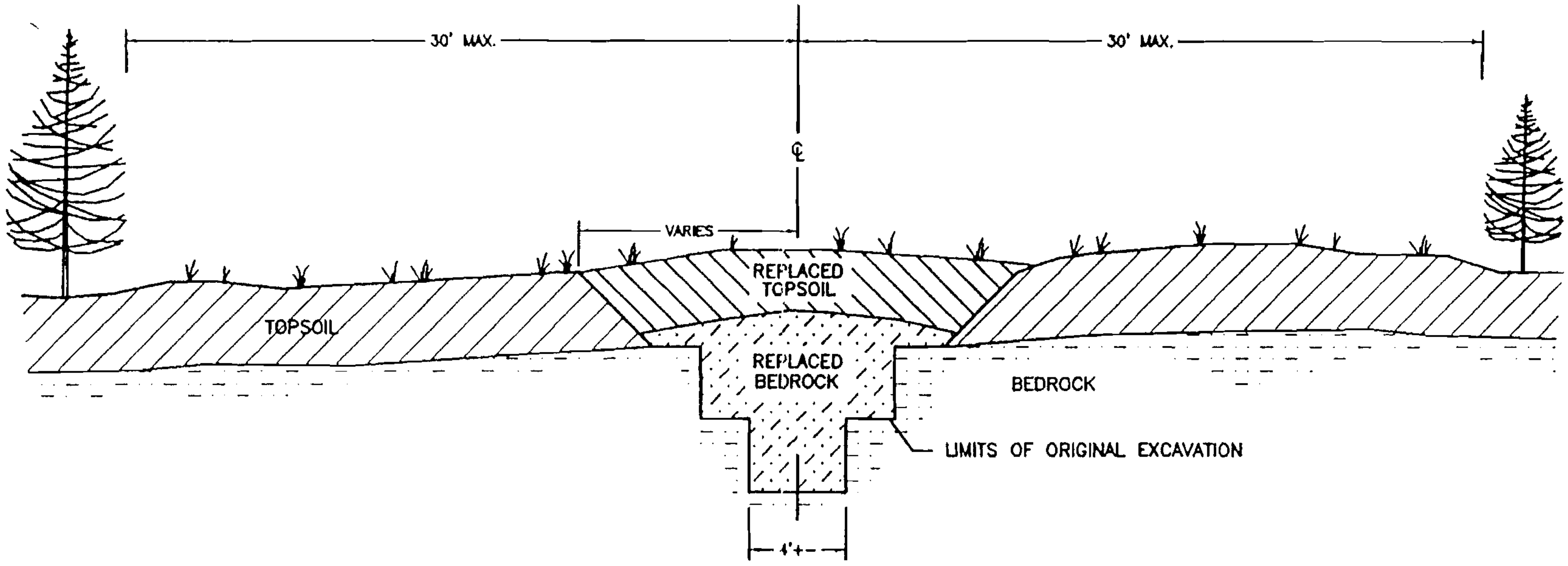
NTS

SRR 01/08/97

Typical Cross Section; Exploration Trench



Overview Drawing, Typical Exploration Trench



NOTES:

SPREAD STOCKPILED TOPSOIL IN ALL DISTURBED AREAS WHERE NATIVE TOPSOIL HAS BEEN REMOVED.

GRADE DISTURBED AREA SUFFICIENT TO REMOVE DEEP RUTS AND RESTORE APPROXIMATE ORIGINAL SURFACE CONTOUR. COMPACT GRADED AREAS BY TRACKING WITH DOZER TREADS TO REDUCE EROSION POTENTIAL.

RECLAMATION OF TRENCHES ON STEEP SLOPES MAY REQUIRE CONSTRUCTION OF CROSS BERMS TO REDUCE DOWN SLOPE RUNOFF AND EROSION.

ALL DISTURBED AREAS WITH INSUFFICIENT NATURAL VEGETATION SHALL BE SEEDED WITH AN APPROVED SEED MIX.

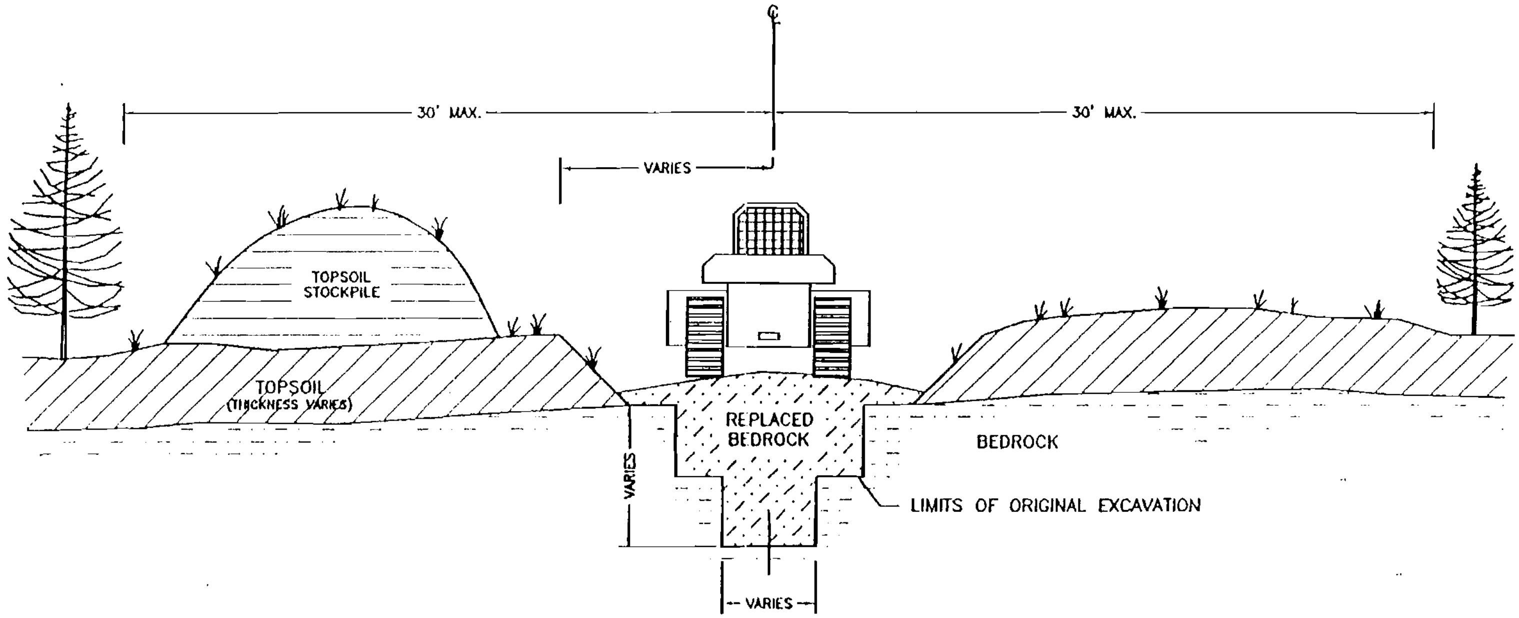
TRENCH ALIGNMENTS TO BE USED AS ACCESS ROUTES FOR EXPLORATION DRILLING SUPPORT SHALL BE RECLAIMED EXCEPT FOR THE SPECIFIC TRAIL FOOTPRINT.

RECLAIMED EXPLORATION TRENCH TYPICAL CROSS SECTION

NTS

SRR 01/22/97

Typical Cross Section, Reclaimed Exploration Trench



NOTES:

EXCEPT FOR ROAD SURFACE, SPREAD STOCKPILED TOPSOIL IN ALL DISTURBED AREAS WHERE NATIVE TOPSOIL HAS BEEN REMOVED.

GRADE DISTURBED AREA SUFFICIENT TO REMOVE DEEP RUTS AND RESTORE APPROXIMATE ORIGINAL SURFACE CONTOUR.
COMPACT GRADED AREAS BY TRACKING WITH DOZER TREADS TO REDUCE EROSION POTENTIAL.

CROWN ROAD SURFACE AND DITCH AS NECESSARY TO CONTROL RUNOFF.

ALL DISTURBED AREAS WITH INSUFFICIENT NATURAL VEGETATION SHALL BE SEEDED WITH AN APPROVED SEED MIX.

RETAIN TOPSOIL IN STOCKPILE FOR FUTURE RECLAMATION OF TEMPORARY ROAD.
FINAL RECLAMATION SHALL BE AS SPECIFIED FOR FULLY RECLAIMED EXPLORATION TRENCH.

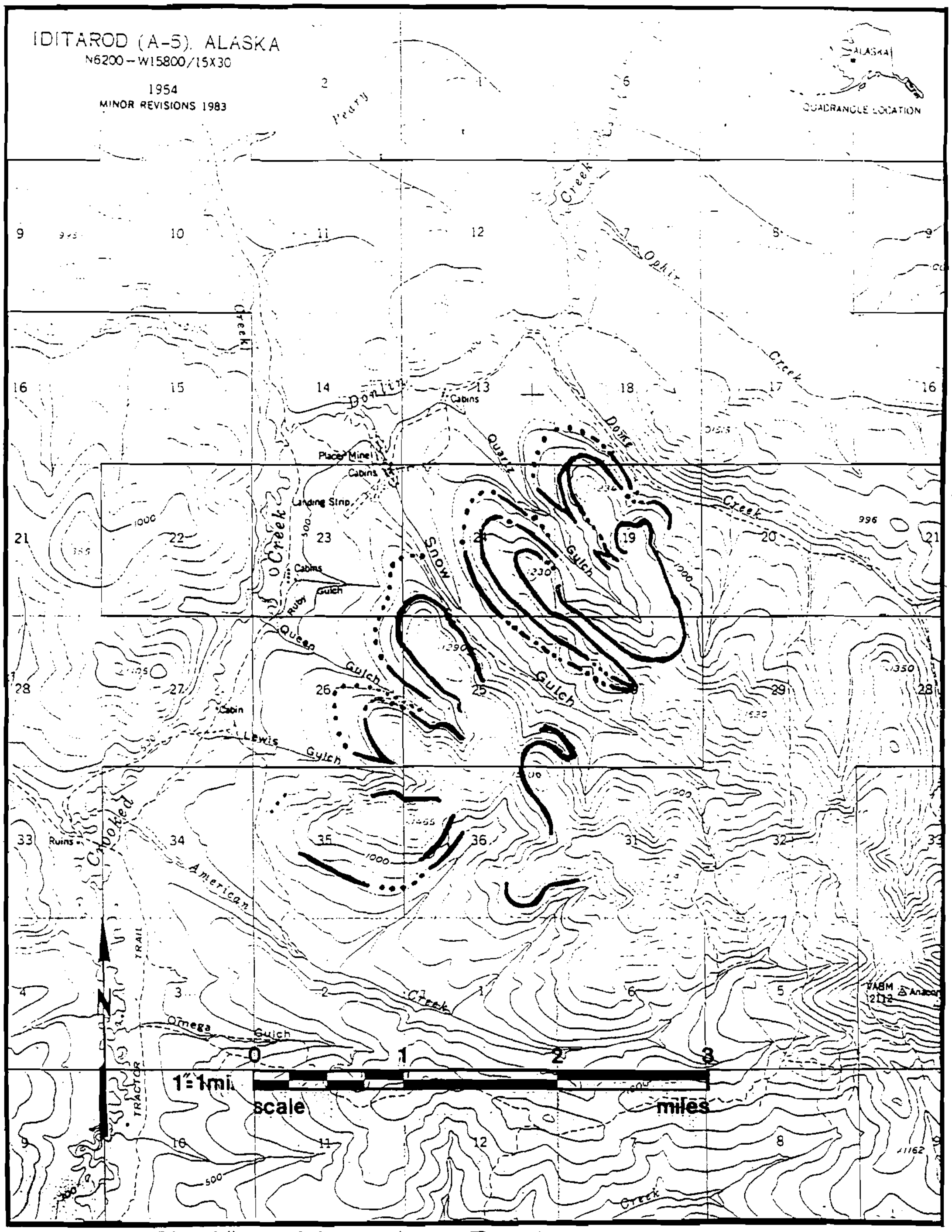
DEPENDING ON THICKNESS OF TOPSOIL UNIT AND CROSS SECTION SLOPE, BACKSLOPES MAY OR MAY NOT EXIST.

RECLAIMED EXPLORATION TRENCH
USED AS UNIMPROVED ACCESS ROAD
TYPICAL CROSS SECTION

SRR 01/23/97

NTS

Typical Cross Section of Trench Retained for Access



Plan View of Approximate Trench Locations

Three Parameters Plus/Placer Dome U.S. Inc.
Donlin Project; 1997 Exploration Program Supplemental Permit Information
January 22, 1997

—— Uplands

• • • • Wetlands

EXPLORATION TRENCH EXCAVATION/SIDECASTING ESTIMATE

TRENCH NO.	LENGTH (Linear Feet)	WETLAND IMPACTS (Linear Feet)	SIDECAST/EXCAVATION ESTIMATE INTO WETLANDS (Cubic Yards)	
			MINIMUM	MAXIMUM
American Creek Watershed				
A1	7,000	2,300	1,380	10,810
A2	1,750	0	0	0
A3	5,950	0	0	0
Subtotal	*14,700*	*2,300*	*1,380*	*10,810*
Lewis Gulch Watershed				
LG1	2,600	0	0	0
LG2	2,450	0	0	0
LG3	4,050	2,700	1,620	12,690
LG4	1,000	1,000	600	4,700
Subtotal	*10,100*	*3,700*	*2,220*	*17,390*
Queen Gulch Watershed				
QG1	8,050	900	540	4,230
QG2	3,450	3,450	2,070	16,215
QG3	4,350	2,100	1,260	9,870
Subtotal	*15,850*	*6,450*	*3,870*	*30,315*
Snow Gulch Watershed				
SG1	1,950	1,950	1,170	9,165
SG2	9,000	0	0	0
SG3	10,800	2,600	1,560	12,220
SG4	8,450	1,200	720	5,640
SG5	6,450	0	0	0
Subtotal	*36,650*	*5,750*	*3,450*	*27,025*
Quartz Gulch Watershed				
Qz1	3,400	2,400	1,440	11,280
Qz2	4,300	250	150	1,175
Qz3	10,400	1,200	720	5,640
Qz4	4,100	0	0	0
Qz5	6,350	1,200	720	5,640
Qz6	2,100	1,550	930	7,285
Subtotal	*30,650*	*6,600*	*3,960*	*31,020*

TRENCH NO.	LENGTH (Linear Feet)	WETLAND IMPACTS (Linear Feet)	SIDECAST/EXCAVATION ESTIMATE INTO WETLANDS (Cubic Yards)	
			MINIMUM	MAXIMUM
Dome Creek Watershed				
D1	3,150	0	0	0
D2	1,350	0	0	0
D3	2,550	300	180	1,410
D4	3,250	0	0	0
D5	2,250	0	0	0
D6	2,300	1,900	1,140	8,930
Subtotal	*14,850*	*2,200*	*1,320*	*10,340*
TOTAL, ALL WATERSHEDS	**122,800**	**27,000**	**16,200**	**126,900**

Q-950120 DONLIN CREEK 1
Sheet 9 of 9

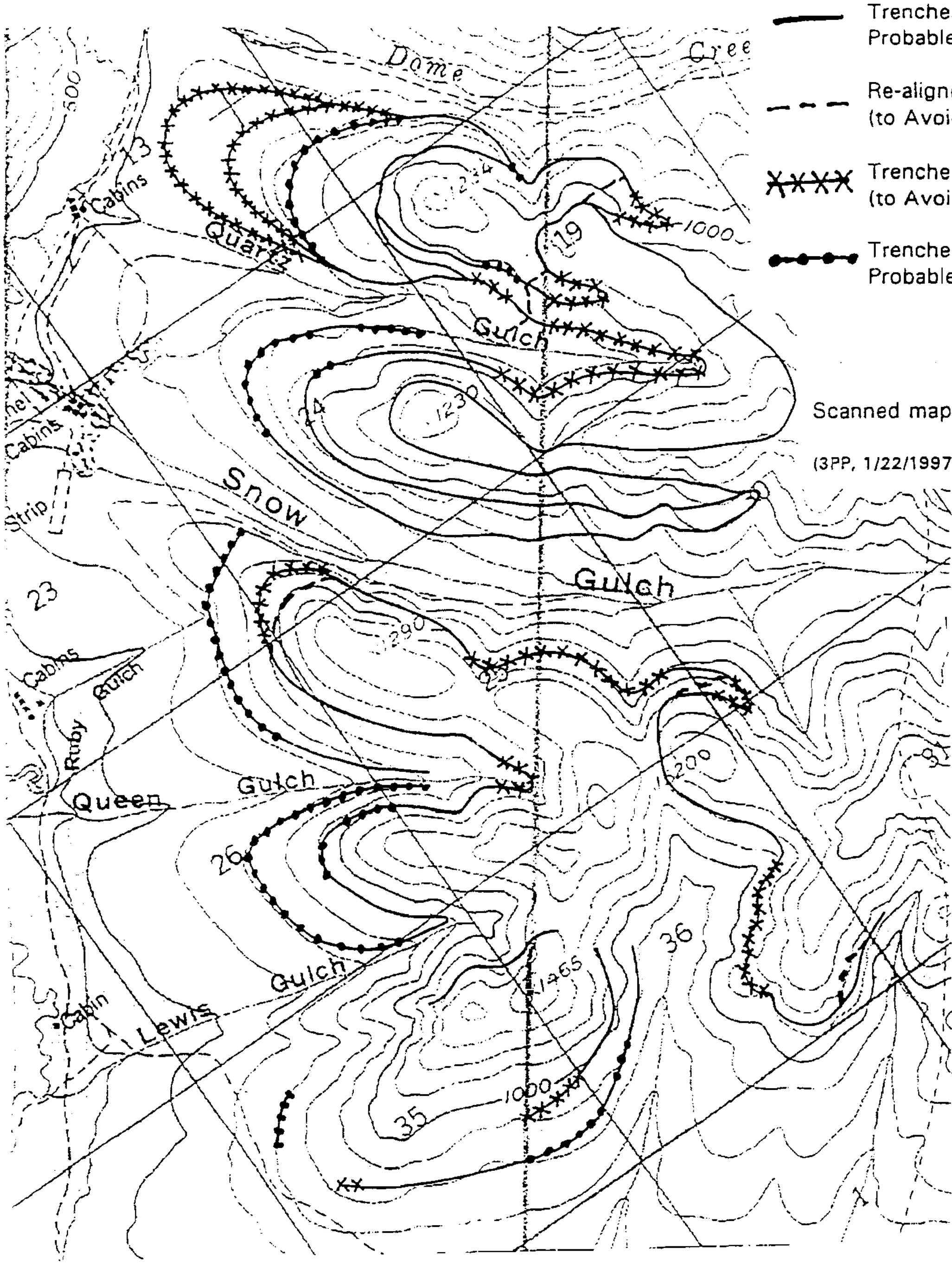
Legend:

Trenches Proposed for Uplands or Probable Uplands, 1997

Re-aligned Trenches (Uplands) (to Avoid/Minimize Impacts to Wetlands

Trenches Eliminated From 1997 Work (to Avoid/Minimize Impacts to Wetlands)

Trenches Proposed for Wetlands or Probable Wetlands, 1997



Scanned map base, 1" = ~ feet.

(3PP, 1/22/1997)

: Original Exploration Plan, 1997 Trenching Program

Three Parameters Plus/Placer Dome U.S. Inc.
Donlin Project; 1997 Exploration Program Supplemental Permit Information
January 23, 1997

Appendix B. George River reconnaissance trip report, September 26, 1995.

ALASKA DEPARTMENT OF FISH AND GAME

DIVISION OF COMMERCIAL FISHERIES
MEMORANDUM

TO: Distribution

DATE: September 27, 1995

FILE: GEORECON.MEM

TELEPHONE: 543-2433

FROM: Charlie Burkey Jr CB
CFMD - Bethel

SUBJECT: George R. reconnaissance

On Sept. 26 Gary Kneufer and I chartered a Cessena 185 to Georgetown a small community (current pop. 3) 372 kilometers up the Kuskokwim River from Bethel. The Georgetown airstrip is owned by Robert Vanderpool who allowed us access and was a most gracious and helpful host. He's lived in Georgetown over 30 years and is an excellent source of information concerning the George River.

We used a 15 ft rubber raft with a 30hp prop motor to survey the George River for possible weir or tower sites. The George River drains the north side of the Kuskokwim River between Crooked Creek and Red Devil. It's drainage is "intermediate" in size, larger in area than the Oskawalik or Holokuk and smaller than the Aniak or Holitna.

It had rained hard the previous day and visibility into the water was about 4 feet at best. Water level was described as slightly below normal for this time of year. The river is very difficult to navigate using a prop driven motor. We found 3 shallow places which the raft had to be pulled over within 5 miles of the river mouth. An 18 ft long, flat-bottomed riverboat with a 55hp jet outboard would work well on this river.

Our survey covered from the mouth to approximately river mile eight. Within this area we identified 5 sites suitable for a weir or counting tower (see map).

Site 1: located about 100 meters from the river mouth just above the island. The stream is 250-300 ft wide with a maximum depth of 4 ft and water velocity of about 3.5 ft/sec. There is a channel along the west side about 50-60 ft wide by 3-3.5 ft deep.

Site 2: was at an island at river mile 1.5. There are two 180-199 ft wide channels. The north side channel had a max depth of 2.5 feet and a velocity of 2.8 ft/sec while the south channel had a max depth of 3 ft and a velocity of 4.4 ft/sec. Boat passage would be difficult at this site because they must be on step to negotiate this section of the river.

Site 3: located at an island at river mile 3. The east channel was 100 ft wide, had a maximum depth of 1 foot and a velocity of 2.5 ft/sec. The west channel was about 200 ft wide, had a maximum depth of 3.5 ft and a velocity of 4.3 ft/sec.

Site 4: located at river mile 4. This was the site with the most even bottom profile. It was about 250-300 ft wide with a maximum depth of 3 ft and a velocity of 2.9 ft/sec. There was a 20-30 ft wide channel along the west bank with depths from 2.5-3 ft.

Site 5: located at river mile 6. This site was about 250-300 ft wide with a maximum depth of 3.5 ft and a velocity of 3.0 ft/sec. The bottom profile was not as even as that at site 4 and there was a 40-50 ft wide by 3-3.5 ft deep channel along the west bank.

Relatively poor water clarity would limit the effectiveness of a counting tower at depths greater than 4 feet in this river. The water is moderately dark due to tannic acid (bog water) and a relatively shallow stream gradient. Water clarity is similar to that found on the Aniak River near the sonar site but better than at the Takotna tower. A fixed or floating weir would be suitable at any of the sites. Site 4 is the most suitable due to relatively low water velocity and even bottom profile. According to Mr. Vanderpool, water levels on the George River are usually low around mid-June, the time weir installation would take place.

The George River is about 18 river miles from Crooked Creek, the nearest airport for large freight delivery. The airstrip at Georgetown should be available for resupply flights using a Cessna 185.

cc: Kron
Cannon
Anderson
Molyneaux
Buklis
Morgan, KNA
Harper, USF&WS
Sundown, AVCP

Appendix C. George River reconnaissance trip report May 30, 1996.

State of Alaska Memorandum
Department of Fish and Game
Commercial Fisheries Management and Development Division

TO:	DISTRIBUTION	**DATE:**	04 June, 1995
		FILE:	GRWTRIP2.DOC
		PHONE:	543-2648
FROM:	Doug Molyneaux Kuskokwim Research Biologist AYK - Bethel	**SUBJECT:**	George River Pre-Season Reconnaissance Trip

On May 30 a pre-season reconnaissance trip was made to the George River. The survey team consisted of Angela Morgan (KNA), Ray Peterson (KNA), Carl Morgan (KNA), Mishka "Johnny" Andreanoff (Crooked Creek resident), Oscar Andreanoff (Crooked Creek Resident) and myself. This was the second reconnaissance trip to the area. The first trip was conducted in September 1995 by Charlie Burkey and Gary Kneufer. The objectives of this second survey were to assess the spring water level conditions and identify and mark the exact location of the proposed weir camp.

The George River is a first order tributary of the Kuskokwim River. The confluence is at approximately river mile 309. The main stem of the George River is approximately 70 river miles in length and there are several major tributaries (East Fork, South Fork, North Fork, Michigan Creek and Beaver Creek).

The KNA representatives and myself departed Aniak by boat at 1055 hr. The boat was equipped with 115 hp outboard motor. We traveled non-stop and arrived at the mouth of the George River at 1345 hr (2'50" travel time). There we joined the two Crooked Creek residents. Ray Peterson and myself transferred to their flat bottom boat which was equipped with a 35 hp prop powered outboard. Angela and Carl Morgan stayed with the larger boat at the mouth while the rest of us traveled up the George River.

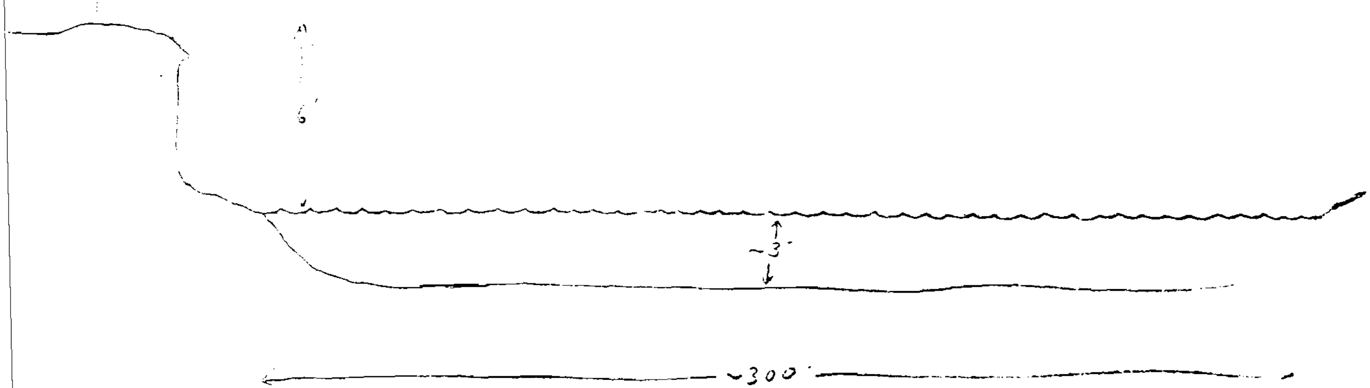
We surveyed to approximately river mile 5 and visited four of the five sites recommended by Charlie the previous year. There was very little woody debris in the river or along the shoreline, however along cut banks there were a lot of trees being undercut by the current. Water clarity was poor with a lot of suspended matter. I would estimate a Secchi of about 1 to 1.5 feet. According to the KNA staff and Crooked Creek residents, clarity is generally very good.

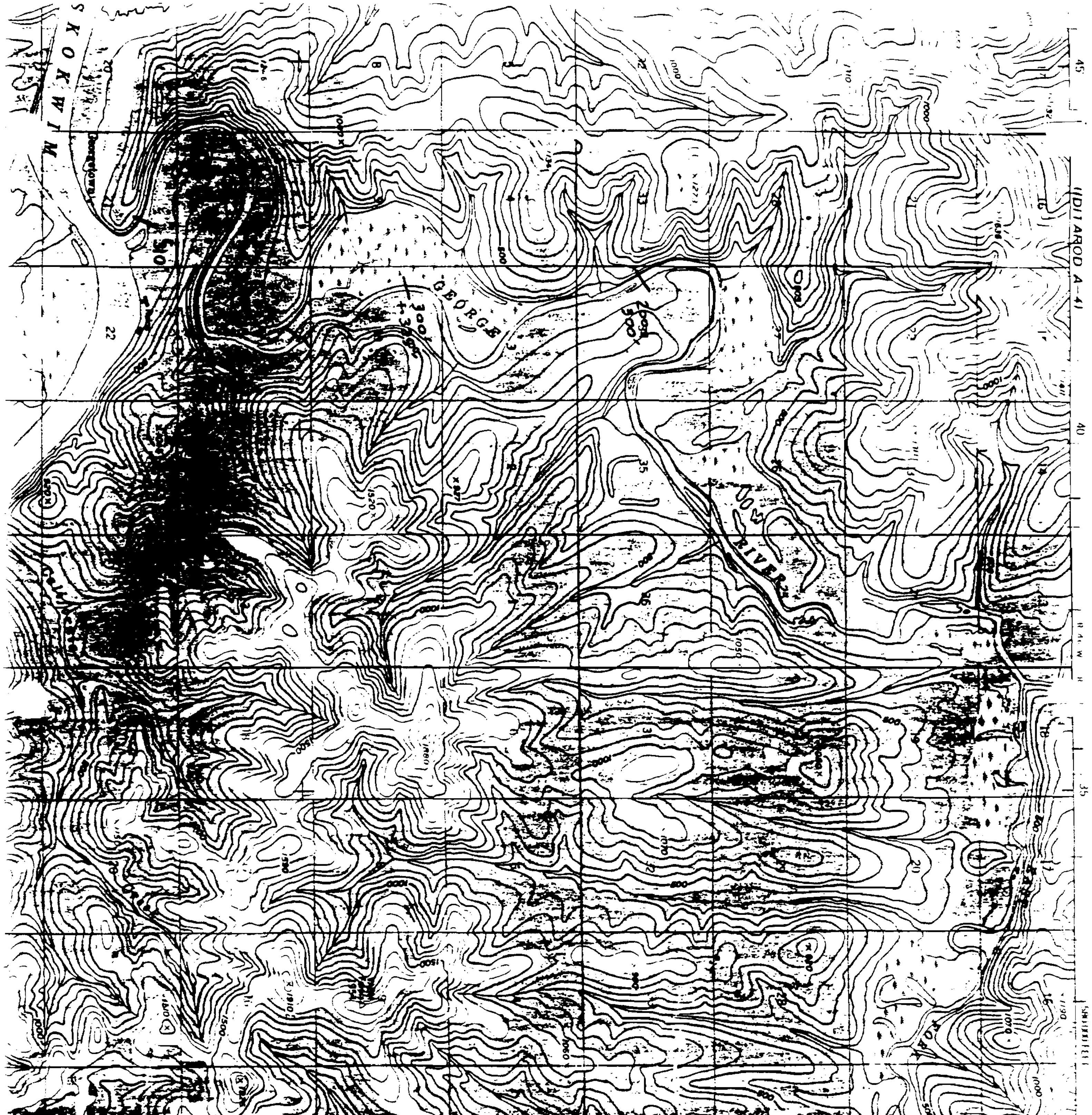
As identified by Charlie, the location he identified as site 4 was the most promising. This site is 4.5 to 5 river miles from the mouth (Latitude N 61° 55.422'; Longitude W 157° 41.958'). The channel width was 300 to 325 feet (we had a 100 foot tape measure, but I was the only one with chest wadders so it was difficult to get a complete measurement) and the maximum depth was 3 feet 4 inches. The bottom profile was very even with most of the span measuring 3 feet in depth. The substrate was composed of medium sized gravel. The velocity was manageable at 2.5 to 3.1 ft./sec. and it was very easy to cross the channel using chest wadders. (At other sites the velocity was 4 ft./sec or more and negotiating the current was difficult.). The east bank had a modest slope (perhaps 30°) spanning 10 to 15 feet. This area was sparsely vegetated. Beyond that point the land leveled out and there was a dense thicket of short willows extending back about 50 yards or more. Along the margin of the west bank was a five to seven foot band of course clean gravel, extending several hundred yards up stream and down stream, then a steep earthen bank. The top of the bank was about 6 feet above the water level. The shore was wooded with a mixture of birch, black spruce and cottonwoods. About a 80 to 100 ~~yards~~ feet back from the shore was a boggy area. This site was marked along the west shore by tying orange surveyor tape to a tree limb which should be easily viewed from the water.

According to Johnny Andreanoff and Ray Peterson, the vast majority of sport fishing occurs down stream of this site so there should be minimal need to pass boats through the weir. Black bears appear to be common in the area. We saw two black bears during our 2.5 hours on the river.

cc:

Burkey
Anderson
DuBois
Bue

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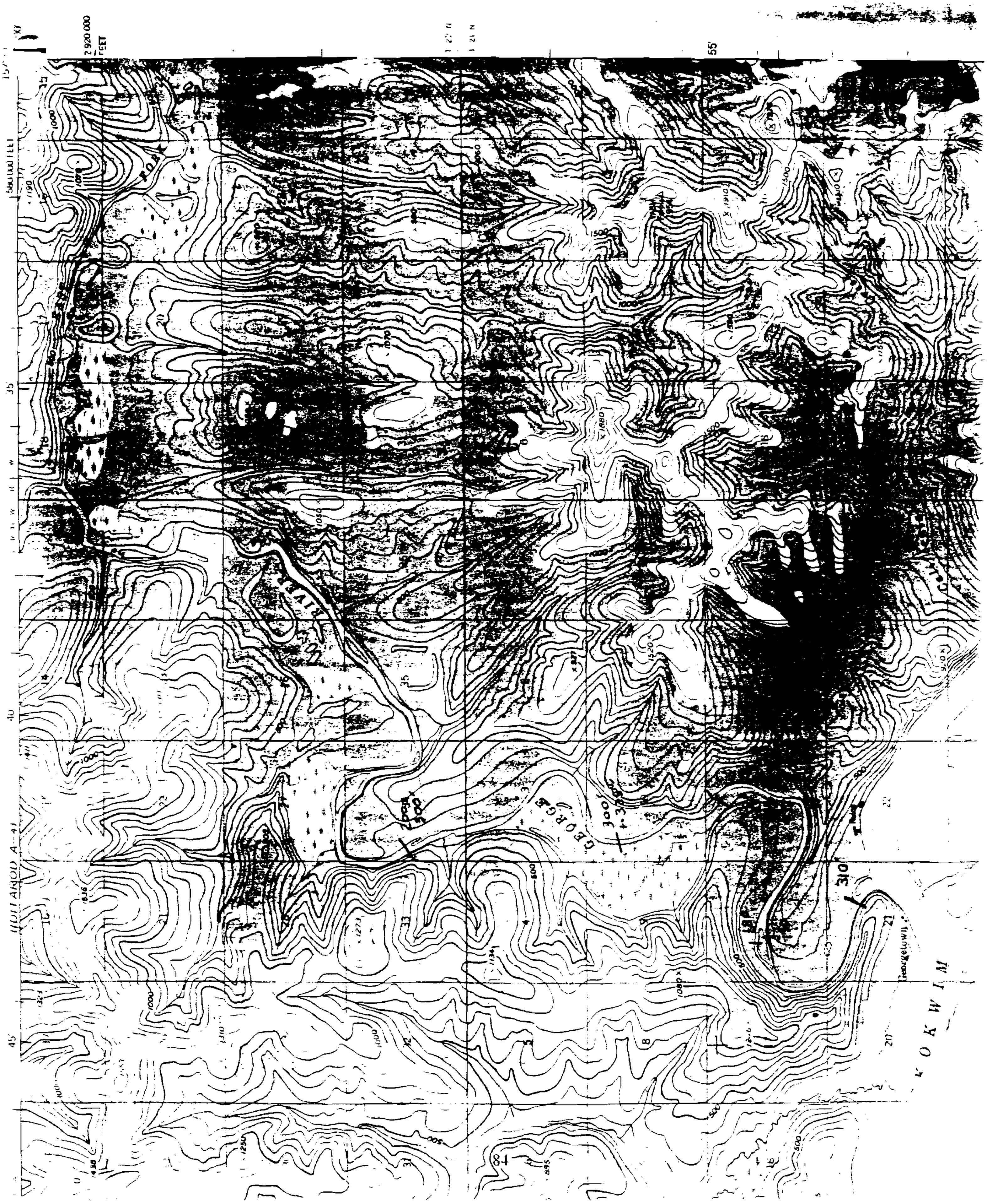
GEORGE
RIVER

3.F4



Appendix D. ADF&G Habitat Division permit for the George River weir project.

TONY KNOWLES, GOVERNOR

DEPARTMENT OF FISH AND GAME

333 RASPBERRY ROAD
ANCHORAGE, ALASKA 99518-1599
PHONE: (907) 344-0541

HABITAT AND RESTORATION DIVISION

FISH HABITAT PERMIT FG 96-II-0147

ISSUED: April 24, 1996
EXPIRES: December 31, 1996

Ms. Angela Morgan
Kuskokwim Native Association
Box 127
Aniak, Alaska 99557

Dear Ms. Morgan:

Re: Weir on George River
(Section 10, T. 21 N., R. 46 W., S.M.)
(Stream No. 335-20-16600-2741)

Pursuant to AS 16.05.870(b), the Alaska Department of Fish and Game (ADF&G) has reviewed your proposal to install and operate a tripod-supported, aluminum picket weir at the referenced location. The purpose of the weir is to enumerate adult salmon for research and management needs. The weir will be installed and operated during the period June 15 through September 15.

The George River has been specified as being important for the spawning, rearing, or migration of anadromous fish pursuant to AS 16.05.870(a). Spawning Chinook, chum and coho salmon, as well as whitefish, use this portion of the waterbody.

In accordance with AS 16.05.870(d), project approval is hereby given subject to the following stipulation(s):

1. Streambanks shall not be disturbed. If streambanks are inadvertently disturbed by activities attributable to this project, they shall be immediately stabilized to prevent erosion and the resultant sedimentation of streams which could occur both during and after weir operations.

2. Weirs shall be operated and maintained so as to ensure that fish mortality caused by delays in migration do not occur.

The permittee is responsible for the actions of contractors, agents, or other persons who perform work to accomplish the approved plan. For any activity that significantly deviates from the approved plan, the permittee shall notify the ADF&G, Habitat and Restoration Division, and obtain written approval in the form of a permit amendment before beginning the activity. Any action taken by the permittee or an agent of the permittee that increases the project's overall scope or that negates, alters, or minimizes the intent or effectiveness of any stipulation contained in this permit will be deemed a significant deviation from the approved plan. The final determination as to the significance of any deviation and the need for a permit amendment is the responsibility of the ADF&G. Therefore, it is recommended that the ADF&G, Habitat and Restoration Division, be consulted immediately when a deviation from the approved plan is being considered.

This letter constitutes a permit issued under the authority of AS 16.05.870. This permit must be retained on site during weir installation and maintenance operations . Please be advised that this approval does not relieve you of the responsibility for securing other permits, state, federal, or local.

In addition to the penalties provided by law, this permit may be terminated or revoked for failure to comply with its provisions or failure to comply with applicable statutes and regulations. The department reserves the right to require mitigation measures to correct disruption to fish and game created by the project, and which were a direct result of the failure to comply with this permit or any applicable law.

The recipient of this permit (the permittee) shall indemnify, save harmless, and defend the department, its agents, and its employees from any and all claims, actions or liabilities for injuries or damages sustained by any person or property arising directly or indirectly from permitted activities or the permittee's performance under this permit. However, this provision has no effect if, and only if, the sole proximate cause of the injury is the department's negligence.

This permit decision may be appealed in accordance with the provisions of AS 44.62.330-44.62.630.

Sincerely,

Robert G. Bosworth, Deputy Commissioner

C. Wayne Dolezal

By: C. Wayne Dolězal
Habitat Biologist
Habitat and Restoration Division
(907) 267-2285

cc: C. Burkey, ADF&G
D. Molyneaux, ADF&G
M. Coffing, ADF&G
S. Gibbens, FWP

Appendix E. U.S. Bureau of Land Management Land Use Permit for the George River weir project.

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF LAND, SOUTHCENTRAL REGION
3601 C STREET, SUITE 1080
ANCHORAGE, AK 99503-5937
PHONE: (907) 269-8552; FAX (907) 269-8913

1996 MULTI-YEAR LAND USE PERMIT VALIDATION

Under AS 38.05.850

PERMIT # LAS 20247

KUSKOKWIM NATIVE ASSOCIATION is issued this 1995 multi-year (seasonal) land use permit validation to use the following described land:

SW1/4NW1/4 of Section: **10** Township: **21N**, Range: **46W**, **SEWARD** Meridian

This 1996 multi-year land use permit validation authorizes:

(a) the establisment and use of an aluminum picket weir to be used in conjunction with the permittee's fisheries research activities. Use of the site for any other purpose is prohibited.

The authorized 1996 term of use is **June 15, 1996** through **September 30, 1996, unless earlier terminated at the state's discretion.**

DIVISION OF LAND

JUL 2 6 1996

ISSUE DATE IS RED

J. Michael Bennett

Signature of Authorized State Representative | NRM I, Upland Services — Title | Date

***The permittee is responsible for conducting the permitted activities in accordance with original, amended and/or new land use permit stipulations attached to the multi-year (seasonal) land use permit and applicable guidelines set forth in 11 AAC 96.140.**
***The permittee is responsible for obtaining authorizations required by other agencies for the permitted activity.**
***The permittee is responsible for maintaining a current address with the division during the term of the multi-year (seasonal) land use permit.**

LAND USE PERMIT

PERMIT NUMBER : LAS 20247

PERMITTEE : KUSKOKWIM NATIVE ASSN.

Contact Person: Angie Morgan

1996 TERM : 06/15/96 - 09/30/96

J. Michael Bennett

DNR AUTHORIZED SIGNATURE

Alaska Department of
NATURAL RESOURCES

This permit must be posted in a conspicuous location visible from the most common access route. Only permit posters with tan or green backgrounds are valid.

Township	Range	Section/Other
21 N	46 W	SW1/4NW1/4 Sec. 10, SM

Division of Land and Water
Southcentral Region
3601 C Street, Suite 1080
Anchorage, Alaska 99503-5937
269-8552

Appendix F. Land use permit from The Kuskokwim Corporation for the George River weir project.

THE KUSKOKWIM CORPORATION

LAND USE PERMIT

PERMIT NUMBER: 96 0384

EXPIRATION DATE: 12/31/1996

APPLICANT/OUTLET INFORMATION

Applicant Name: Kuskokwim Native Association (KNA) Natural Resources

Address: P.O. Box 127
Aniak, AK 99557

Driver's License No. ______

Description of Land Used: Tents (2) with frames.

Proposed Period of Use (Weirs on George River)

From: June 10 To: Sept. 15, 1996

Vehicles Used: Boat/Motor

License #: ______ Tail: ______

Is Applicant TKC Shareholder: Yes

OUTLET INFORMATION

Issue Date ______

Outlet Name ______

$ Fee Collected ______

OFFICE USE ONLY

Fee Recvd: ______

Date Recvd: ______

Reimburse: ______

Out. Code: ______

LAND USE ACTIVITY & FEE

___ Fishing

___ Hunting

___ Camping—Temporary

_*_ Campsite—Seasonal

_*_ Land Crossing

_✓_ Research

~~FEE: $100.00 administration fee.~~

Admin. Fee waived

PERMITS FOR USES MARKED ABOVE WITH "" CAN ONLY BE ISSUED THROUGH TKC OFFICES AND MAY BE SUBJECT TO ADDITIONAL TERMS, CONDITIONS, AND FEES.

GENERAL INFORMATION

Note: A seasonal campsite involves **one** campsite, such as a fishcamp, that is used one or more seasons (summer, fall, etc.). Temporary camping involves campsites that are used, regardless of season, for a maximum of seven (7) consecutive days.

THE KUSKOKWIM CORPORATION

429 D St., Suite 307	P.O. Box 227
Anchorage, AK 99501	Aniak, AK 99557
(907) 276-2101	(907) 675-4470

I AGREE THAT I will abide by the GENERAL TERMS AND CONDITIONS listed on the back of the Land Use Permit and any other stipulations that might be attached.

APPLICANT'S SIGNATURE [signature] DATE 3/27/96

Angela Morgan
Natural Resources/Subsistence Director

OVER FOR GENERAL CONDITIONS

APPLICANT COPY

Appendix G. George River weir equipment and supply inventory, September 1, 1996.

Storage Loca	Owner	Description	Quantity	Comment
Vanderpool's				
	ADFG	lg. yellow drum	1	empty
	ADFG	med. yellow drum	1	empty
	ADFG	Sm. Yel drum	1	contains KNA tools
	ADFG	Fish Dip Net	1	large dipcraft trapizoid
	ADFG	painting set	1	
	ADFG	first aid kit	1	
	ADFG	Weath. prt. patch kit	1	
	ADFG	Weath. prt. lag bolts	many	
	ADFG	Weathprt w/ frame	1	in fish tote
	ADFG	6" pipe vent	1	
	ADFG	informative books	a few	photo copied
	ADFG	polarized glasses	1	fair condition
	ADFG	Chuck Box	1	w/ kitchenware
	ADFG	Honda Generator (EM1800XK1)	1	ID. # 10074038
	ADFG	Hand Saw	1	
	ADFG	grapple hooks	2	
	ADFG	blue ext. cords	2	
	BSFA	blk plastic mesh	1 roll	
	BSFA	wood stove	1	
	BSFA	collapsable pipe	1	
	KNA/ ADF&G	come-alongs	2	red/blue
	KNA	carp. belt	1	inside small yellow storge drum
	KNA	Skilsaw	1	inside small yellow storge drum
	KNA	Makita Drill w/bits	1	inside small yellow storge drum
	KNA	Twine	2	inside small yellow storge drum
	KNA	Tape Measure	1	inside small yellow storge drum
	KNA	Gas Nozzle cnvtr	1	inside small yellow storge drum
	KNA	Square meas. instr.	1	inside small yellow storge drum
	KNA	Chalk /chalkline	1	inside small yellow storge drum
	KNA	Claw Bar	1	inside small yellow storge drum
	KNA	6" chainsaw file	1	inside small yellow storge drum
	KNA	spark plug wrench	1	inside small yellow storge drum
	KNA	various woodbits	4	inside small yellow storge drum
	KNA	Well Pipes	3	
	KNA	Well Point	1	
	KNA	Well hand pump	1	
	KNA	rakes	2	
	KNA	Shovels	3	
	KNA	lg. blue tarp	1	
	KNA	Coleman stoves	2	one used, one new
	KNA	Pic/ insect repellent	plenty	in small box
	KNA	Coleman Lanterns	2	good cond.
	KNA	lantern fuel	1	gallon
	KNA	burlap sandbags	1 md. box	
	KNA	Push Broom		
	KNA	Pots and Pans	1 box	
	KNA	axe	1	
	KNA	sledgehammer	1	
George River Weir				
	ADFG	tripods	35	
	ADFG	stringers (remaining from original)	34	need minimum of 36 more for replacements
	ADFG	panels (remaining from original)	123	need min. of 3 replacements plus 10 extras)
	ADFG	lumber	scraps	in tree cache
	ADFG	ladder	2	
	ADFG	beds	3	

- continued -

Appendix G. (page 2 of 2)

Storage Loca	Owner	Description	Quantity	Comment
	ADFG	table	1	
	ADFG	steps	1	
	ADFG	55 gallon drum	1	empty
	ADFG	outhouse	1	
	BSFA	wall tent frame	1	
	KNA	tent platform	1	
Bethel				
warehouse:				
	USFWS	Bear fence	1	returned to Kenai
	ADFG	lg. white cooler	1	
	ADFG	level meter stick	1	
	ADFG	36" crow bar	1	
	ADFG	tool box	1	
	ADFG	shallow 5 3/8 net	1	
	ADFG	lg. blue tarp	1	
	ADFG	boatw/ 50 Honda jet	1	winterized
	ADFG	Imhoff Cone	1	
	ADFG	Surber Sampler	1	
	ADFG	Colorimeter	1	
	ADFG	Plastic bottles for water samples	12	wide mouth
	ADFG	rinse bottles	5	
	ADFG	tripod braces	10	
	ADFG	through bolts (H/C SCR NC 5/8-11x8 galvinized 307A x 1'0")	16	enough for 4 tripods
	ADFG	Hex Nuts (5/8-11 GR-2 galvinized x 1'0")	19	enough for 4 tripods
	ADFG	Flat Washers (5/8" USS galvinized x 1'0")	38	enough for 4 tripods
	ADFG	cable ties (black) (14" Calterm 73274; 120 lbs.)	80	
	ADFG	boat box tool kit	1	
	ADFG	wrench set	1	
herring shed:				
	ADFG	propane tanks	2	borrow fr. herring
	ADFG	solar panels	2	borrow fr. herring
	ADFG	Cabela's tent	1	
gun storage:				
	ADFG	12 gauge rifle	1	winterized
	ADFG	shells	5	boxes
old bunkhouse:				
	ADFG	battery charger	1	
	ADFG	panels (extras)	7	stored under old bunkhouse
new bunkhouse:				
	ADFG	chest waders	1	
	ADFG	SSB radio w/ 3230 & 5195 antenna	2	
office:				
	ADFG	specimen collector	1	
	ADFG	water sample cont.	9	in small box
	ADFG	singleside band radio	1	w/ antenna
	ADFG	mobile phone	1	
	ADFG	less lethal shot gun shells	20	4 boxes
	ADFG	logbook/papers		
	ADFG	Talley-counter (8 key)	2	

Appendix H. Historic daily river stage of the Kuskokwim River at Akiak (NOAA).

Date	Kuskokwim River Stage (ft)												
	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Mean 84-95
5/31	16.3	26.4	16.0		21.2		23.2						14.6	20.6
6/01	16.1	26.4	15.9	19.2	21.7	22.8	21.9	23.3	22.0		19.6		14.5	20.9
6/02	15.8	26.4	16.0	18.7	22.0	22.8	21.8	23.1	22.3		19.6		14.4	20.8
6/03	15.6		16.0	18.4	22.4	23.2	21.3	23.0	22.2		19.1		14.4	20.1
6/04	15.4	26.4	16.0	18.0	22.6	23.2	21.1	22.8	22.2		18.7		14.3	20.6
6/05	15.3	26.4	16.0	17.8	23.1	23.4		22.4	22.1	20.7	18.6		14.2	20.6
6/06	15.1	26.4	16.1	17.8	22.9	23.1		22.1	21.7	20.6	18.4		14.2	20.4
6/07	15.0	26.4	16.0	17.6	22.9	23.1		21.6	21.3	20.6	18.1		14.4	20.3
6/08	14.6	26.3	16.1	17.5	22.7	23.0		19.8	20.2		17.5		14.6	19.7
6/09	14.1	26.3	16.0	18.6	22.4	22.6		21.5	19.9		17.2		14.5	19.9
6/10	13.7	26.3	16.1	18.4	22.0	22.4	22.0		19.7	19.9	17.0		14.4	19.7
6/11	13.3	26.1	16.1	18.4	21.5	22.2			19.7	19.9	17.0		14.3	19.3
6/12	13.3	25.4	16.1	18.3	21.3	22.0		20.5	19.8	19.7	16.9		14.2	19.3
6/13	13.1	25.2	15.5	18.7	21.0	21.7		20.4	18.4	19.0	16.9	19.6	14.5	19.0
6/14	13.9	25.2	14.4	18.5	21.2	21.4		20.3	18.2	18.8	16.8	19.6	14.6	18.9
6/15	14.1		14.3	18.3	21.0	21.2		20.2	18.0	18.6	16.8	19.7	14.5	18.2
6/16	13.9		14.2	17.4	20.8	19.9			17.8	18.5	16.7	19.1	15.1	17.6
6/17	13.9		14.2	17.2	20.7	21.0		20.7	17.7	18.4	16.7	18.9	15.0	17.9
6/18	14.2	21.7	14.2	17.1	20.6	20.7		20.0	17.6	18.1	16.7	18.8		18.1
6/19	14.2		14.2	17.0	20.4	20.4		20.1	17.4		16.7	18.8	14.8	17.7
6/20	14.1		14.4	16.8	20.3	20.0		19.8	17.2	18.1	16.9	18.6	14.6	17.6
6/21	14.0		14.4	16.6		19.7		19.6	17.1	18.2	17.0	18.6	14.5	17.2
6/22	14.0		14.8	16.3	20.3	19.5		19.5	16.9	18.1	17.8	18.5	14.4	17.6
6/23	14.0		14.9	16.3	19.8	19.3		19.4	16.7	18.2	17.8	18.5	14.3	17.5
6/24	13.9		15.6	16.1	19.6	19.0		19.5	16.4	18.4	18.1	18.4	14.4	17.5
6/25	13.6		16.8	16.1	19.2	18.3		19.7	16.1	18.2	18.3	18.2	14.2	17.5
6/26	13.3		16.4	16.2	17.6	17.8		19.7		18.3	18.7	17.5	14.2	17.3
6/27	13.5		15.9	16.3	17.3	17.6		19.8		18.3	19.2	17.2	14.2	17.2

- continued -

Appendix H. (page 2 of 4)

Date	Kuskokwim River Stage (ft)													
	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Mean 84-95
6/28	13.7	20.2	14.7	16.3	17.1	17.5	17.2	19.8			19.7	17.1	14.4	17.3
6/29	13.8	19.8	14.2	16.3	16.9	17.9	17.2	19.8		18.3	19.7	17.1	15.4	17.4
6/30		19.8	13.6	16.4	16.7	17.7	17.2	19.8		18.2	19.3	17.0	15.4	17.6
7/01	13.1	19.7	13.2	17.1	16.6	17.5	17.1	19.8	16.2	18.1	19.1	16.8		17.0
7/02	13.3		12.9	16.5	16.6	17.3	17.0	19.9	16.2	18.1	18.3	16.7		16.6
7/03	12.9	20.7	13.0	16.5	17.0	17.2	17.0	19.8	16.1	18.0	17.9	16.5		16.9
7/04			14.1	16.6	16.8	17.2	16.8		16.3	17.8	17.5	16.5		16.6
7/05	12.7	20.6	13.8	16.6	16.7	17.1			16.6	18.0				16.5
7/06	12.6	20.9	12.9	16.6	16.4	17.2	17.1	19.6	16.9	17.8	16.7		15.4	16.8
7/07	12.8		13.1	16.5	16.1	17.1	17.1	19.7	16.7	17.7		16.7	14.8	16.3
7/08	12.0	22.0	13.3	16.5		16.9	17.1	19.7	16.7		16.7		14.5	16.7
7/09	12.3	21.9	13.6	16.2	15.4	16.4	17.1	19.6		17.1	16.7	16.8	14.5	16.7
7/10	12.0	22.1	13.7	16.3	15.4	16.4	17.1	19.6		16.9			14.5	16.6
7/11	12.1	21.7	14.0	16.4	15.3	15.7	17.1	19.2		16.7		16.5	14.5	16.5
7/12	12.4	21.3	14.1	17.0	15.0	15.3	17.1	19.0		16.5		16.4	14.4	16.4
7/13	12.5	20.9	14.3	17.1	14.7	14.9	17.1	18.7		16.4		16.4	14.0	16.3
7/14	12.5	20.5	14.3	17.1	14.3	14.7	17.0	19.0		16.8	16.7	16.4	13.9	16.3
7/15	12.5	20.2	14.2	17.1	13.5	14.6	16.9	18.5		17.2	16.9	16.4	13.7	16.2
7/16	12.2	19.8	14.2	17.1	13.5	14.2	16.7	18.3		17.2	17.4	16.5	14.4	16.1
7/17	12.1	19.1	13.7	17.1	13.5	15.7	16.5	18.1			17.7	16.5	14.2	16.0
7/18	12.1	18.8	13.2	17.2	13.3	16.4	16.7	17.7			17.6	16.5	14.2	16.0
7/19	12.2	18.5	13.0	17.3	12.8	17.5	16.4	17.7		16.4	17.4		14.3	15.9
7/20	12.1	18.0	13.3	17.2	12.6	17.7	16.8	17.7		16.4	17.3		14.4	15.9
7/21	12.0	17.8	14.1	17.2	12.5	17.5	16.7	17.3		16.4	17.2		14.4	15.9
7/22	11.7	17.8	14.2	18.2	12.3	17.4	16.5	17.3					14.4	15.7
7/23	11.5	17.8		18.2	12.3	17.1	16.4	17.3					14.3	15.8
7/24	11.5	17.8	15.2	18.1	12.7	16.9		17.3				15.7	14.3	15.6
7/25	11.3	17.9	17.2	18.7	12.6	16.4			17.5			15.7	14.3	15.9

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Appendix H. (page 3 of 4)

Date	Kuskokwim River Stage (ft)													
	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Mean 84-95
7/26	11.1	17.8	18.5	18.9	12.9	16.2			17.4	17.1	17.8	15.7	14.4	16.3
7/27	10.9	18.3	18.7	19.0	12.4	16.0		17.2	17.3	17.1	17.8		14.8	16.5
7/28	10.9	22.0	18.7	18.9	13.6	16.0		17.3	17.2	17.1	17.6		14.9	16.9
7/29	11.6	21.7	18.4		13.9	15.9		17.2	17.2	17.1	17.5	16.6	14.9	16.7
7/30	12.0	19.8	18.1	18.2		15.9	16.1	17.2	17.2	17.1		16.6	14.9	16.8
7/31	12.2	18.3	17.9	17.6					17.1	17.1		16.6	16.6	16.7
8/01	12.3	19.7	17.6			16.0			16.9	17.0		16.5	19.6	16.6
8/02	13.0	19.6	17.5			15.9			16.9	17.1		16.5	19.5	16.6
8/03	14.2	19.5	17.3			15.9				17.2		16.5	19.8	16.7
8/04	13.8	19.5	18.2			16.0				16.2		16.4	19.6	16.7
8/05	13.4	19.0	18.0			16.5				15.8		16.4		16.5
8/06	13.3	19.3	17.7			16.5				15.8	17.0	17.0		16.7
8/07	14.6	19.7	17.6			16.6				15.7	17.1	17.1		16.9
8/08	14.3	20.6	17.5		11.6	16.9					17.6	17.0		16.5
8/09	14.2	20.1	17.0		10.9	17.0					18.0	17.3		16.3
8/10	14.2	19.2	16.7		15.6	16.9		19.1		16.2	19.0	18.1		17.2
8/11	14.2	19.5	16.3		14.0	17.8		19.2		16.7	18.0	18.4		17.1
8/12	14.2	19.6	16.1			18.6		18.8		16.6	17.4	17.7		17.4
8/13	14.1	19.9	16.1			19.0		18.1	17.5	16.7	17.0	17.7		17.3
8/14	13.8	20.1	16.0			20.8		17.9	17.5	16.7	16.9			17.5
8/15	12.8	21.9	16.0		13.9			17.7	17.8	16.9	16.9			16.7
8/16	13.0	20.0	15.9		13.9	21.8		17.6	18.0	17.0	16.7		19.5	17.1
8/17	13.4		15.9					17.4	18.0	18.8			19.7	16.7
8/18	11.7		15.9			22.7	16.8	17.3	17.8	22.3	16.9		19.3	17.7
8/19	11.5	21.8	15.3		14.2	21.7		17.3	17.8	22.3	16.8		19.2	17.6
8/20	11.4	22.5	14.9			20.6		17.6	17.8	22.4			19.0	18.2
8/21	11.4	22.4	14.8			20.4		17.7	17.8	21.9			18.4	18.0
8/22	11.8	22.2	14.9		13.2	19.9	16.9	17.9	17.9	21.6			18.1	17.4

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Appendix H. (page 4 of 4)

Date	Kuskokwim River Stage (ft)												
	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Mean 84-95
8/23	13.9	22.0	16.0		13.1	20.0	17.0	17.8	17.8	21.2			17.8	17.6
8/24	14.2	22.2	15.5		13.1	19.8	17.4	17.9	17.7	19.6		16.8	17.5	17.4
8/25	14.4	22.3	15.9		13.6	20.0	17.2	18.0	17.7	19.2			18.2	17.6
8/26	14.5	22.3	17.0		13.6	19.8	17.2	17.9	17.7	18.9	17.5		18.2	17.6
8/27	14.9	22.0	17.5		13.9	19.5	17.2	17.4	17.6	18.0	17.6		18.1	17.6
8/28	15.6	22.1	18.3		14.0	19.6	17.3	17.3	18.8	17.8	17.9		18.7	17.9
8/29	16.0	22.1	18.4		14.2	19.4	18.2	17.4	19.3	17.2	19.6		19.7	18.2
8/30	16.2	19.8	19.1		14.0	19.2	20.1	17.5	20.0	17.0	20.7		20.5	18.3
8/31	16.2	20.8	19.9		13.8	19.0		17.7	20.3	16.6	21.7		20.7	18.5
9/01	16.0	20.4	19.8		12.9	18.9	21.8	17.6		16.7	22.3		20.5	18.5
9/02	15.8	20.0	19.1		12.9	18.7	21.7	17.3	20.2	17.7	22.4		20.2	18.6
9/03	15.6	19.3	19.4		12.7	18.8	21.4	17.2	20.0	17.7			19.5	18.0
9/04	15.0	18.8	19.0		12.4	17.6	21.3	17.1	20.0	18.4			19.0	17.7
9/05	14.5	18.4	18.9		12.4	18.8	21.1	17.1	20.0	18.9	20.7		18.6	18.1
9/06	14.3	18.6	17.8		12.5	20.1		17.0	19.9	19.2	19.7		18.2	17.7
9/07	14.1	18.6	16.7		11.7	19.7	19.7	16.7	19.9	20.2	18.9			17.6
9/08	13.7	18.5	16.3		10.9	19.9	19.6	16.6	20.1	22.8	18.7			17.7
9/09	12.9	17.8	16.1			19.8	20.0	16.6		23.0	18.3			18.0
9/10	11.7	17.9	16.4			20.0	20.2	16.5		23.4	17.8			18.0
9/11	10.8	18.0	16.9			20.2	20.7	16.5		23.4	17.5			18.0
9/12	10.4	18.1	18.2			20.6	22.0	16.3		23.4	17.0		15.4	18.2
9/13	9.9	18.2	19.1			20.8	23.0	16.2		23.5	17.5		15.2	18.5
9/14	9.7	18.8	20.1			20.8		16.1		23.6	17.5		14.9	18.1
9/15	9.2	19.8	20.1			20.7	24.9	16.2			17.4		15.2	18.3
9/16	8.7	19.8	19.8			20.8	25.4	16.8					15.3	18.6
9/17	8.5	19.6	19.4			20.8	25.5	16.8					15.1	18.4
9/18	8.8	20.5	19.8			20.6	26.6	16.9					15.0	18.8
9/19	9.3	22.4	19.6			19.8	26.0	17.1					14.4	19.0
9/20													14.6	

Appendix I. Precipitation and snow pack statistics for the Kuskokwim River drainage.

Precipitation Statistics: [a]

Month	1996	Normal	Deviation	% of Normal
April	0.06	0.7	0.64	8.6
May	0.62	0.78	0.16	79.5
June	1.09	1.44	0.35	75.7

Snow Pack Statistics [b]

Location	April 1, 1996		April 1 Average, 1961-90	
	Snow Pack (in.)	Water Content (in.)	Snow Pack (in.)	Water Content (in.)
McGrath	27	7.2	26	5.4
Minchumina	19	3.8	22	4.4
Telequana	19	4.1	1996 lowest in 5 years of project	
Chuathbaluk	13	1	1996 lowest in 9 years of project	

[a] Source: National Weather Service, Bethel.

[b] Source: USDA. 1996. Alaska basin outlook report, April 1, 1996. USDA, Natur Resources Conservation Service.