SUSITNA PROJECT REVIEW

Division of Commercial Fisheries

Central Region

October 2 - 4, 1985

See also RTS Files
I 800.200.400 (1),(2)
for draft FY86
RSA/POS
I 800.100.200(4)

REVIEW TEAM

Susitna Aquatic Review
October 2 - 4, 1985

Review Team Staff	Position	Division Mailing Address	Phone Number
Sport Fish			
Paul Krasnowski	Regional Supervisor	FRED Div. 333 Raspberry Road Anchorage, Alaska 99501	267-2168
Michael Mills	Biometrician III	SPORT FISH Div. 333 Raspberry Road Anchorage, Alaska 99501	267-2369
Commercial Fish			
Kenneth Florey	Regional Supervisor	COMMERCIAL FISHERIES Div. 333 Raspberry Road Anchorage, Alaska 99501	267-2104
Douglas Eggers	Biometrician III	COMMERCIAL FISHERIES Div. 333 Raspberry Road Anchorage, Alaska 99501	267-2104
Habitat			
Carl Yanagawa	Regional Supervisor	HABITAT Div. 333 Raspberry Road Anchorage, Alaska 99501	267-2283

REVISED AGENDA

Susitna River Project Review
October 2 - 4, 1985

Wednesday, October 2

8:30a - 9:30a	Lower River Salmon Escapement (K. Tarbox)
9:30a - 10:30a	Middle River Salmon Escapement (M. Thompson)
10:30a - 12:00p	Middle River Outmigrant Evaluation (K. Roth)
12:00p - 1:00p	BREAK FOR LUNCH
1:00p - 2:00p	Lower River Spawning Habitat Evaluation (L. Bartlett)
2:00p - 3:00p	Middle River Resident Fish Study (R. Sundet)
3:00p - 4:30p	Aquatic Habitat Monitoring (D. Vincent-Lang)

Thursday, October 3

8:30a - 10:30a	Long Term Monitoring Strategies (L. Bartlett)
10:30a - 12:00p	Review Team Discussion
12:00p - 1:00p	BREAK FOR LUNCH
1:00p - 4:30p	Review Team Report Preparation

Friday, October 4

10:00a - 12:00p	ADF&G/APA Long Term Monitoring Meeting

REVIEWERS GUIDE

Your participation in the Susitna Project Review is sincerely appreciated. As a reviewer, your comments and recommendations will assist the Commercial Fisheries Division develop and refine future fisheries study plans for the Susitna River.

The Division presently has two primary management goals for the Susitna. The first goal is "TO ENSURE THAT OPTIMUM ("ADEQUATE") SPAWNING ESCAPEMENTS ARE MAINTAINED FOR SUSITNA RIVER SALMON STOCKS." The second primary goal addresses monitoring potential changes resulting from the construction and operation of the Susitna Hydroelectric Project on fish populations and their habitats. More specifically the goal is "TO DESCRIBE THE NATURAL PRE-PROJECT VARIATIONS IN FISH POPULATIONS AND THEIR HABITATS AT A LEVEL OF RELIABILITY NECESSARY TO DETECT AND EXPLAIN POSSIBLE FUTURE CHANGES CAUSED BY THE HYDRO-ELECTRIC DEVELOPMENT".

Given the reality of shrinking budgets and rapidly increased resource demands, we must carefully assess our fisheries projects to ensure 1) technical merit 2) cost effectiveness, and 3) relevance to primary management goals. In this regard, please attempt to use the following list of questions as an outline to structure your comments and recommendations.

1. Do the objectives of this project appear to adequately address the Division's primary goals? How might project objectives be modified to more clearly address our goals?

2. If you believe that technical difficulties associated with this project may exist; what are they and how might they be remedied?

3. Could our sampling programs be modified to reduce project costs without unreasonably sacrificing technical quality.

4. What priority would you give this project in terms of meeting the Division's primary goals?

Table of Contents

Susitna Project Review
October 2 - 4, 1985

B-1 Lower River Salmon Escapement

PROJECT TITLE: Lower River Salmon Escapement

PROJECT SUPERVISOR: Kenneth Tarbox

ASSISTANT PROJECT SUPERVISOR: Bruce King

FY 86 ALLOCATION:

Susitna Station	- $ 53,500	(operational)
Biosonic Contract	- 74,147	(C.I.P.)
Species Allocation	- 15,000	(C.I.P.)

FY 86 SPENT TO DATE (AUGUST):

Susitna Station	- $ 32,612
Biosonic Contract	- 71,147
Species Allocation	- 14,100

PROBLEM STATEMENT:

The Susitna River drainage is located within the northern portion of the Cook Inlet area and drains an area exceeding 49,200 km^2. The mainstream Susitna River extends approximately 442 km from its source in the Alaska Mountain Range to its point of discharge on the west side of Cook Inlet. The major tributaries are the Chulitna, Talkeetna, and Yentna Rivers. All are glacial in origin and are heavily silt laden during ice free months. Many smaller tributaries are characterized by clear water and are perennially silt free.

Determining total salmon escapement by species into the Susitna River is complicated by the glacial nature and multiple channels of the major streams. No successful method for achieving this result has been defined to date.

OBJECTIVES:

The objectives of the Susitna Station and Yentna River drainage salmon escapement project is to assess:

1) the relative magnitude of escapement, migrational timing, and migrational behavior of sockeye salmon in the mainstem river at River Mile 26;
2) the age, length, weight, sex, and scale characteristics of the sockeye salmon escapement; and
3) the magnitude, timing and distribution of spawning sockeye salmon within established tributary index areas.

Additional objectives within the time frame of the sockeye salmon escapement project are to assess:

1) the relative magnitude of escapement of coho salmon, chum salmon, and pink salmon in the mainstem river; and
2) the age, length, weight, and sex characteristics of coho salmon, chum salmon, and pink salmon escapements.

OVERVIEW OF METHODS:

Because of the complex nature of this project, please refer to the attached operational plans for each project phase. However, in general, hydroacoustic equipment was operated as follows in 1985:

Susitna River Mile 26 (east bank) - Bendix counter (1978 model)
Bendix long range counter (1984 model)

Yentna River Mile 4 (north bank and south bank) -
Bendix counter (1980 model)

Susitna River Mile 26 (transect across river) -
Biosonic dual beam system

Sampling for species allocation of hydroacoustic targets was accomplished by fishwheels and gill nets.

CONCLUSIONS DRAWN TO DATE:

1. The horizontal and verticle distribution of salmon in the Susitna River (RM 26) is variable and dependent on a number of factors (water velocity, depth, bottom profile, species, tributary input, etc.).

2. Downstream movement of salmon is evident and a counting system must take this into consideration.

3. A flexible counting system is required to monitor and meet changing river conditions.

4. Species apportionment of hydroacoustic targets remains a critical problem.

5. The Bendix system alone is not conducive to achieving a total estimate of salmon escapement.

6. The Bendix system fixed counting logic is not suitable for monitoring fish behavior.

7. The ultimate cost of counting salmon by hydroacoustic techniques in the mainstem at RM 26 may reach $100,000-$200,000 annually.

RECOMMENDATIONS:

1. Evaluate the cost/benefit of counting salmon in the Susitna River.

2. Continue the Yentna River and east bank Susitna Station Bendix counting operations for inseason management.

3. Continue the Biosonic program with emphasis on deployment techniques and system design.

UPPER COOK INLET SOCKEYE SALMON ENUMERATION INVESTIGATION

OPERATIONAL PLAN

1985

INTRODUCTION

Sockeye salmon escapement enumeration projects will be conducted on the Kenai, Kasilof, Susitna, Yentna and Crescent Rivers in 1985 (Figure 1). Methods of enumeration and monitoring will include side scanning sonar counters, fishwheels, and index area escapement surveys.

The Kenai River drainage encompasses approximately 5,200 km^2 of the western Kenai Peninsula and is considered to be the major sockeye salmon producing watershed in the Upper and Lower Cook Inlet areas (Figure 2). Four species of Pacific salmon (sockeye salmon, coho salmon, pink salmon, and chinook salmon) spawn in the river or tributary lakes and streams. Chum salmon, a fifth species, do not utilize the drainage to an appreciable extent. Numerous sockeye salmon nursery lakes are contained within the drainage: Skilak, Kenai, Hidden, Upper Trail, Lower Trail, Upper Russian, Lower Jean and Tern (Mud) Lakes. Skilak, Kenai, Upper Trail, and Lower Trail Lakes are glacially occluded.

Two runs of sockeye salmon occur in the Kenai River. An early run enters the river from late May through June and a late run enters the river from late June through August.

Early-run fish are believed to be bound predominately for Upper Russian Lake and its tributaries and Lower Jean Lake. The late run fish are more numerous, and excluding Lower Jean Lake, spawn throughout the system upstream of the outlet of Skilak Lake. Since 1964 only the late run of sockeye salmon has been commercially harvested.

Sonar enumeration of the sockeye salmon escapement into the Kenai River has been conducted annually 32 km upstream of the river mouth. Since 1980, enumeration efforts have employed two 1980 model Bendix side scan sonar (SSS) counters.

Escapement sampling was originally conducted from 1957 to 1959 to monitor the age, length, and sex characteristics of the Kenai River sockeye salmon. Sampling was discontinued from 1960 to 1965, however, investigations were resumed in 1966 and have been conducted annually to establish a data bank of escapement information.

Surveys of the clearwater sockeye salmon index spawning areas in the Kenai River drainage were initiated in 1925. Comprehensive surveys have been conducted annually since 1946 to obtain an indication of spawner distribution and relative escapement magnitude. These index area surveys have also served as an alternate index of escapement to compare with more recent sonar enumeration.

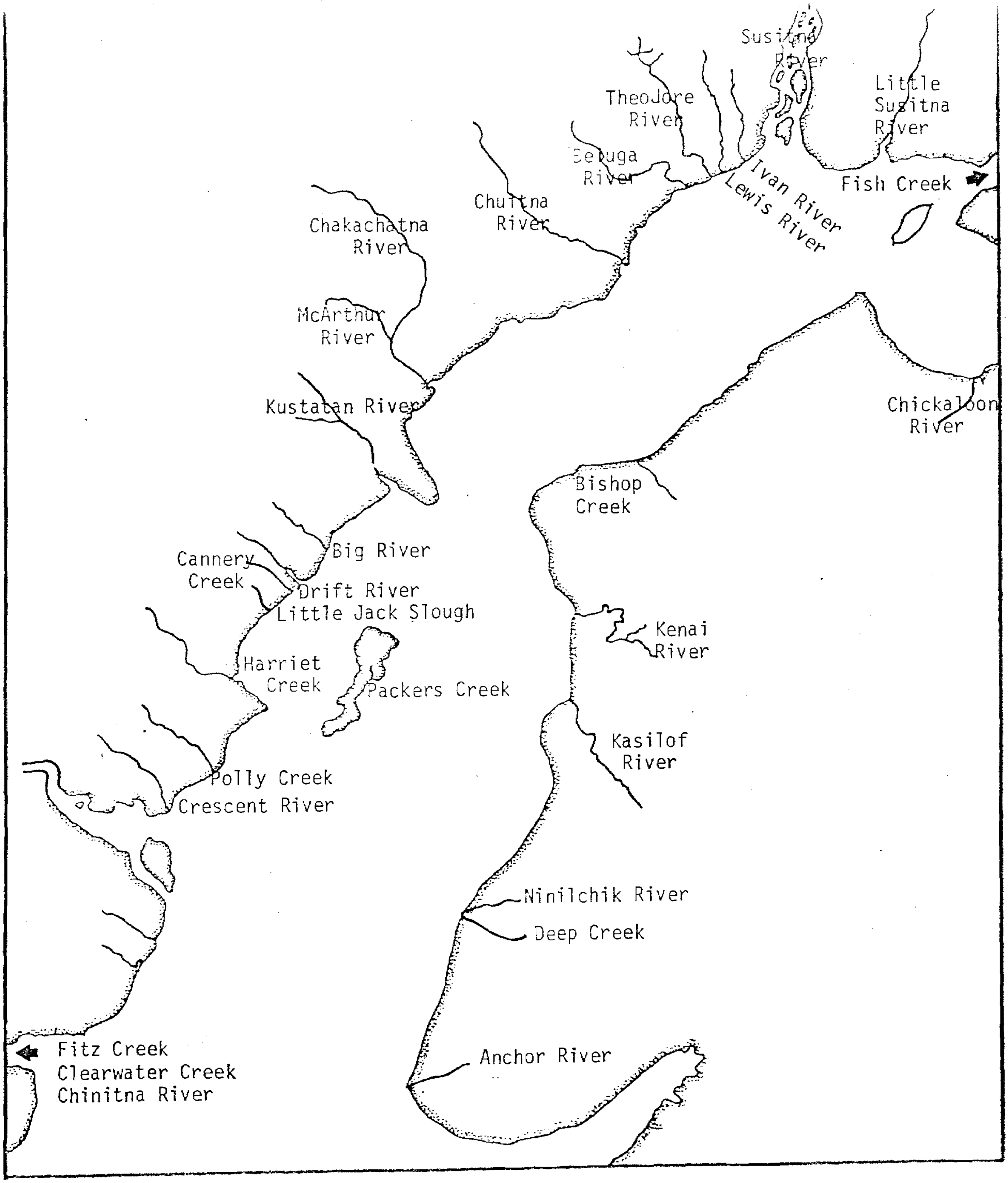


Figure 1. Anadromous streams of Upper Cook Inlet, Alaska.

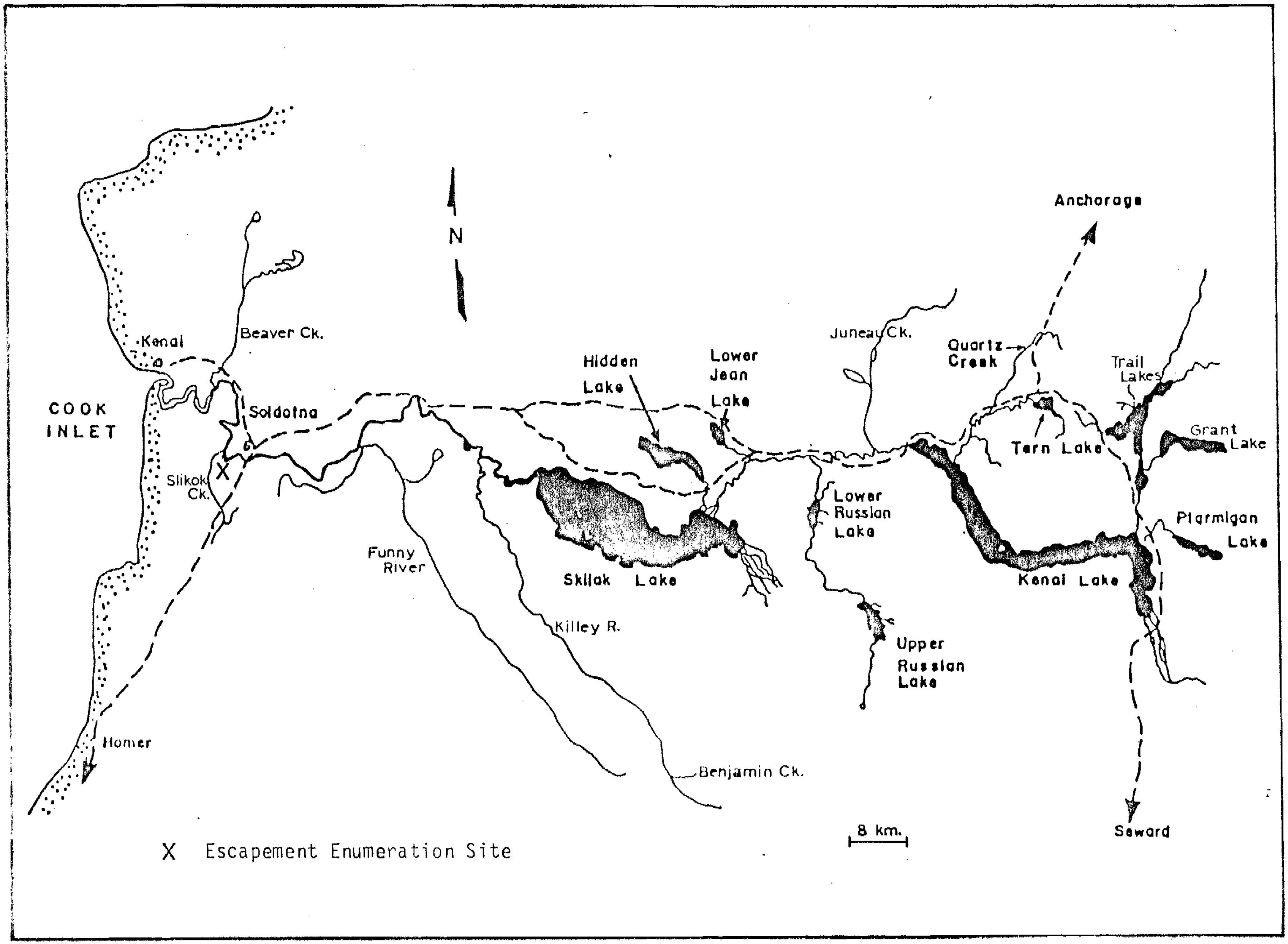


Figure 2. Kenai River drainage and major sockeye salmon rearing lakes.

The Kasilof River drainage encompasses 190 km^2 and contains the largest glacial lake, Tustumena Lake, in the Cook Inlet area (Figure 3). Four species of Pacific salmon, sockeye salmon, coho salmon, pink salmon, and chinook salmon are known to spawn within the drainage. Chum salmon are infrequently observed in the system. Sockeye salmon are believed to begin entering the river in early June, but the majority of the run occurs in July.

In-season escapement enumeration in the past has been limited by the glacial nature of the Kasilof River and Tustumena Lake. Prior to the initial deployment of sonar counters in 1968, escapement enumeration activities consisted of test fishing at the mouth of the river; age, length, and sex sampling; and index area escapement surveys. Test fishing was conducted from 1962 through 1974. Sonar enumeration (using two 1978 model SSS counters) of sockeye salmon has been conducted annually 27 km upstream of the mouth of the Kasilof River. A new site (adjacent to the Sterling Highway bridge) was selected for operation of the SSS system in 1983. The move was accomplished to provide counting conditions more suitable to the Bendix system. Age, length, and sex characteristics of sockeye salmon escapement have been monitored annually since 1966. Clearwater index area surveys have been conducted annually since 1925 to determine relative escapement magnitude and distribution. More recently, these surveys have also been used to establish the reliability of the sonar counts.

The Susitna River drainage is located within the northern portion of the Cook Inlet area and drains an area exceeding 49,200 km^2. The mainstream Susitna River extends approximately 442 km from its source in the Alaska Mountain Range to its point of discharge on the west side of Cook Inlet (Figure 4). The major tributaries are the Chulitna, Talkeetna, and Yentna Rivers. All are glacial in origin and are heavily silt laden during ice free months. Many smaller tributaries are characterized by clear water and are perennially silt free.

The salmon stocks of the Susitna River drainage are major contributors to the Cook Inlet sport and commercial salmon harvest. All five species of Pacific salmon (*Oncorhynchus sp.*) spawn within the drainage.

Determining total escapement into the Susitna River is greatly complicated by the glacial nature and multiple channels of the major streams. A test fish program was conducted near the mouth of the river from 1963 through 1970 to determine relative abundance of all salmon species. A fishwheel and gillnet escapement sampling program was initiated 40 km upstream from the Susitna River mouth at Susitna Station in 1969 and continued through the 1972 season. Research investigations were expanded in 1972 to include monitoring of the salmon escapement into the Talachulitna River drainage, a major producer of sockeye salmon and pink salmon.

Since 1974 various methods have been employed to generate salmon escapement estimates. A sockeye salmon tag and recovery population estimate was derived for the Yentna River in 1974. This program was expanded in 1975 to encompass the entire Susitna River drainage for population estimates of sockeye salmon and chum salmon. In 1976, two 1972-model MTS (multiple transducer sonar)

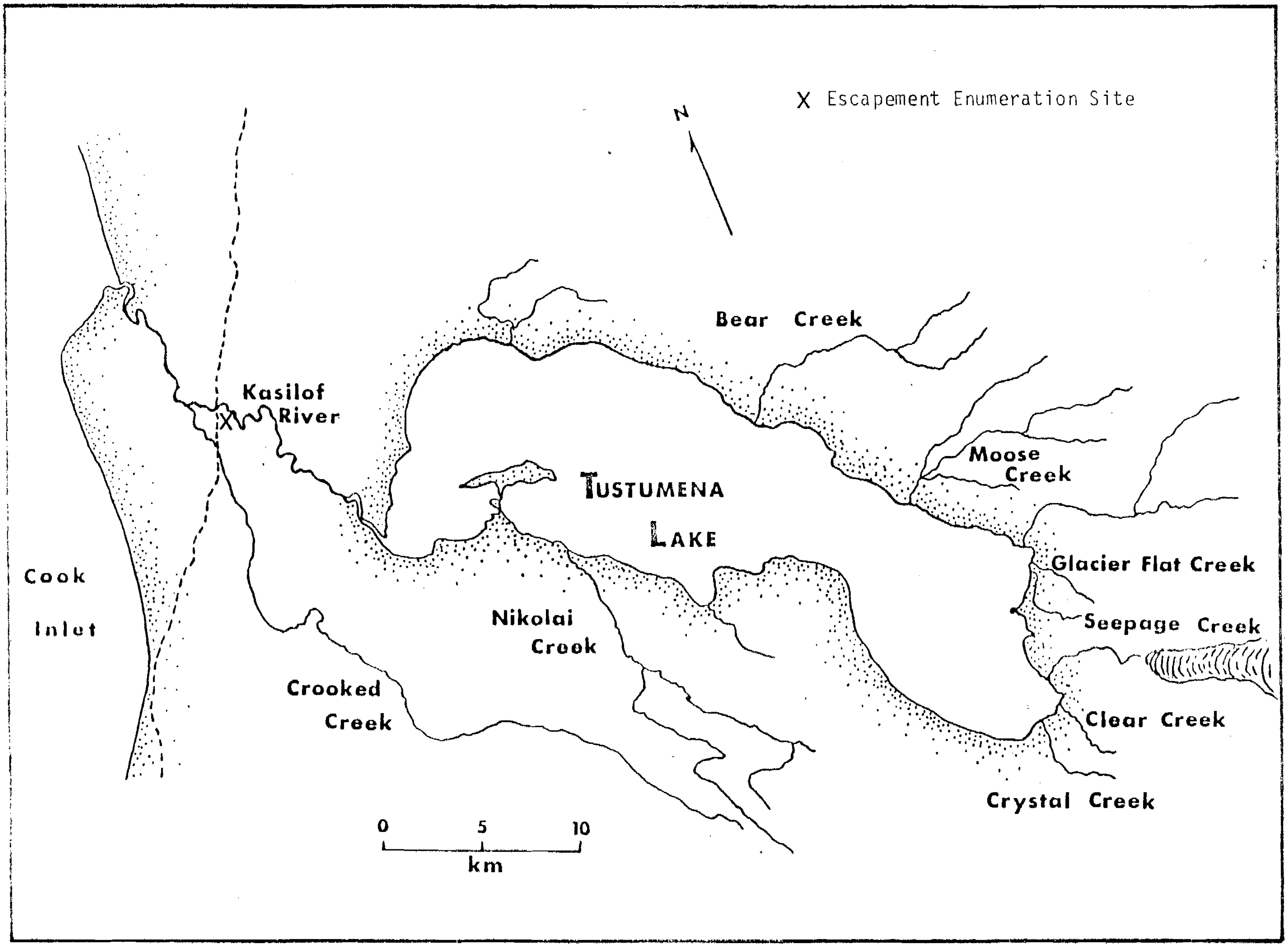


Figure 3. Kasilof River drainage and major sockeye salmon spawning and rearing areas.

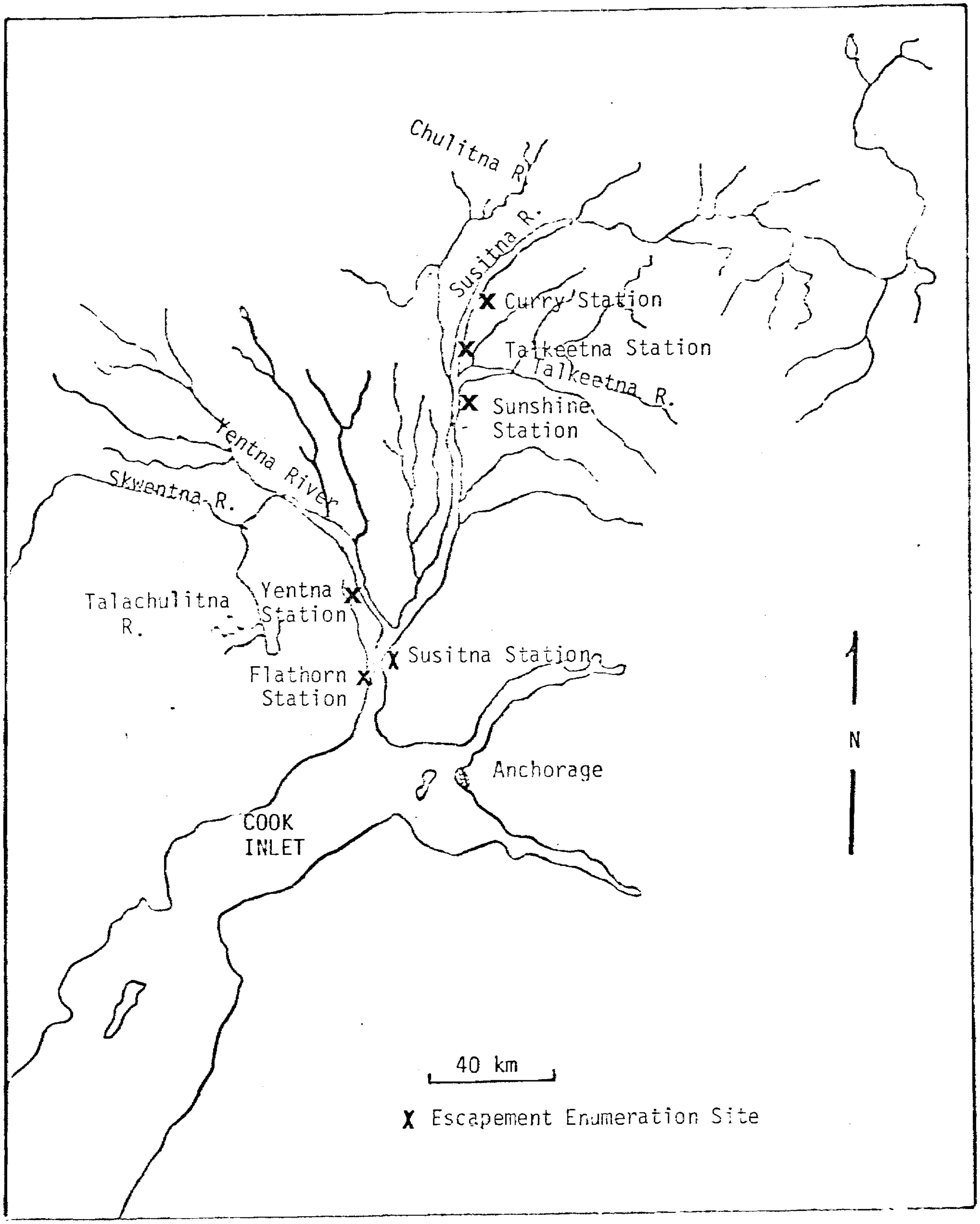


Figure 4. Susitna River drainage and major tributary rivers.

counters were deployed at Susitna Station, but problems associated with pressure on the transducers as a result of water depth precluded an accurate estimate of sockeye salmon numbers. In 1977 a tag and recovery project was reinstituted at Susitna Station with major emphasis on sockeye salmon although partial escapement estimates were determined for coho salmon, chum salmon, and pink salmon. Two 1978 model SSS counters have been used at Susitna Station since the 1978 season. Because of siting and operational problems in 1982 and 1983, the west bank counter will not be operated in 1985. Sonar counts and fishwheel catches from Yentna Station will provide daily escapement estimates for the west bank. Additional studies will be conducted on the east bank to assess mid-river and upper water column migration of salmon. These studies will be performed with existing side scanning equipment, and a new experiemental substrateless long range (up to 500 feet) counter recently developed by Bendix Corporation.

The Crescent (Grecian) River drainage comprises a major sockeye salmon spawning and rearing area on the west side of the Central District of the Cook Inlet area (Figure 5). All five species of Pacific salmon spawn within the watershed. Crescent Lake, a semi-glacial lake approximately 10 km long and 3 km wide is drained by the river.

Annual escapement surveys of the clear water spawning areas were initiated in 1947. Escapement enumeration activities were limited to post-season surveys until 1974 when the State Legislature appropriated funds for a fishwheel project. No work was conducted in the area from 1976 to 1978. A side scanning sonar unit and a multiple transducer sonar unit were placed in the river in 1979 for in-season escapement enumeration of sockeye salmon. Two side scanning sonar units (one 1977 and one 1979) have been operated since the 1980 season. Beginning in 1984, the Crescent River sonar project was moved to a site approximately one to two miles from the terminus of the river at Cook Inlet. Success of the project at the new site will determine whether additional enumeration activities at the Crescent Lake site are necessary. If it appears that this is the case, enumeration equipment will be transferred to the upper site prior to entry of the run into Crescent Lake.

OBJECTIVES

The objectives of the Kenai, Kasilof, Susitna, Yentna and Crescent River drainage escapement projects in 1984 will be to determine:

1) the relative magnitude of escapement and migrational timing of sockeye salmon in the mainstem river;
2) the age, length, weight, sex, and scale characteristics of the sockeye salmon escapement; and
3) the magnitude, timing and distribution of adult sockeye salmon within established index areas (excluding Crescent River).

Additional objectives within the time frame of the sockeye salmon escapement project will be to determine:

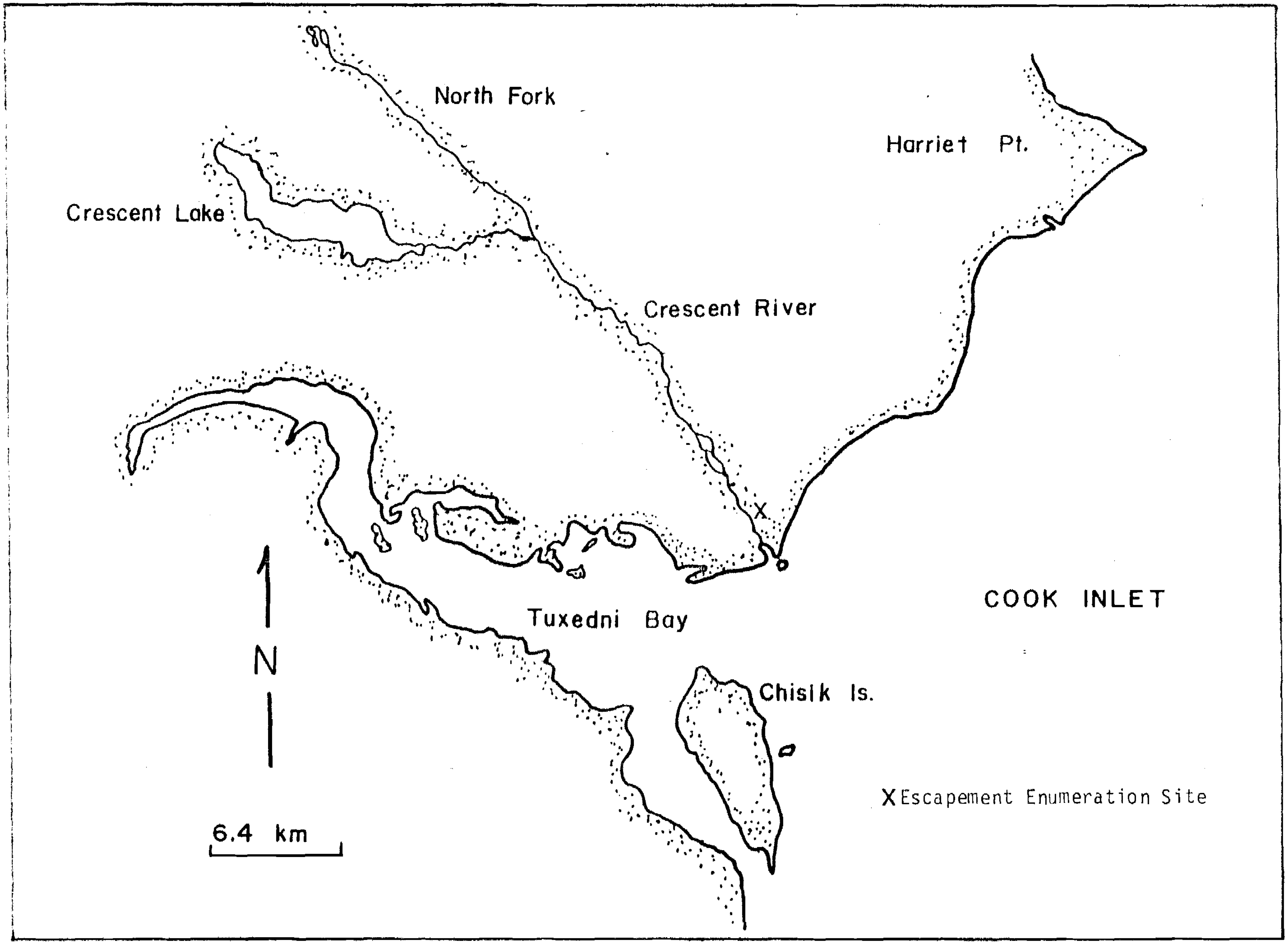


Figure 5. Crescent River drainage and major sockeye salmon rearing lake.

1) the relative magnitude of escapement of coho salmon, chum salmon, and pink salmon in the mainstem river; and
2) the age, length, weight, and sex characteristics of coho salmon, chum salmon, and pink salmon escapements.

PERSONNEL

During the 1985 season, supervision of projects will be the responsibility of the Research Section of the Division of Commercial Fisheries. Project supervisors will be Ken Tarbox and Bruce King. The crew will consist of four seasonal fishery biologists and eleven seasonal fishery technicians. The crews will be assisted in the field periodically by the project supervisors.

OPERATION DATES

Field activities for sonar enumeration will begin and end on the following dates:

Kenai River Sonar: 22 June to 8 August
Kasilof River Sonar: 10 June to 31 July
Crescent River Sonar: 16 June to 31 July
Susitna River Sonar: 1 July to 31 July
Yentna River Sonar: 1 July to 8 August

Index area escapement surveys for the Kenai, Kasilof and Susitna River drainages will occur between 1 August and 1 September.

METHODS

Two Bendix SSS counters will be employed at each of the sonar sites except Susitna Station. Procedures for deployment of the substrate and equipment operations are described in the Cook Inlet Field Operations Manual.

Sonar counters and transducers will be tested and monitored by Mr. Al Menin (Bendix Corporation engineer) and trained ADF&G personnel.

Counts of salmon crossing the substrate will be recorded on printer tape each hour of the day. The paper printouts will be removed from the counters and the counts tabulated on a separate form once each day. The accuracy of the counter will be monitored daily by hand tallying fish-related echos displayed on an oscilloscope. The ratio of visual counts to SSS counts will be used to derive a calibration factor. This calibration factor will then be used to adjust the fish swimming speed setting on the sonar counter.

Because the sockeye salmon run into each system differs in strength, entry pattern, and daily timing, different criteria for adequate monitoring are necessary for each sonar system. All sites will monitor a minimum of two hours per counter per day (four visits at one-half hour each) prior to the beginning of the peak of the run.

When the sonar counts begin to increase indicating the beginning of the peak, monitoring time at the Crescent and Kasilof River sites will increase to three hours per counter per day. The approximate dates during which increased monitoring will be conducted (based on historic average escapement dates for entry of 60% of the run) are as follows:

Kasilof River: 5 July - 21 July
Crescent River: 1 July - 24 July

These dates may be adjusted in-season at the discretion of the Project Leader. Monitoring time on the Kenai, Susitna and Yentna Rivers will be increased when sonar counts reach 500 per hour (12,000 per day) as follows:

1) a minimum of 100 visual oscilloscope counts per hour will be recorded and compared with SSS counts to determine counter accuracy;
2) if counts from the two sources differ by more than 20%, then the pulse repetition rate will be adjusted accordingly;
3) if results from monitoring indicate a change in pulse rate is necessary, then an additional 100 fish targets will be counted to assess the results of the change. This step will be repeated after each change in pulse rate;
4) as counts drop below the 500 per hour level, the monitoring level will return to a minimum of two hours per counter per bank.

Evaluation of hourly passage rate between 1979-1984 suggests definite trends in fish movement during different parts of the day at each site. Therefore, monitoring effort will be concentrated during those periods when most of the fish are moving. Monitoring schedules will be as follows:

Crescent River: 1200 - 1800 hours
Yentna River: 0800 - 2200 hours
Susitna River: 0800 - 2200 hours
Kenai River: 1600 - 0400 hours
Kasilof River: 0800 - 2200 hours

Fishwheels will be installed at all sites to assist in assessing migrational timing and relative abundance of salmon species, apportion sonar counts, and obtain escapement samples. All fish captured in the fishwheels will be enumerated by species and sampled according to methods and schedule provided in the Cook Inlet Field Operations Manual. Additional crewmembers will be provided to assist in obtaining samples during peak passage periods.

Radio or telephone contact will be maintained between sonar sites and Soldotna on a daily basis.

Index area escapement surveys will be conducted by staff personnel on the Kenai, Kasilof, and various Northern District minor river systems. Foot surveys will be conducted on the Kenai and Kasilof River drainages. Spawning areas to be surveyed are listed in Table 1. A minimum of two survey rounds will be conducted in each area.

Table 1. Upper Cook Inlet sockeye salmon escapement index areas.

Susitna River Drainage	Kenai River Drainage	Kasilof River Drainage	Northern District Minor System
Byers Lake	Railroad Creek	Nikolai Creek	Fish Creek (Big Lake) 1/
Talachulitna River	Johnson Creek	Crystal Creek	Nancy Lake
Trinity-Movie Lakes	Carter-Moose Creek	Clear Creek	Coal Creek (Beluga River)
Shell Lake	Ptarmigan Creek	Glacier Flat Creek 1/	Cottonwood Creek
Hewitt-Whiskey Lakes	Tern (Mud) Lake	Seepage Creek	
Red Salmon Lake	Quartz Creek 1/	Moose Creek	
Puntilla Lake	Lower Russian River	Bear Creek 1/	
West Fork Yentna River	Hidden Lake 1/		
Chelatna Lake			
Fish Lake			
Clear Creek			
Stephan-Murder Lakes			
Larson Lake 1/			
Swan Lake			
Red Shirt Lake			

1/ F.R.E.D. Division weir counts.

STATE OF ALASKA

STANDARD AGREEMENT FORM
FOR PROFESSIONAL SERVICES CONTRACT

State Contract No.	
Contract Type	
Encumbrance Reference No.	
Contract Authority No.	86-0017

This contract is between the State of Alaska,

Department of: Fish and Game, Division of Commercial Fisheries — *hereafter, the State, and*

Contractor: BioSonics, Inc. — *hereafter, the Contractor*

Mailing Address (Street or P.O. Box)	City	State	Zip Code
4520 Union Bay Pl NE	Seattle,	WA	98105

ARTICLE 1. Appendices: Appendices referred to in this contract and attached to it are considered part of it.

ARTICLE 2. Performance of Services:

2.1. Appendix A (General Provisions), Articles 1 through 14, governs the performance of services under this contract.

2.2. Appendix B sets forth the liability and insurance provisions of this contract.

2.3. Appendix C sets forth the services to be performed by the contractor.

ARTICLE 3. Period of Performance: The period of performance this contract begins July 15, , 19 85 , and ends December 20 , 19 85 . Performance may be extended for additional periods by the written agreement of the parties.

ARTICLE 4. Consideration:

4.1. In full consideration of the Contractor's performance under this contract, the State shall pay the Contractor a sum not to exceed $ 63,647 in accordance with the provisions of Appendix D.

4.2. When billing the State, the Contractor shall refer to the State Contract Number and send the billing to:

Department of	Attn: Division of
Fish and Game	Commercial Fisheries

Mailing Address: Box 3-2000 Juneau, AK 99802

CONTRACTOR SNE91-1034706	STATE
Name of Firm: BioSonics, Inc.	Department or Agency/Division: Fish and Game / Div. of Commercial Fisheries
Signature of Authorized Representative:	Signature of Project Director: [signature]
Typed or Printed Name of Authorized Representative:	Typed or Printed Name of Project Director: David Gaudet
Title:	Title: Sonar Coordinator

APPROVAL BY THE CONTRACTING AGENCY	APPROVAL BY THE DEPARTMENT OF ADMINISTRATION
NOTICE! This certifies availability of funds. 11-40-1-962 (57,000) 11-40-1-954 (6,647)	
Signature of Head of Contracting Agency or Designee:	
Typed or Printed Name of Authorizing Official:	
Title:	
Date:	

NOTICE! This contract has no effect except as an offer by the Contractor until it is approved by the Department of Administration.

APPENDIX A
GENERAL PROVISIONS

Article 1. Definitions.

1.1. In this contract and appendices, "Project Director" means the person who signs this contract on behalf of the Department and includes a successor or authorized representative.

1.2. "Department" means the agency for which this contract is to be performed and for which the Project Director is acting in signing this contract.

Article 2. Inspection and Reports.

2.1. The Department may inspect, in the manner and at reasonable times it considers appropriate, all the Contractor's facilities and activities under this contract.

2.2. The Contractor shall make progress and other reports in the manner and at the times the Department reasonably requires.

APPENDIX C

In order to achieve a quantitative description of the horizontal and vertical distribution of migrating salmon in the Susitna River the contractor will provide 4 field technicians for to be stationed at the Alaska Department of Fish and Game Field Camp at Susitna Station and provide them with two complte hydroacoustic systems and all necessary support instrumentation and supplies to perform data acquistion. Data collection will begin on July 20, 1985 or later if requested by ADF+G personnell, and continue for 20 days.

During this time, the contractor will implement the following sampling strategy:

a. section the horizontal distance (at the high water marks) of the river into 10 segments with six, 200 ft. segments (3 on each bank) beginning at the high water mark on either bank. The remaining midriver distance will be divided into 4 equal parts.

b. partition the 20 day data collection period into 20, 24 hour periods with each period consisting of 2 ten hour periods (beginning and ending times to be determined by consultation with ADFG staff). Each of the 10 segments will be sampled during each 10 hour period. Two 30 minute samples will be collected in the nearest inshore segment on each bank while one 30 minute sample will be collected in each of the 8 remaining segments. A sampling period will be extended 15 minutes when less than 20 fish are observed. The location of each sample will be randomly located in each segment.

c. within each segment, transducers will be aimed vertically such that position in the water column can be determined along with upstream or downstream movement. When water depth is less than 4 ft., transducers will be oriented horizontally and depth information collected by varying the horizontal aiming angle, as feasible

Postseason, the contractor will process data in order to record:

a. time of detection

b. range at first detection

c. range at last detection

d. target strength as determined by dual beam recordings

The contractor will also analyze data according to 4 day groupings in order to determine:

a. the number of fish passing through each segment per unit time

b. the vertical distribution in each segment

c. basic statistics of distributions for each segment

The contractor will provide a draft report to ADFG for review no later than

November 18, 1985 with a final report to follow no later than December 20 including;

a. a summary by sampling station of the horizontal and vertical distribution of migrants over the field season. A minimum of 4 summaries will be prepared with one each for combinations of upstream and downstream migrants with periods of high and low passage rates.

b. summaries by 4 day periods of horizontal and vertical distribution of migrants over the total field season by direction of movement and time of day.

c. other summaries as requested by ADFG and agreed through mutual consent.

Alaska Department of Fish and Game will provide the following:

1. round trip transportation of personneil and equipment from Anchorage to Susitna Station

2. boats, motors and gasoline at Susitna Station

3. food and lodging at the Susitna Station (estimated cost to ADF+G is $1,200)

APPENDIX D

1. The total amount of this contract shall not exceed $63,647.

2. Up to 20% of the total amount as stated in Appendix D, Article 1, may be withheld by the state as the final payment in order to insure the Contractor's complete performance of all terms as specified in Appendix C of this contract.

3. The Contractor shall submit a detailed billing including manhours worked and overhead charges upon satisfactory completion of the contract. The Department project representative as designated under Article 4.2 of this contract will approve the billings and forward same to the Director, Division of Administration, Department of Fish and Game for prompt payment.

4. The Contractor will be reimbursed for actual costs according to the following budget:

Project management and supervision	$3,449
Data acquistion technician labor	$19,792
Travel	$4,000
Equipment leases	$11,500
Expendable supplies	$5,000
Data reduction techician	$5,760
Data analysis	
Project leader	$10,883
Project technician	$1,200
Reporting	
Wordprocessing	$911
Technical editing	$1,152
TOTAL	$63,647

BioSonics™
BioSonics, Inc.
4520 Union Bay Place NE
Seattle, Washington 98105
(206) 627-0905

14 March 1985

Dave Gaudet
Alaska Dept. of Fish and Game
Commercial Fish Division
Box 3-2000
Juneau, AK 99802

Telephone * 907-465-4210
Telefax * 907-586-6595

Dear Dave,

Here's the detail sheets for the proposed project. If you have questions please try to catch me tomorrow since I'll be out of my office until friday of next week.

Sincerely,

Tom

Thomas J. Carlson

BioSonics™

DATE: 14 March 1985

TO: Dave Gaudet, Alaska Dept. of Fish and Game

FROM: Tom Carlson

SUBJECT: Detail for Project to Estimate the Horizontal and Vertical Distribution of Upstream Migrants in the Susitna River, Alaska Using Hydroacoustic Methods

DATA ACQUISITION

Crew, Boat and Hydroacoustic Instrumentation

A single boat will be used (I spoke with Ken Tarbox when I was in Soldotna. He described the various boats available. I believe that one of the existing project boats will be adequate with the addition of a canvas canopy to provide shelter to the instruments and crew. We will be able to purchase the canopy out of the project funds allocated for miscellaneous supply expenses.).

The crew will consist of four men working in two 10 hour shifts each day continuously through the 20 day data acquisition period. The two 10 hour periods will be selected in conference with ADF&G Suistina project management so that daily time periods of major interest are included. The crew will arrive at the project site four days before sampling is to begin to install the hydroacoustic equipment aboard the boat and to position the sampling stations marker buoys. The crew will spend one day after sampling has ended to remove the instrumentation from the boat and prepare it for shipment and to perform other camp breaking chores. The total time at the project site will be 25 days. It is assumed that food and lodging will be provided for the crew at no cost to the project budget while they are at the project site (i.e. they will be incorporated into the project camp and treated as other ADF&G employees at the camp). It is also assumed that ADF&G will provide transportation of the field crew to the project site from Anchorage at no additional cost to the project budget. BioSonics will provide air transportation of the crew to Anchorage from Seattle using project funds allocated for that purpose.

Two hydroacoustic systems and all necessary support instrumentation and supplies required to perform the data acquisition program to be described will be provided by BioSonics. A detailed list of this equipment including its demensions and weight will be provided to ADF&G personnel who are to arrange for transfer of the equipment from Anchorage to the project site during project planning. It is assumed that ADF&G will pay the round trip costs of shipping the equipment between the project site and Anchorage. BioSonics will make all arrangements necessary to ship the equipment to Anchorage and will pay for air freight from project funds allocated for that purpose.

BioSonics™

Sampling Strategy

The river cross section at or near the project site will be divided into ten segments (measured horizontally bank to bank). There will be three 200 foot wide segments as measured from the expected high water boundry for each bank. There will also be four segments of equal width that will include the total river width not included in the other six 200 foot segments.

It's expected that the majority of fish will pass within the first few hundred feet of the shore (i.e. that is, the distribution of fish across the river is not expected to be uniform but skewed toward shore). The exact nature of the distribution of upstream migrants across the river is not known, of course, or this study would not be necessary but experience by ADF&G personnel to date indicates that this is a reasonable assumption and need be included in the design of the study. In addition, it is the near shore environment most susceptiable to both short terms as well as long term changes due to erosion, change in river flows, etc. It is not unreasonable to expect that, given the probability of higher passage rates nearer shore, the short term instability of the nearshore environment (relative to mid river regions) and the unknown species specific behavioral tendencies for near shore versus off shore migration; that these first few hundred feet from shore will be locations where the behavior (i.e. vertical and horizontal distribution among other variables) of fish will be most variable and where the most sampling effort need be allocated to achieve sample sizes large enough to overcome (in a statistical sense) the effect of this higher variability.

In addition to those statistical arguments that could be made for allocation of more sampling effort nearshore, there is also the need to measure as accurately as possible the nearshore distribution of fish so that data acquired in the past by ADF&G and others using various hydroacoustic and nonhydroacoustic methods to estimate fish passage can be reevaluated. An essential estimate in this context is an estimate of the percentage of the total number of adult fish passing upstream and downstream that pass within 200 feet of shore.

The boundries of the segments will be marked with buoys held in place with anchors (The anchors will be weighted with chain and will be large enough to maintain their position even should the buoy ropes become fouled with debris.). In addition to boundry markers the buoys will serve as points to tie the boat during sampling. The location of the sampling station boundries will be determined using a positioning system.

The primary objective of the study is to estimate the horizontal and vertical distribution of upstream migrants passing through river mile 28. It's clear that the time and resources to achieve this objective are limited so bounds must be placed on the spacial and temporal resolution with which estimates of upstream migrant distribution are to be made. Resolution of the measurements to be made is the subject of the rest of this section.

Temporal considerations. The field season will consist of 20 days (more precisely twenty 24 hour periods) of sampling plus four days prior to sampling at the project site preparing the boat and instruments and one day after sampling ends to break the equipment down and prepare it for shipment back to Seattle. This 20 day sampling period will be divided into five 4 day segments.

BioSonics™

During each 24 hour period there will be two 10 hour sampling shifts. The assignment of the sampling shifts within the 24 hour periods will be made at the beginning of the field season after consultation with ADF&G personnel at the site. Ideally one 10 hour period will correspond to the time during each 24 hour period when passage rate is highest the other to when passage rate is lowest or to some other phenomon such as day/night periods which might effect the behavior of upstream migrants.

One of the primary products of the project will be ten estimates of the vertical and horizontal distribution of upstream migrants, one estimate corresponding to each 10 hour period within each 4 day sampling segment. Each of these estimates will be based on a sample size of 4 measurements, one measurement resulting from the sampling conducted each 10 hour period. Thus the planned temporal resolution of the measurements will be a single estimate of the vertical and horizontal distribution of upstream migrants each 96 hour period.

Special considerations. Individual samples will consist of the fish detected during standard observation periods each 30 minutes long. The standard observation period will be extended an additional 15 minutes if fewer than 20 fish are detected during the standard period.

During each 10 hour sampling shift each of the 10 sampling segments (stations) across the river will be sampled. Because of the importance of the near shore segments two samples will be taken in each of the two near shore segments and one sample will be taken in each of the remaining 8 segments for a total of twelve 30 minute standard observation periods each sampling shift. The location of each sample will be randomly selected within each segment.

Transducer orientations. The standard sampling methodology will be to use vertically aimed transducers. The vertical aiming angle will be selected to optomize the detection of migrants while permitting determination of their direction of travel (i.e. upstream or downstream) and location in the water column, which is necessary data for estimation of vertical distribution. The exception to this standard will be the near shore region where water depths are less than 4 feet. In these regions horizontally aimed transducers will be used. The orientation of the horizontally aimed transducers will not necessarily be restricted to a shore outward orientation. Other orientations that have proven to be very effective in similar situations such as upstream or downstream orientations will also be used to optomize fish detection and determination of fish direction of movement.

In locations where water depth will not permit vertical orientation of transducers, the location of migrants within the water column cannot be determined and thus vertical distribution cannot be estimated.

BioSonics™

DATA PROCESSING, ANALYSIS AND REPORT PREPARATION

Data Processing

Data will be acquired in two forms, as echograms and as tape recordings.

The primary data form will be echograms. Echograms will be processed by digitization using a computer and bit pad. For each fish detection the following data will be recovered from the echogram record: 1) time of detection, 2) range at first detection, 3) range at last detection and 4) sampling station. This data will permit estimation of the direction of travel of the detected fish, the fish's location in the water column and will place the fish in the river and in time.

Only dual beam echo returns will be tape recorded (excluding the possibility of chart recorder failure). These records will be processed to obtain mean target strength estimates of detected fish. Additional processing may be undertaken to produce measures similar to those obtained during echogram processing.

Data Analysis

The primary statistic to be estimated from each sample is the flux of fish (number of fish passing through the total ensonified volume per unit time) through each station. A basic assumption is that the flux of fish through the total volume ensonified by the transducers used for sampling is a good estimate of the flux through the sampled segment as a whole (i.e. an assumption of uniform distribution of fish flux through each segment).

The first stage of analysis will be to compute estimates of fish flux and vertical distribution from each sample. These estimates will be grouped according to the scheme presented earlier and estimates of mean flux and mean vertical distribution for 4 day long periods will be computed. The mean estimates and associated statistical measures of dispersion will provide a basic data base for further analysis of differences between periods within days and over the course of the field season. However, since this project has been designed primarily to provide estimates of migrant distribution and no specific hypotheses have been stated, extensive analysis of data more appropriate to hypotheses testing will not be undertaken.

Estimates of mean single fish target strength will be analysed to evaluate the use of such measurements as elements of a method to classify fish echoes.

Report Preparation

Data reduction and analysis will be conducted immediately following data acquisition. A draft report will be submitted for review on November 18. A final report will be submitted by December 20 after approximately 2 weeks of review of the draft report by ADF&G.

A major portion of the report will be presentation of the data acquired during the project. The data will also be stored in files written in IBM format on floppy disks. Copies of the disks and a description of the data file structure will accompany the final report.

BioSonics™

The rest of the report will consist of presentation of the analysis of the vertical and horizontal distribution of migrants passing through river mile 28. Definite results to be presented will be:

1. A summary by sampling station of the horizontal and vertical distribution of migrants over the total field season. At least 4 summaries will be prepared one each for combinations of upstream and downstream migrants with periods of high and low passage rate.

2. Summaries by 4 day periods of the horizontal and vertical distribution of migrants over the total field season. This will result in 20 data tables grouped according to the direction of migrant movement and time of day (i.e. passage rate period).

3. Other summaries determined during the project as desireable or requested by ADF&G.

No attempt will be made to extrapolate the results of this study to previous or current ADF&G studies of migrant passage or to interpert the results of this study in the context of the results of such studies.

B-2 Middle River Salmon Escapement

EXECUTIVE SUMMARY

Project Title: Susitna River Adult Salmon Investigations (1981-1985)

Project Supervisor: Larry Bartlett

Task Manager: Mike Thompson

FY 86 Allocation: 335.7K

Spent To Date: Unavailable.

Problem Statement:

Anadromous fish utilizing the lower and middle Susitna River are one facet of the fisheries resource that may be impacted from operation of proposed hydroelectric development at Devil and Watana canyons. Because of this potential impact, the Alaska Power Authority has contracted the Alaska Department of Fish and Game (ADF&G) to provide a baseline data base on the escapement of anadromous fish to the middle and to a lesser extent, the lower river reaches.

Objectives:

1. Determine the abundance of sockeye, pink, chum, and coho salmon at Flathorn (1984-85), Yentna (1981-84), Sunshine (1981-85), Talkeetna (1981-84), and Curry (1981-85) stations. Also, determine the abundance of chinook salmon at Flathorn (1985), Sunshine (1982-85), Talkeetna (1982-84), and Curry (1982-85) stations.

2. Evaluate migrational timing and migrational characteristics (rates of travel and bank/channel preference) of adult salmon at stations operated from 1981-85.

3. Monitor the age, length, and sex composition of the adult salmon escapements at the locations and years defined in objective 1.

4. Assess the extent of adult salmon spawning in middle river side channel, main channel, slough and tributary habitats (1981-85).

5. Assess the extent of adult salmon spawning in lower river main channel, side channel, slough (1981-84, except 1983) and tributary stream mouths (1984-85) habitats.

6. Determine the timing, age, length, and sex characteristics and spawning areas of eulachon in the Susitna River (1982-83).

Overview of Methods:

Salmon escapements were enumerated using either a modified Petersen estimator or Bendix side scan sonar. The Petersen estimate was derived using the tagged to untagged ratios of salmon captured in fishwheels and from spawning ground surveys. The number of tags deployed was adjusted for tag loss prior to calculating population estimates. The Bendix sonars were 1980 models and had an effective counting range (with substrate) of up to 60 feet. All sonar counts were apportioned to species using fishwheel catch composition.

Migrational timing and characteristics (bank/channel preference and travel rates) were determined from fishwheel catch per unit effort information and recapture of previously tagged fish.

Age, length, and sex composition were assessed from a subsample of the fishwheel catch. Standard sampling procedures were employed.

Location, timing, and extent of salmon spawning in slough, side channel, main channel, and tributary habitats were determined using data collected from foot and helicopter surveys.

Conclusions:

All presented conclusions are a very brief synopsis of findings presented in 1981-84 Su Hydro, Adult Anadromous reports. Therefore, stated conclusions relate specifically to the years of study.

1. Population estimates by location and year:

ESCAPEMENT BY SPECIES AND SAMPLING LOCATIONS FOR 1981-1984

SAMPLING LOCATION	YEAR	ESCAPEMENT					
		CHINOOK	SOCKEYE 2/	PINK	CHUM	COHO	TOTAL
Flathorn Station	1984	3/	605,800	3,629,900	812,700	190,100	5,238,500
Yentna Station	1981		139,400	36,100	19,800	17,000	212,300
	1982		113,800	447,300	27,800	34,100	623,00
	1983		104,400	60,700	10,800	8,900	184,800
	1984		149,400	369,300	26,500	18,200	563,400
Sunshine Station	1981	3/	133,500	49,500	262,900	19,800	465,700
	1982	52,900	151,500	443,200	430,400	45,700	1,123,700
	1983	90,100	71,500	40,500	265,800	15,200	483,100
	1984	121,700	130,100	1,017,000	765,000	94,700	2,128,500
Talkeetna Station	1981	3/	4,800	2,300	20,800	3,300	31,200
	1982	10,900	3,100	73,000	49,100	5,100	141,200
	1983	14,400	4,200	9,500	50,400	2,400	80,900
	1984	24,800	13,100	177,900	98,200	11,800	325,800
Curry Station	1981	3/	2,800	1,000	13,100	1,100	18,000
	1982	11,300	1,300	58,800	29,400	2,400	103,200
	1983	9,700	1,900	5,500	21,100	800	39,000
	1984	18,000	3,600	116,900	49,300	2,200	190,000

1/ Escapement estimates were derived from tag/recapture population estimates except Yentna Station escapements which were obtained using side scan sonar.

2/ Second-run sockeye salmon escapements only.

3/ Chinook salmon were not monitored for escapement.

2. Migration timing and rates:

Adult salmon occupied the middle river from mid-June through mid-September based on fishwheel catches. Specifically, each species were present as follows:

Chinook	mid-June to mid-July
Sockeye	mid-July to end of August
Pink	last of July to mid-August
Chum	mid-July to end of August
Coho	last of July to mid-September

There was a behavioral trend, exhibited by all species, to increase their travel rate as they progressed beyond the three rivers confluence (Susitna, Chulitna, and Talkeetna). This trend was attributed to milling in the confluence area.

3. Spawning:

Chinook salmon spawned exclusively in tributary habitats in the middle river. Peak spawning generally occurred during the last week of July and first week of August. Chinook have been documented in four tributaries above the proposed Devil Canyon dam site.

Second-run sockeye spawned primarily in middle river slough habitats. Minor spawning has been noted in main channel areas (1983-1984). Peak spawning in sloughs has occurred between the first and third weeks of September.

Pink salmon, like chinook, spawned almost exclusively in middle river tributaries. They spawned in sloughs to a limited extent, while the main channel was not used for spawning. Peak spawning in tributaries has occurred during mid-August.

Chum salmon spawn in middle river main channel, slough, and tributary habitats. Spawning in sloughs reaches a peak during the first week of September, one or two weeks later than peak spawning in tributaries.

Coho spawn primarily in middle river tributary streams. Peak spawning occurred during the last two weeks of September.

4. Eulachon:

Eulachon entered the Susitna River in two distinct runs (1982-83). In 1982, the first migration passed through the intertidal reach (RM 0-7) after ice breakup, in late May (May 16-30). A second migration followed in early June (June 1-8). In1983, the first migration occurred in mid-May (May 10-17) followed by a second migration in mid-May and early June (May 19-June 6).

The upper distance of eulachon migration in the Susitna River was about 50 miles in 1982 and 1983. The first migration reached RM 40.5 in 1982 and RM 28.5 in 1983. The second migration reached RM 48.5 and 50.5 in 1982 and 1983, respectively. The largest concentrations of first and second migration eulachon in both years remained in the initial 29 miles of the Susitna River main channel.

Recommendations:

1. Refine the existing tag/recapture model to a form which stratifies tag deployment into several time intervals. This will allow seasonal variation in gear efficiency to be addressed.

2. Review alternative methods to assess stock characteristics (age, length, and sex composition). Presently, all reported characteristics are subject to fishwheel selectivity bias.

3. Develop a method to accurately assess milling at population estimate sites.

OPERATION PLAN

Adult Salmon Escapement

Division of Commercial Fisheries
Susitna Aquatic Studies
Anchorage, Alaska

Prepared by Mike Thompson
September 1985

I. Problem Statement

Anadromous fish utilizing the lower and the middle Susitna River are one facet of the fisheries resource that may be impacted from operation of the proposed hydroelectric development at Devil and Watana canyons. Because of this potential impact, the Alaska Power Authority has contracted the Alaska Department of Fish and Game (ADF&G) to provide a baseline data base on the escapement of anadromous fish to the middle and to a lesser extent, the lower river reaches.

A. Scope:

Adult salmon captured with fishwheels were tagged and released at Flathorn, Sunshine, and Curry stations (Figure 1). Tag recovery and spawning ground surveys were conducted in all middle river sloughs and streams and to a limited extent in lower river sloughs and streams. Population estimates were derived by the Petersen method. Tag recoveries were also used to evaluate migrational timing between fishwheel sites. The adult salmon escapement composition of age, length and sex was determined from a sub-sample of the fishwheel catch.

B. Objectives:

1. Determine the abundance of sockeye, pink, chum, and coho salmon at Flathorn (1984-85), Yentna (1981-84), Sunshine (1981-85), Talkeetna (1981-84), and Curry (1981-85) stations. Also, determine the abundance of chinook salmon at Flathorn (1985), Sunshine (1982-85), Talkeetna (1982-84), and Curry (1982-85) stations.

2. Evaluate migrational timing and migrational characteristics (rates of travel and bank/channel preference) of adult salmon at stations operated from 1981-85.

3. Monitor the age, length, and sex composition of the adult salmon escapements at the locations and years defined in objective 1.

4. Assess the extent of adult salmon spawning in middle river side channel, main channel, slough and tributary habitats (1981-85).

5. Assess the extent of adult salmon spawning in lower river main channel, side channel, slough (1981-84, except 1983) and tributary stream mouth (1984-85) habitats.

6. Determine the timing, age, length, and sex characteristics and spawning areas of eulachon in the Susitna River (1982-83).

C. Justification:

In the event of hydroelectric construction on the Susitna River, a fisheries baseline data base will be necessary to develop a long-term monitoring program and to make specific recommendations concerning possible mitigation.

II. Project Narrative

A. Duration:

1. Adult salmon escapement monitoring stations were operated as follows:

Flathorn Station (RM 22)	May 25 - September 3
Sunshine Station (RM 80)	June 4 - September 10
Curry Station (RM 120)	June 10 - September 12

2. Lower river tag recovery surveys began July 5 and will end October 7.

3. Middle river tag recovery and escapement surveys began July 15 and will end October 15.

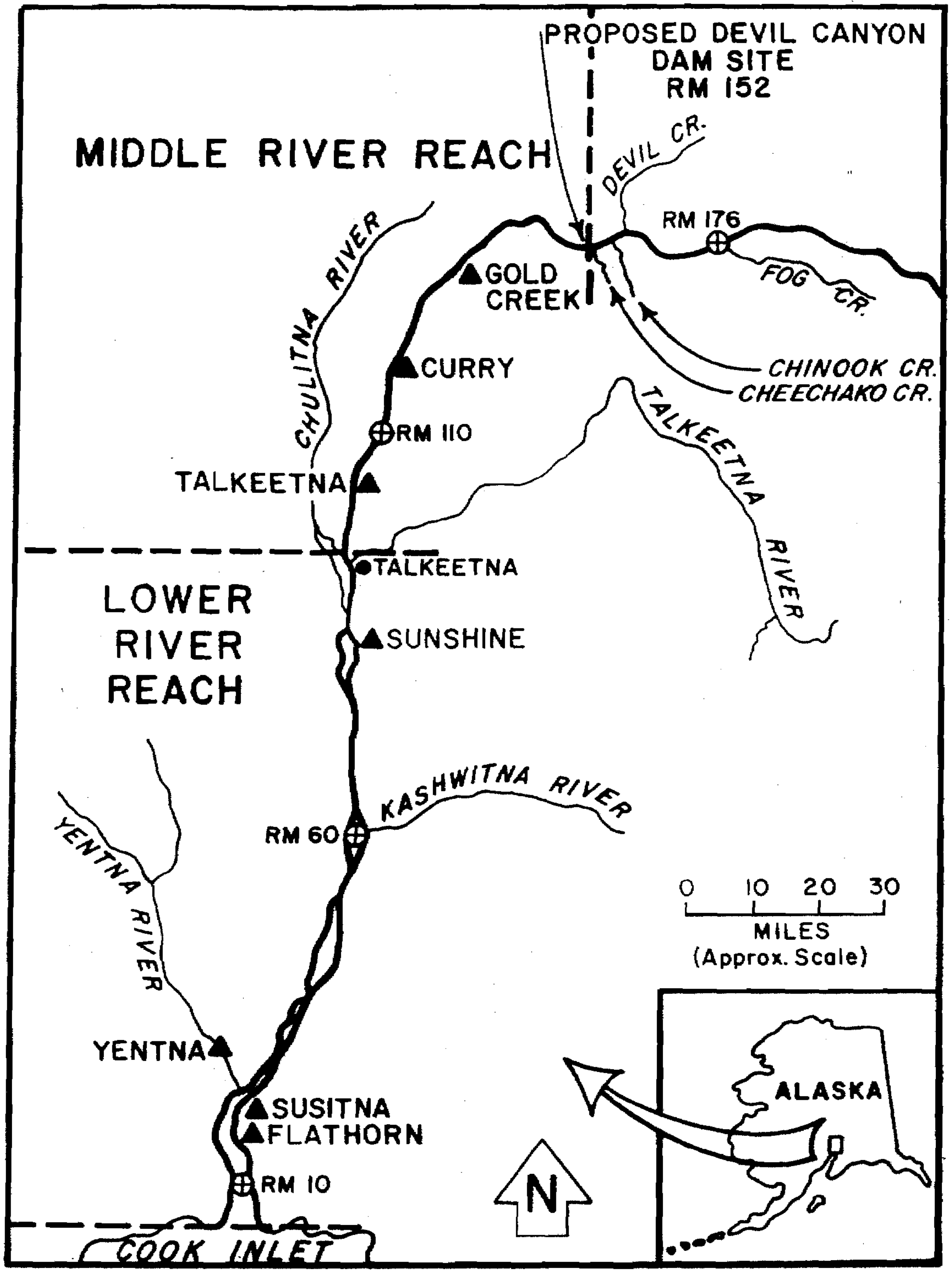
B. Location:

1. Escapement monitoring locations are presented in Figure 1.

2. Lower river tag recovery survey schedules:

Table 1. Lower river general salmon escapement survey schedule.

STREAM	RIVER MILE	SURVEY PERIOD	FREQUENCY	METHOD	DISTANCE
Noname Creek	27.8	7/5-10/7	Weekly	Foot	1/3 mile
Fish Creek	31.2	7/5-10/7	Weekly	Foot	1/3 mile
Whitsol Creek	35.2	7/5-10/7	Weekly	Foot	1/3 mile
Rolly Creek	39.0	7/5-10/7	Weekly	Foot	1/3 mile
Willow Creek	49.1	7/5-10/7	Weekly	Foot	1/3 mile
Little Willow Creek	50.5	7/5-10/7	Weekly	Foot	1/3 mile
Grays Creek	59.5	7/5-10/7	Weekly	Foot	1/3 mile
Kashwitna River	61.0	7/5-10/7	Weekly	Foot	1/3 mile
Caswell Creek	64.0	7/5-10/7	Weekly	Foot	1/3 mile
Sheep Creek	66.1	7/5-10/7	Weekly	Foot	1/3 mile
Goose Creek	72.0	7/5-10/7	Weekly	Foot	1/3 mile
Montana Creek	77.0	7/5-10/7	Weekly	Foot	1/3 mile
Rabideux Creek	83.1	7/5-10/7	Weekly	Foot	1/3 mile
Sunshine Creek	85.1	7/5-10/7	Weekly	Foot	1/3 mile
Birch Creek	89.2	7/5-10/7	Weekly	Foot	1/3 mile
Trapper Creek	91.5	7/5-10/7	Weekly	Foot	1/3 mile
Cache Creek	95.5	7/5-10/7	Weekly	Foot	1/3 mile



PROPOSED DEVIL CANYON
DAM SITE
RM 152
MIDDLE RIVER REACH
DEVIL CR.
RM 176
FOG CR.
CHULITNA RIVER
GOLD CREEK
CURRY
CHINOOK CR.
CHEECHAKO CR.
RM 110
TALKEETNA RIVER
TALKEETNA
TALKEETNA
LOWER RIVER REACH
SUNSHINE
KASHWITNA RIVER
RM 60
YENTNA RIVER
0 10 20 30
MILES
(Approx. Scale)
YENTNA
SUSITNA
FLATHORN
ALASKA
RM 10
N
COOK INLET

Table 2. Specific lower river chinook salmon tag recovery survey schedule.

STREAM	RIVER MILE	SURVEY PERIOD	FREQUENCY	METHOD	DISTANCE
Alexander Creek	10.1	7/15-8/5	Once Min.	Boat	Field Selected
Talchulitna Creek	28.0	7/20-8/5	Once Min.	Boat	Field Selected
Lake Creek	28.0	7/15-8/5	Once Min.	Boat	Field Selected
Deshka River	40.6	7/20-8/5	Once Min.	Raft	Field Selected
Rabideaux Creek	83.1	7/20-8/5	Once Min.	Canoe	Field Selected
Clear Creek	97.1	7/15-8/1	Once Min.	Helicopter	Field Selected
Prairie Creek	97.1	7/15-8/1	Twice Min.	Foot	Field Selected
Troublesome Creek	97.8	7/20-8/5	Once Min.	Foot	Field Selected
Byers Creek	97.8	7/20-8/5	Once Min.	Foot	Field Selected
Middle Fork Chulitna River	97.8	7/20-8/5	Twice Min.	Raft	Field Selected

3. Middle river tag recovery and escapement survey schedules:

Table 3. General salmon escapement survey schedule above river mile 97.1.

STREAM	RIVER MILE	SURVEY PERIOD	FREQUENCY	METHOD	DISTANCE
Fish Creek	97.1	8/10-8/25	Twice	Foot	Field Selected
Larson Creek	97.1	8/11-8/10	Once	Foot	Field Selected
Byers Creek	97.8	8/10-8/15	Once	Foot	Field Selected
Unnamed Tributary to Tokositna	97.8	8/1-8/10	Once	Foot	Field Selected
Troublesome Creek	97.8	9/5-9/15	Once	Foot	Field Selected
Byers Creek	97.8	9/5-9/20	Once	Foot	Field Selected
All Sloughs	98.6-161.0	8/6-10/7	Weekly	Foot	Entire
Whiskers Creek	101.4	8/6-10/7	Weekly	Foot	0.5
Chase Creek	106.4	8/8-10/7	Weekly	Foot	0.75
Slash Creek	106.9	8/8-10/7	Weekly	Foot	0.25
Gash Creek	11.6	8/8-10/8	Weekly	Foot	1.0
Lane Creek	113.6	8/8-10/7	Weekly	Foot	0.5
Lower McKenzie Creek	116.2	8/8-10/7	Weekly	Foot	0.25
McKenzie Creek	116.7	8/8-10/7	Weekly	Foot	0.25
Little Portage Creek	117.7	8/8-10/7	Weekly	Foot	0.25
Deadhorse Creek	120.9	8/8-10/7	Weekly	Foot	0.25
Fifth of July Creek	123.7	8/8-10/7	Weekly	Foot	0.25
Skull Creek	124.7	8/8-10/7	Weekly	Foot	0.25
Sherman Creek	130.8	8/8-10/7	Weekly	Foot	0.25
Fourth of July Creek	131.1	8/8-10/7	Weekly	Foot	0.25
Gold Creek	136.7	8/8-10/7	Weekly	Foot	0.25
Indian River	138.6	8/8-10/7	Weekly	Foot	1.0
	138.6	8/8-10/7	Weekly	Helicopter	Upper Spawning Limit
Jack Long Creek	144.5	8/8-10/7	Weekly	Foot	0.25
Portage Creek	148.9	8/8-10/7	Weekly	Foot	0.25
	148.9	8/8-10/7	Weekly	Helicopter	Upper Spawning Limit
Cheechako Creek	152.4	8/8-10/7	Weekly	Helicopter	1.0
Chinook Creek	157.0	8/8-10/7	Weekly	Helicopter	1.5
Devil Creek	161.0	8/8-10/7	Weekly	Helicopter	1.0

Table 4. Chinook salmon escapement and tag recovery survey schedule.

STREAM	RIVER MILE	SURVEY PERIOD	FREQUENCY	METHOD	DISTANCE
Whiskers Creek	101.4	7/15-8/5	Twice	Foot	0.5 Mile
Chase Creek	106.9	7/15-8/5	Once	Foot	1 Mile
Lane Creek	113.6	7/15-8/5	Twice	Foot	Upper Spawning Limit
Fifth of July Creek	123.7	7/15-8/5	Twice	Foot	Upper Spawning Limit
Sherman Creek	130.8	7/15-8/5	Twice	Foot	Upper Spawning Limit
Fourth of July Creek	131.1	7/15-8/5	Twice	Foot	Upper Spawning Limit
Gold Creek	136.7	7/15-8/5	Twice	Foot or Helicopter	Upper Spawning Limit
Indian River	138.9	7/15-8/15	Four	Foot	1 Mile
Portage Creek	148.9	7/15-8/15	Four	Foot	0.25 Mile
Cheechako Creek	152.4	7/15-8/5	Twice	Helicopter	Upper Spawning Limit
Chinook Creek	157.0	7/15-8/5	Twice	Helicopter	Upper Spawning Limit
Devil Creek	161.0	7/15-8/5	Twice	Helicopter	Upper Spawning Limit

C. Personnel:

Project Leader:	1 Fishery Biologist III
Task Manager:	1 Fishery Biologist II
Flathorn Station:	6 Fishery Technician II's
Sunshine Station:	9 Fishery Technician II's
Curry Station:	1 Fishery Biologist I & 1 Fishery Technician II
Lower river survey:	2 Fishery Biologist I's
Middle river survey:	1 Fishery Biologist I & 1 Fishery Technician II

D. Discussion of Assumptions:

Tag/Recapture and Sonar

This project has had the unique opportunity to evaluate tag/recapture and sonar as methods of population enumeration at the same site in the same year. The tag/recapture projects used the modified Petersen estimator and the sonars were 1980 model Bendix side scan units.

There were discrepancies between population estimates from sonar versus estimates from the tag/recapture project. Both estimates have inherent deficiencies. It should not be assumed that all fish pass over the sonar substrate. The sector distribution of salmon will vary with site and species, with an undetermined number of salmon passing beyond the counting range. A major source of error present in sonar counts is related to the methods of apportionment and the bias inherent in those methods. Although all fishwheels used to apportion counts were in close proximity to the counters, it must be recognized that fishwheels are species selective. The apportioned sonar counts would then reflect the selected catchability of the fishwheel. In addition, sonar counters are adjusted for fish velocity and sensitivity, thereby introducing an unknown variance component into the counts.

Tag/recapture methods of estimating the population and the Petersen estimate in particular make six assumptions. Failure to meet these assumptions will bias the population estimate and consequently the confidence intervals. The following assumptions were made in estimating population size:

1. Fishwheel capture of salmon was random with respect to the population.

2. There was no mortality as a result of the tagging process.

3. There was no differential mortality between tagged and untagged salmon.

4. Tagged salmon mixed randomly within the population.

5. Recovery of tagged salmon was not influenced by the tag.

6. There was no unknown tag loss.

In summary, both methods of enumerating salmon have potential drawbacks but at this point, they represent the state of the art in estimating population sizes in glacial river systems. The discrepancies, where they exist, between Petersen and sonar population estimates reflect the limitations inherent in both techniques.

E. <u>Procedures</u>:

1. Tagging Operation

Fishwheels were operated for tag/recapture at all main channel monitoring stations. At Flathorn Station, six fishwheels were operated for the duration of the chinook salmon escapement period, approximately May 25 through July 1, and four for the remainder of the season. Two fishwheels were deployed on each side the Susitna River at Sunshine Station and a single fishwheel offshore of each bank at Curry Station.

Fishwheels were operated on a continuous 24 hour basis. Exceptions were during periods of high flows when fishwheels were not operated for safety reasons and during periods of peak catches when fishwheels were stopped for four hours from 4:00 a.m. to 6:00 a.m. and 4:00 p.m. to 6:00 p.m.

Fishwheels were sampled for catch and checked for maintenance needs a minimum four times daily.

All adult salmon caught by fishwheels at Flathorn, Sunshine, and Curry stations were tagged and released except:

1. Fish that appeared lethargic or stressed.
2. Fish which were in post-spawning condition.
3. Chinook salmon less than 400 mm in length (FL) and sockeye, pink, chum, and coho salmon less than 300 mm in length.
4. Fish previously tagged at another tagging site.

These fish were released untagged.

The type of tag, color, and percent of each species tagged at Flathorn, Sunshine, and Curry stations are defined in Table 5.

Table 5. Tag type, color and percent of each species tagged at Flathorn, Sunshine, and Curry stations.

STATION	RIVER MILE	SPECIES	LENGTH	PERCENT OF CATCH TAGGED	TAG TYPE	TAG COLOR
Flathorn	22	Chinook	400 mm	0	-----	-----
		Chinook	400 mm	100	FT-4 Spaghetti	Yellow
		Sockeye	300 mm	100	FT-4 Spaghetti	Yellow
		Pink	300 mm	100	FT-4 Spaghetti	Yellow
		Chum	300 mm	100	FT-4 Spaghetti	Yellow
		Coho	300 mm	100	FT-4 Spaghetti	Yellow
Sunshine	80	Chinook	400 mm	0	-----	-----
		Chinook	400 mm	100	FT-4 Spaghetti	Orange
		Sockeye	300 mm	100	FT-4 Spaghetti	Orange
		Pink	300 mm	100	FT-4 Spaghetti	Orange
		Chum	300 mm	100	FT-4 Spaghetti	Orange/Blue
		Coho	300 mm	100	FT-4 Spaghetti	Orange
Curry	120	Chinook	400 mm	0	-----	-----
		Chinook	400 mm	100	1" dia. Petersen Disc	Orange
		Sockeye	300 mm	100	1" dia. Petersen Disc	Orange
		Pink	300 mm	100	1" dia. Petersen Disc	Orange
		Chum	300 mm	100	1" dia. Petersen Disc	Orange
		Coho	300 mm	100	1" dia. Petersen Disc	Orange

Special Tagging Instructions:

1. At Flathorn Station odd one thousand tag series (xxxx) were used for fish captured in west channel fishwheels and even one thousand tag series were used for fish captured in east channel fishwheels (note: 0-999 are considered even one thousand series).

2. Chinook salmon captured at Flathorn and Sunshine stations were tagged with 15 inch FT-4 spaghetti tags. All other species at these sites were tagged with 13.5 inch FT-4 spaghetti tags.

3. At Sunshine Station early run sockeye salmon (through approximately June 28) were tagged with blank FT-4 spaghetti tags

Fish recaptured from other tagging location were released with the original tag left in place following species identification and recording of tag type, color and number. All resident fish were identified to species and, if time allowed, tagged before being released.

2. Age, Length and Sex Composition Sampling

At Flathorn, Sunshine and Curry stations age, length and sex data were collected daily from 50 chinook, sockeye, pink, chum and coho. At Flathorn Station the 50 samples were divided such that 25 are from west channel fishwheels and 25 were from east channel fishwheels.

3. Surveys

Sloughs were surveyed in their entirety and streams to a distance previously defined in Tables 1-4. Surveyors wore polarized glasses and used hand held tally counters to enumerate live tagged and untagged salmon and carcasses.

Salmon spawning in main and side channel habitats was recorded on the Adult Anadromous Spawning Site Map form. Information recorded included date, river mile, geographic code, a map of the spawning site, number of fish and a general habitat description.

4. Eulachon

Eulachon timing and age, length and sex compositon were determined from set gillnet catches between river mile 3 and 5 on the Susitna River.

Spawning locations and the upper limits of migration were identified by electrofishing and hand-held dipnets.

F. Budget:

		LINE					
TASK	DESCRIPTION	100	200	300	400	500	TOTAL
4A	Middle River Escapement	55.4	0.2	7.5	14.8	0	77.9
5A	Sunshine Escapement	98.2	0.4	13.6	15.7	0	127.9
8A	Flathorn Escapement	101.6	1.4	8.9	18.0	0	129.9
	TOTAL	255.2	2.0	30.0	48.5	0	335.7

B-3 Middle River Outmigrant Evaluation

EXECUTIVE SUMMARY

Project Title: Susitna River Juvenile Salmon Outmigration Monitoring; Susitna Aquatic Studies, Tasks 4B, 5B, and 8B.

1. Task 4B: Middle River Outmigrant Monitoring

2. Task 5B: Sunshine Outmigrant Monitoring

3. Task 8B: Flathorn Outmigrant Monitoring

Project Supervisor: Larry Bartlett

Task Manager: Kent J. Roth

FY 86 Allocation:

Task 4B	257.1
Task 5B	36.1
Task 8B	85.1
TOTAL	378.3

Spent to Date: Not Available.

Problem Statement:

The hydroelectric development proposed for the Susitna River would alter the natural environmental conditions and subsequently would affect the incubation, emergence, and outmigration of juvenile salmon produced in the middle reach of the river (Talkeetna to Devil Canyon). We must determine the present regimes of seasonal juvenile salmon distribution and relative abundance in this reach, as well as the timing of outmigration and its response to naturally changing habitat conditions. These baseline data will assist to observe and mitigate dam-induced changes in the freshwater life history of middle river juvenile salmon.

Objectives:

1982

1. Estimate the timing, size, and relative abundance of the five species of juvenile salmon outmigrating past the Talkeetna Monitoring Station.

2. Estimate the affects of changes in mainstem Susitna River discharges and other environmental variables on juvenile salmon outmigration rates and timing.

3. Continue the data collection on the relative timing, abundance, and size of downstream migrating juvenile resident fish.

1983

4. Estimate the middle river population of emergent chum and sockeye salmon fry and their survival from egg to outmigrant fry.

1984 to Present

5. Continuation of objectives 1 through 4 and inclusion of objectives 1 through 3 at Flathorn Monitoring Station.

6. Estimate the timing, rate of movement, and population size of juvenile chinook and coho salmon outmigrating from Indian River.

7. Estimate the overwintering survival of juvenile chinook salmon in the middle river.

8. Estimate the horizontal distribution of juvenile salmon migrating past Flathorn Station.

Overview of Methods:

Minnow traps, beach seines, and backpack electroshockers provided initial data during 1981 to catalog and inventory the distribution and relation abundance of juvenile salmon in the Susitna River from Cook Inlet upstream to Devil Canyon. Outmigration studies were begun in 1982 with the deployment of an inclined plane trap at Talkeetna Station. A mark-recapture study was initiated in 1983 using one-half length coded wire tags to mark post-emergent chum and sockeye salmon fry, and a second outmigrant trap was deployed at Talkeetna Station which served as the primary recapture site. Cold branding of juvenile chinook and coho salmon in the middle river was begun in 1984, and a stationary and a mobile outmigrant trap were operated at Flathorn Station in the lower river. The collection equipment at Flathorn Station was improved during 1985 and the outmigrant programs are continuing.

Conclusions Drawn to Date:

Chinook Salmon

A significant percentage of middle river chinook salmon juveniles outmigrate from this reach as age 0+ fry. Peak downstream movement past Talkeetna Station occurs from late June through mid-August at a mean total length of approximately 55 millimeters (mm). The remaining chinook fry overwinter in the natal tributaries or in sloughs and side channels of the middle river, and then outmigrate as age 1+ fish during May and June at a mean length of approximately 90 mm. A portion of the outmigration of age 0+ fish occurs in response to changes in the mainstem discharge.

Coho Salmon

Juvenile coho salmon outmigration from the middle river is relatively continuous for all age classes through the open water season. Most coho juveniles enter the ocean as age 1+ or 2+ fish after rearing in tributary, side channel, slough, or beaver pond habitats.

Sockeye Salmon

Similar to chinook salmon juveniles, a large percentage of middle river sockeye outmigrate from this reach as age 0+ fish. Preliminary data indicates that many of these fish enter side channel habitats in the lower river to overwinter while some continue to the ocean as age 0+ smolts. Peak downstream movement of this age class past Talkeetna Station occurred from June through August. Coded wire tagging data showed that following emergence, sockeye fry grow approximately three millimeters each week until they reach a critical size of 50 to 55 mm. The juvenile sockeye which overwinter in the middle river outmigrate at a mean length of approximately 75 mm.

Information collected from the coded wire tagging program for sockeye salmon fry are presented in the following table.

SAMPLING SEASON	NO. OF FRY MARKED	NO. OF FRY CAPTURED	NO. OF MARKS RECAPTURED	POPULATION ESTIMATE	95% C.I.	SURVIVAL ESTIMATE	95% C.I.
1983	17,963	12,312	394	560,000	509,000 to 620,000	34.4	31.3 to 28.1
1984	14,532	7,484	366	299,000	268,000 to 328,000	21.9	19.6 to 24.0
1985*	11,436	5,082	189	306,000	266,000 to 353,000	9.3	8.1 to 10.8

* Through August 31, 1985 (Provisional)

Not a C.I.

Chum Salmon

Chum salmon outmigrate as age 0+ fish during the spring and summer with peaks observed during May and June, and the outmigration is virtually complete by the end of July. A portion of the chum fry outmigrate shortly after emergence while the other fry remain in the middle to rear for a few weeks before outmigrating. The peaks in chum salmon fry outmigration coincide with increasing mainstem discharge.

Population and survival estimates for middle river chum fry are presented in the following table.

SAMPLING SEASON	NO. OF FRY MARKED	NO. OF FRY CAPTURED	NO. OF MARKS RECAPTURED	POPULATION ESTIMATE	95% C.I.	SURVIVAL ESTIMATE	95% C.I.
1983	24,287	8,616	62	3,322,000	2,633,000 to 4,327,000	14.0	11.2 to 18.4
1984	31,396	3,590	51	2,039,000	1,845,000 to 2,414,000	16.0	14.8 to 19.4
1985*	13,341	8,126	34	3,098,000	2,236,000 to 4,426,000	12.0	8.7 to 17.2

* Provisional

Pink Salmon

Pink salmon outmigrate soon after emergence and the peak catches at Talkeetna Station occur during May and June.

General:

The methods presently being used to monitor middle river outmigration are very effective in collecting and marking juvenile salmon. Coded wire tagging has been shown by this program to be the most efficient method of marking large numbers of post-emergent sockeye and chum salmon fry while cold branding is very efficient in providing long-term marks on larger juvenile salmon. The inclined plane traps provide an effective method of capture for juvenile fish in a river system such as the Susitna River, and marked fish are randomly mixed with unmarked fish as they pass the recapture site.

Recommendations:

1. Continue the outmigrant programs being conducted in the middle river to provide the long-term data base on the timing and size of juvenile salmon outmigration in this reach.

2. Begin the operation of the mobile outmigrant trap at Talkeetna Station for comparison to the stationary trap data. The information collected in the mobile trap would also show the horizontal distribution of outmigrating fish as well as helping to more accurately define the timing and abundance of outmigrating chum and pink salmon fry and age 1+ fish. The mobile trap would also help to collect a larger percentage of marked chum fry resulting in tighter confidence intervals for the population estimates.

3. Develop a sampling design that would allow for the comparison of the stationary trap catch data to the mobile trap data to determine if it would be possible to provide the outmigration data by operating only the mobile trap. This comparative design would also assist in determining if a reduced sampling schedule would be sufficient to provide the outmigration data.

4. Monitor specific sites to quantify present spawning success at sites which would be affected by hydroelectric development.

5. Monitor specific sites to quantify present overwintering survival of rearing juvenile salmon to provide a data base for comparison to the construction and operation phases of development.

OPERATION PLAN

Susitna River Juvenile Salmon Outmigration

Division of Commercial Fisheries
Susitna Aquatic Studies
Anchorage, Alaska

Prepared by Kent J. Roth
September 1985

I. Problem Statement

   A. Scope

   B. Objectives

   C. Justification

II. Project Narrative

   A. Duration

   B. Location

   C. Personnel

   D. Assumptions

   E. Procedures

   F. Budget

   G. Literature Cited

I. Problem Statement

Determine the present regimes of juvenile salmon seasonal distribution and relative abundance in the Susitna River as well as the timing of outmigration and its response to naturally changing habitat conditions. This information is necessary to provide the baseline data to assist in observing and mitigating changes in the freshwater life history of middle river juvenile salmon resulting from the proposed hydroelectric development.

A. Scope:

Post-emergent chum and sockeye salmon fry were marked using 1/2 length coded wire tags, and juvenile chinook and coho salmon were marked using cold brands. Outmigrating fish were collected at the Talkeetna Station traps and all marked and unmarked fish were recorded. Population estimates were calculated using the Schaefer (1951) and Petersen (Ricker 1975) methods.

Population estimates for juvenile chinook and coho were also calculated using the Jolly-Seber method (Ricker 1975). Survival estimates were generated by comparing the population estimate to the calculated total potential egg deposition. Habitat timing, size, and growth data as well as environmental variables were collected at the outmigrant trapping sites monitored.

B. Objectives:

1982

1. Estimate the timing, size, and relative abundance of the five species of juvenile salmon outmigrating past the Talkeetna Monitoring Station.

2. Estimate the affects of changes in mainstem Susitna River discharges and other environmental variables on juvenile salmon outmigration rates and timing.

3. Continue the data collection on the relative timing, abundance, and size of downstream migrating juvenile resident fish.

1983

4. Estimate the middle river population of emergent chum and sockeye salmon fry and their survival from egg to outmigrant fry.

1984 to Present

5. Continuation of objectives 1 through 4 and inclusion of objectives 1 through 3 at Flathorn Monitoring Station.

6. Estimate the timing, rate of movement, and population size of juvenile chinook and coho salmon outmigrating from Indian River.

7. Estimate the overwintering survival of juvenile chinook salmon in the middle river.

8. Estimate the horizontal distribution of juvenile salmon migrating past Flathorn Station.

C. Justification:

A measurement of the current production of juvenile salmon in the Susitna River is necessary to assess potential impacts resulting from hydroelectric development. These data can also be used as a benchmark to compare to future project effects and for determining the mitigation required to protect the fisheries resources in areas impacted by this development.

II. Project Narrative

This narrative describes the 1985 field season.

A. Duration:

1. Post-emergent chum and sockeye salmon fry were marked with coded wire tags from breakup through late June.

2. Juvenile chinook and coho salmon were minnow trapped from late June through early October, and collected fish were marked with cold brands.

3. Outmigrant trapping was conducted through the open water period (mid-May through early October).

B. Location:

1. Coded wire tagging was conducted at Indian River and at sloughs where high density adult spawning was documented the previous fall.

2. Cold-branding was conducted at two sites in Portage Creek and four sites in Indian River.

3. Outmigrant trapping and mark recovery was conducted at Talkeetna Station (RM 103). Outmigrant trapping and horizontal distribution studies were conducted at Flathorn Station (RM 22).

C. Personnel:

Larry Bartlett (FB III) was the supervisor during the 1985 field season. Kent Roth (FB II) was the task manager in charge of the outmigrant studies. Gold Creek Station (coded wire tagging and cold-branding) was operated by one FB I (crew leader) and one Fishery Biologist (FB I) and two Fishery Technicians (FT II). Talkeetna Station outmigrant trapping was conducted by one to two FB I's and one to two FT II's. Flathorn Station outmigrant trapping was conducted by one FB II, one to four FB I's, and one to two FT II's.

D. Assumptions:

1. Neither mortality nor catchability varies between marked and unmarked fish.

2. Tag retention does not vary between tagging and recovery.

3. Marked fish are randomly distributed within the total outmigrant population at the point of recovery.

4. All marks were recognized and reported during recovery.

E. Procedures:

1. Coded Wire Tagging Operation

Binary coded one-half length wire tags were used in conjunction with adipose fin clips to field mark post-emergent sockeye and chum salmon fry.

Coded wire tagging operations were conducted at Slough 11 (RM 135.3) with equipment and personnel staged in a portable wall tent. Fish to be tagged were transported in an aerated holding tub from the various collection areas to the tagging site at Slough 11. The tagged fish were returned to the areas of collection, held overnight, and then released the following day.

The primary fisheries collection techniques were beach seines and weirs. One or more seines were set as weirs at fixed locations across the lower end of the sampling location and fished as necessary during the tagging period. The seines were made from 3/16 inch or 1/4 inch square mesh, four feet in depth and 25 to 40 feet in length. The weirs were checked periodically to collect fish and remove debris. All captured fish were removed by dipnet and placed in live boxes for holding until the tagging operation. Active beach seining supplemented the weirs at sites where weiring did not provide enough fish for the tagging operation, or at those sites at which weirs were not deployable.

The coded wire tagging equipment was leased from Northwest Marine Technology, Inc. (Shaw Island, Washington) and operated in accordance with the manufacturer's instruction and operation manual. The equipment used was the NMT, Model MK2A tagging unit and included the following:

--- Coded wire tag injector with 1/2 length tag capability
--- Quality Control Device (QCD)
--- Water pump
--- Portable power supply

The one-half length tag capability was necessary due to the small size of the fish to be tagged. Susitna River chum salmon emerge at a mean total length of 40 millimeters (mm) and averaging 1,500 fish per pound, while sockeye salmon were observed emerging at a mean total length of 32 mm and averaging approximately 3,000 fish per pound. The small area of cartilage in the snout of fish at this size for tag implantation does not allow the use of full length tags.

The coded wire tags for the program were made from biologically inert stainless steel wire which are capable of magnetic detection, and have a continually repeating binary code etched into the wire which allows code reading of recovered tags. Half-length tags measure .02 inches (.533 mm) in length and .01 inches (.254 mm) in diameter.

A total of 60,000 one-half length coded wire tags consisting of 21 separate binary code groups were ordered for the program. As many tag code groups as possible were implanted, however, only one tag code was used for each species at any given site during each collection and tagging period. A tagging period consisted of one to six days of tagging per site, depending on the availability of fish. At the completion of each tagging period, a new tag code group was used for the next site or species to be sampled. Up to four different tag code groups were implanted at any one site for a given species during the entire program.

The coded wire tag implantation procedures were similar to those outlined by Moberly et al. (1977). Adjustments to these procedures were implemented as necessary by our particular field program.

The following day, a random sample of 100 tagged fish were collected from the holding tank and run through the QCD to determine the percent tag retention and tag mortality was recorded. All tagged fish were released at the capture site at the end of each tagging period.

Coded wire tagging data recorded at each site included date tagged, tag code, species, number of fish tagged, percent tag retention, mortality, and date and time of release data as well as final tag retention and mortality were tabulated for each tag code.

2. Cold Branding

Cold-branding operations were conducted at the Gold Creek camp (RM 136.3). The fish were transported in buckets from the collection site to the Gold Creek camp and were then returned to the release site after branding. Fish were held a minimum of 24 hours after branding to determine mortality.

The primary fisheries collection techniques included beach seines, dip nets, and minnow traps. Minnow traps and beach seines were used to collect juvenile chinook and coho salmon in Portage Creek. Ten minnow traps were set twice each week in each of the three upper Indian River sites. Twenty-five traps were fished daily at the mouth of Indian River.

The cold-branding equipment included:

--- Cyrogenics nitrogen container (60 liter)
--- Cold-branding box
--- Brands

This equipment is all field portable. The nitrogen container is a doubled-walled insulated canister which will last for approximately 10,000 juvenile fish brands or 15 days. The cold-branding box was constructed from a polyvinyl chloride (PVC) pipe coupling, a 4 inch brass-cap, threaded brass pipes, and spray urethane insulation. The design is similar to that used by Mighell (1969), Raleigh et al. (1973) and Laird et al. (1975). The brands consisted of letters and symbols approximately 3 mm in height soldered on threaded brass caps by a local jeweler.

Juvenile chinook and coho salmon were marked with a distinctive brand to signify the collection site and date of their capture. Fish were marked on one side of the body at one of three target branding areas, and a branding time of two seconds was used.

Date, collection site, gear type, fishing effort, species, number of fish captured, and brand symbol were recorded for each site. The number of recaptures by species and the symbols for previously marked fish were also recorded. Total length was measured for 50 fish of each species for each collection site every two weeks.

3. Talkeetna Station Outmigrant Traps

Two inclined plane outmigrant traps were operated continuously through the open water season. Trap fishing depths and distances from shore were adjusted to maximize catches while maintaining trap efficiency. All juvenile fish captured were anesthetized using MS-222 (Tricaine methanesulfonate). Field specimens were identified using the guidelines set forth by McConnell and Snyder (1972), Trautman (1973), and Morrow (1980). Juvenile chinook and coho salmon collected at the traps were checked for a cold-brand mark and all recovered marks were recorded. Chum and sockeye salmon juveniles with a clipped adipose fin were passed through a detector to verify the presence of coded wire tag. All coded wire tagged fish recovered at the traps were preserved and tags will be later removed and decoded using a reading jig and a binocular microscope. All other fish recovered at the traps were held until anesthetic recovery was complete and then released downstream of the traps.

Measurements of the following habitat parameters were recorded daily at the outmigrant traps: surface water temperature (°C), turbidity (NTU), water velocity (ft/sec), and mainstem stage data. The equipment and methods used to collect the habitat data are given in ADF&G (1985).

Scales were collected from a sub-sample of fish captured for comparison to length frequency data for final age class determination. Biological and habitat data were entered directly into an Epson HX-20 microcomputer. Printouts and cassettes were periodically transferred to Data Processing to be entered into a mainframe computer for later data retrieval and analysis.

Length and weight relationship data were also collected from samples of juvenile salmon captured in the outmigrant traps at Talkeetna and Flathorn stations. Total length was recorded to the nearest millimeter and live weights were determined to the nearest 0.1 gram.

4. Flathorn Station Outmigrant Traps

Two inclined plane outmigrant traps were operated daily from 7:00 a.m. to 7:00 p.m. The traps were fished continuously for one 24 hour period each week. Data collected were similar to Talkeetna Station.

A mobile inclined plane outmigrant trap was fished daily at up to 12 transect points. Vertical sampling was conducted at a single transect point once each week. Transect number, fishing effort, total water column depth, set velocity, and drift velocity (if the trap was not held stationary during the set) were recorded for each individual transect point at which the mobile outmigrant trap was fished. Total catch by species and age class was also recorded, and total length measurements were taken for all captured fish. Data were recorded on a field data form for later analysis.

F. Budget: (FY 86)

	TASK 4B	TASK 5B	TASK 8B	TOTAL
Line 100	178.0	24.7	56.8	259.5
Line 200	4.7	1.2	1.0	6.9
Line 300	16.9	2.7	7.3	26.9
Line 400	57.5	7.5	20.0	85.0
Line 500	0	0	0	0
TOTAL	257.1	36.1	85.1	378.3

G. Literature Cited:

Alaska Department of Fish and Game (ADF&G). 1985. (Unpublished draft). Resident and juvenile anadromous studies. Procedures manual draft (May 1984-April 1985). Susitna Hydro Aquatic Studies Program, Alaska Department of Fish and Game. Anchorage, Alaska.

Laird, L.M., R.J. Roberts, W.M. Shearer, and J.F. McArdle. 1974. Freeze branding of juvenile salmon. Journal of Fisheries Biology. (7):167-171.

McConnell, R.J. and G.R. Snyder. 1972. Key to field identification of anadromous juvenile salmonids in the Pacific Northwest. National Oceanic and Atmospheric Administration Technical Report, National Marine Fisheries Service CIRC-366.

Mighell, J.L. 1969. Rapid cold-branding of salmon and trout with liquid nitrogen. Journal of the Fisheries Research Board of Canada. 26(10): 2765-2769.

Moberly, S.A., R. Miller, K. Crandall, and S. Bates. 1977. Mark-tag manual for salmon. Alaska Department of Fish and Game. Fisheries Rehabilitation and Enhancement Division.

Morrow, J.E. 1980. The freshwater fishes of Alaska. Alaska Northwest Publishing Company, Anchorage, Alaska.

Raleigh, R.F., J.B. McLaren, and D.R. Graff. 1973. Effects of topical location, branding techniques and changes in hue on recognition of cold brands in Centrarchid and Salmonid fish. Transactions of the American Fisheries Society. 102 (3):637-641.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin of the Fisheries Research Board of Canada. 191.

Schaefer, M.B. 1951. Estimation of the size of animal populations by marking experiments. United States Fish and Wildlife Service, Fisheries Bulletin 52:189-203.

Trautman, M.B. 1973. A guide to the collection and identification of pre-smolt Pacific salmon in Alaska with an illustrated key. National Oceanographic and Atmospheric Administration Technical Memorandum. NMFS ABFL-2.

B-4 Lower River Spawning Habitat Evaluation

EXECUTIVE SUMMARY

Project Title: Chum Salmon Spawning and Passage Habitat Assessment in Lower River Mainstem and Side Channel Habitats; Susitna Aquatic Studies Task 9

Project Supervisor: Larry Bartlett

Task Manager: Tim Quane

FY 85 Allocation: 128.2 K

Spent to Date: FY 86 20.2
FY 85 27.6

Problem Statement:

Approximately 5,000 chum salmon were discovered spawning in lower river mainstem side channel and slough habitats in 1984. Baseline data to characterize this spawning habitat had not been collected.

Substantial numbers of 0+ juvenile salmon outmigrate passed Talkeetna Station. It is uncertain if these fish outmigrate to Cook Inlet or overwinter in side channel and slough habitat in the lower river.

Objectives:

1. Estimate the number of adult salmon spawning in mainstem and side channel habitats of the lower Susitna River between RM 28.0 and RM 98.6 (Yentna River confluence and the Talkeetna/Chulitna rivers confluence).

2. Monitor the inmigration and the outmigration of juvenile salmon to Trapper Creek Side Channel to ascertain the use of this side channel by outmigrating middle river juvenile salmon as overwintering habitat.

3. Evaluate passage conditions for adult salmon in those side channel habitats identified from surveys to support relatively large numbers (>100) of spawners.

Overview of Procedures:

Adult surveys by helicopter followed by foot. Passage by physical measurement of depth and length correlated to mainstem discharge. Water surface elevation by physical measurement and survey to a temporary bench mark; correlated to mainstem discharge. Juvenile inmigrants captured in fyke nets.

Conclusions:

1. Chum salmon utilize lower river side-channels for spawning; incubation is successful.

2. Chinook, coho and sockeye juvenile salmon utilize lower river side channel habitat for overwinter rearing.

3. Passage, spawning, incubation and rearing success is related to ground water flow in side channels and the controlling mainstem discharge.

Recommendations:

1. Baseline data be collected through the 1985 season on side channel habitat in the lower river when large numbers of adult salmon spawn.

2. The section of the lower river between RM 63 and RM 98 be monitored in conjunction with the middle river reach for project related impacts if the baseline data collection indicates this habitat is used by substantial numbers of salmon for spawning and/or overwinter rearing.

APPENDIX

Table 1. Summary of chum salmon spawning observations in lower river sloughs and side channels.

YEAR	NUMBER FISH	RIVER MILES	SURVEY PERIOD
1981	72	68.3 - 97.0	9/2 - 10/9
1984	3,600 - 4,900	57.0 - 98.6	-----
1985	1,400[1/]		8/8 - 9/10

1/ This number represents the peak counts of chum salmon for the period of 8/8 - 9/10. Total salmon observed from surveys for same period is 1,590 and includes chum, sockeye, and coho.

Table 2a. Summary of outmigrating juvenile salmon observations in lower river side channel habitats April-May 1985. Task 9 Technical memorandum.

	SPECIES				
SIDE CHANNEL	CHINOOK	COHO	SOCKEYE	CHUM	PINK
Trapper Creek	372	436	671*	32	45
Sunset	2	4	0	165	2
Circular	310	143	36	131	1
Birch Creek	2	2	0	1	1

* Includes six 1+ sockeye tagged as 0+ in the middle river during the 1984 season; an estimated 250 additional sockeye were released uncounted.

Table 2b. Summary August-September of juveniles salmon observations in Trapper Creek side channel. Task 9, 1985.

	INMIGRANT SPECIES				
	CHINOOK	COHO	SOCKEYE	CHUM	PINK
Total Fish Passing Inmigrating Aug. 26-Sept. 11	240	373	118	2	0
Fish With Ventral Clip 1/	4	11	1	0	0
Total Fish Passed Outmigrating Aug. 29-Sept. 11	80	114	16	0	1
Fish With Ventral Clip 2/	6	21	2	0	0

1/ Fish were clipped when observed outmigrating.
2/ Fish were clipped when captured inmigrating.

Table 3. Summary of lower Susitna River study sites to be evaluated for passage conditions during the 1985 open water season.

STUDY SITE	RIVER MILE	SALMON UTILIZATION
Circular Side Channel 1/	75.3	Chum
Sunset Side Channel 1/	86.9	Chum
Birch Creek Side Channel	87.0	Chum, Sockeye, Coho
Birch Camp Area	88.5	Chum
Trapper Creek Side Channel	96.0	Chum, Sockeye, Coho
Upper Cache Side Channel	99.0	Chum, Sockeye, Coho

1/ Turbid water has precluded an accurate count of fish in these side channel. Field observations from 1984 have shown these side channel to have over 100 chum salmon spawning. Present surveys have noted salmon in Sunset Side Channel.

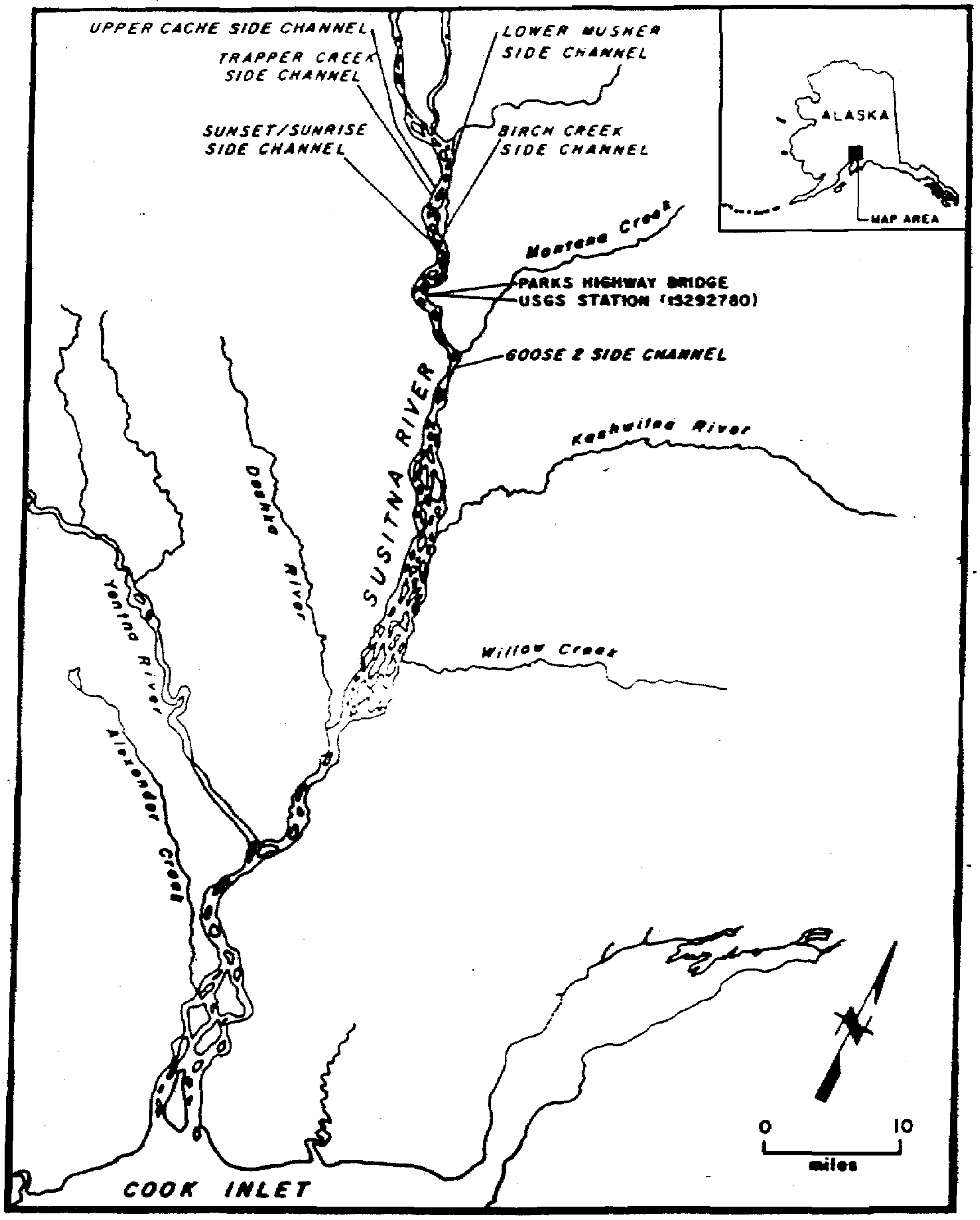


Figure 1. Side channel and slough habitats surveyed for spawning chum salmon in the lower Susitna River (mile 28 to mile 98.6) 1985. Task 9.

Table 4. Main channel and side channel salmon areas surveyed to date in the lower reach of the Susitna River between RM 28.0 and 98.6, for 1985. Other side channels have been observed to have fish but due to flow conditions, spawning counts have not been possible.

SITE	RIVER MILE
Upper Cache Side Channel	99.0
Trapper Creek Side Channel	96.0
Lower Musher Side Channel	95.2
Birch Creek Side Channel	87.0
Sunset Side Channel	86.9
Goose East Side Channel	70.0

Summary of conclusions of work conducted in 1984 as reported in the Task 9 Technical memorandum June 1985.

1. Substantial numbers of chum salmon were observed to spawn in the lower river side channel habitats.

2. Chum salmon spawn primarily in side channel areas influenced by ground water upwelling or bank seepage.

3. Intragravel water temperatures in side channels influenced by ground water upwelling are generally warmer and more stable in temperature than is surface water.

4. Water surface elevations in side channels influenced by ground water upwelling remain relatively constant over a wide range of mainstem flows until breaching occurs. Low winter mainstem flows lower the water surface elevations in side channel until the mainstem ice cover forms. The surface water elevation then rises and stabilizes.

5. Substrate composition varies from site to site and within sites. Composition is predominantly large gravel (1.3") from the surface to approximately 4 inches. Smaller gravel generally follows the larger gravel to a depth of approximately 16 inches. Sand and silt are intermixed to varying degrees throughout. (Substrate was not limiting to survival at any redds examined.)

6. Weighted usable area (WUA) for spawning in most side channels peaked just after the site flows became controlled by mainstem discharge and then decreased as mainstem flows increased. Overall, the sites with higher controlling discharges provided more WUA for chum salmon spawning over time than did sites with lower controlling discharges.

7. The survival of incubating embryos was generally high during the incubation period examined (August-January). Those side channels subject to dewatering had higher mortality than those that were not because of redd desiccation and freezing.

8. Outmigrant trapping confirms the survival of chum salmon embryos through emergence and the overwinter use of the habitat by rearing chinook, coho, and sockeye juvenile salmon.

OPERATION PLAN

Susitna Aquatic Studies - Task 9

Chum Salmon Spawning and Passage Habitat Assessment in Lower River Mainstem and Side Channel Habitats

I. Problem Statement

1. Adult Salmon

Approximately 5,000 salmon (predominantly chum) were discovered spawning in lower river mainstem side channel and slough habitats during 1984 (Barrett et al. 1985). The Alaska Power Authority, funding agency of the Susitna Aquatic Studies, has proposed that the Department of Fish and Game ascertain if observations of this magnitude were the result of an above normal 1984 escapement or if these habitats are used consistently but undiscovered in previous years. Baseline data to characterize this spawning habitat had not been collected; and because of the large number of fish utilizing this habitat, and its proximity to the impacted middle reach, a reconnaissance study of spawning habitat is underway.

2. Juvenile Salmon

Trapping of outmigrant juvenile salmon at Talkeetna Station has proven that substantial numbers of 0+ juvenile salmon outmigrate from the middle river. The life history of these juvenile salmon after they pass Talkeetna Station (e.g., do they overwinter downstream or migrate to the estuary?) is uncertain. In the spring of 1985, 1,556 1+ juvenile salmon were caught when leaving Trapper Creek side channel where they allegedly overwintered. Several of these fish had been coded wire tagged as 0+ in the middle river the previous spring. The Alaska Power Authority has proposed that the Department of Fish and Game undertake a reconnaissance level study to determine the timing, species composition, age class, and relative abundance of juvenile salmon entering Trapper Creek side channel to overwinter.

A. Scope:

This task will determine the timing, location, and abundance of adult chum salmon spawning in the side channel and mainstem habitats of the lower river. The effects of temperature on spawning will be monitored by monitoring the ground water temperature at selected sites until the mainstem ice cover forms and the ground water flow stabilizes for the winter.

Potential passage and incubation problems will be identified through the correlation of mainstem discharge to side channel ground water flow.

The timing and abundance of juvenile salmon migrating into Trapper Creek side channel to overwinter will be determined by capturing inmigrating and outmigrating fry during the fall until the numbers of fish caught substantially fall off.

B. Objectives:

1. Estimate the number of adult salmon spawning in mainstem and side channel habitats of the lower Susitna River between RM 28.0 and RM 98.6 (Yentna River confluence and the Talkeetna/Chulitna river confluence).

2. Monitor the inmigration and the outmigration of juvenile salmon to Trapper Creek side channel to ascertain the use of this side channel by outmigrating middle river juvenile salmon as overwintering habitat.

3. Evaluate passage conditions for adult salmon in those side channel habitats identified from surveys to support relatively large numbers ($>$100) of spawners.

C. Justification:

There is no baseline data base for spawning habitat in the side channel and mainstem habitats where substantial numbers of salmon were observed spawning in 1984; and in Trapper Creek side channel for juvenile salmon which were observed to have allegedly overwintered there.

II. Project Narrative

A. Duration: (1985)

Task 9 begins with the spawning surveys in mid-August. The surveys continue through approximately October 15.

Temperature data is collected from selected side channels until the mainstem ice cover is formed and the ground water flow in the side channels stabilize.

The passage assessment begins when the side channels are no longer breached and will continue through mainstem discharge increments of approximately 5,000 cfs until passage is no longer possible.

Water surface elevations will be obtained from selected side channels from when the side channels are no longer breached until a solid ice cover is formed on the mainstem.

Juvenile salmon inmigration and outmigration will be monitored at one side channel (Trapper Creek) beginning in mid-September and until migrations have substantially decreased.

This task is presently funded for one year only (FY 86).

B. Location:

Side channel, slough and mainstem habitats of the lower reach of the Susitna River. For this task, the lower reach of the Susitna River is characterized as extending from the Yentna River confluence (RM 28.0) to the Talkeetna/Chulitna river confluence (RM 98.6).

The trapping of inmigrant and outmigrant juvenile salmon is being conducted at Trapper Creek side channel (RM 91.6). This side channel is logistically accessible; was not observed to totally freeze over during the winter of 1984-85; and was discovered to contain a sizable number (1,556 captured) of overwintering juvenile salmon in the spring of 1985.

C. Personnel:

1. Project Leader: Larry Bartlett, FB III
2. Task Manager: Tim Quane, FB II
3. Field Crew: Jeff Bigler, FB I
4. Field Crew: Jeff Blakely, FB I

D. Assumptions:

1. Chum salmon utilize lower river side channel and mainstem habitats for spawning and their presence in 1984 was not the result of an above average escapement.

2. Changes in seasonal with-project mainstem flows may affect the ground water contribution and water surface elevations in side channel habitats. This may result in impacts on passage, spawning, incubation, and overwinter rearing.

3. Lower river side channels are important overwinter rearing habitat for juvenile salmon. Juvenile salmon from upstream habitats enter the side channels (which offer suitable habitat) in September and October to overwinter.

E. Procedures:

1. Spawning Surveys - Mainstem and side channel habitats between RM 28.0 and RM 98.6 will be surveyed for adult salmon spawning from mid-August through mid-October. These spawning surveys will include both aerial counts and foot counts. The reach of river extending from RM 28.0 to RM 98.7 will be divided into three sub-reaches identified as follows:

   Sub-reach 1: RM 28 - Willow Creek
   Sub-reach 2: Willow Creek - Montana Creek
   Sub-reach 3: Montana Creek - Chulitna Confluence

   Aerial Survey: Adult salmon will be enumerated by absolute count from a hovering helicopter. The aerial count will be performed on one day for the reach of Susitna River from RM 28.0 to RM 98.6 and will be repeated following a minimum of 7-9 days (chum salmon streamlife in the Susitna River has been estimated to be 7 days; Barrett et al. 1984).

   Foot Survey: Immediately following the aerial count, foot surveys will be conducted on sub-reaches 1-3. One day will be expended for foot surveys for each sub-reach. Foot surveys will include a count of live and dead salmon with carcasses being marked.

2. Temperature - Intragravel and surface water temperatures will be obtained on a continuous basis using Omnidata two-channel recorders. These recorders simultaneously record both surface and intragravel water temperatures.

3. Passage Evaluation - Passage reaches will be identified in the field by locating areas where water depth is potentially limiting passage of adult salmon into spawning areas. Passage reaches will be defined as areas where the thalweg water depths are 0.5 feet or less based on the passage criteria threshold for successful passage (Blakely et al. 1985). At each identified passage reach, a transect is established perpendicular to the flow of water to represent the depth characteristics of the passage reach and provide a consistent point of measurement. Representative transects are established at the shallowest or most critical point of the passage reach and marked with wood stakes and rebar headpins. The physical habitat characteristics of individual passage reaches are defined by measuring lengths, widths, and water depths, using the established transect as a reference point. Passage reach lengths and widths are measured with a fiberglass surveyor's tape graduated in one-tenth foot increments. A standard surveying rod is used to measure the thalweg depth at each transect.

Substrate conditions will be evaluated to determine the type of substrate present at each passage reach. Substrate data are collected by visually classifying the substrate present in the passage reach into the two dominant size groups based on the substrate size classification system presented in the following:

Table 1. Substrate size classification system used to evaluate substrate conditions at lower river study sites.

SUBSTRATE TYPE	SYMBOL	SIZE CLASS
Silt	SI	Very Fines
Sand	SA	Fines
Small Gravel	SG	1/4 - 1"
Large Gravel	LG	1" - 3"
Rubble	RU	3" - 5"
Cobble	CO	5" - 10"
Boulder	BO	Greater than 10"

Passage reach data collected will include length, width, depth, and substrate. These data will be summarized in table format for the physical conditions characterizing each passage reach. Site maps will be developed from aerial photos to illustrate locations of passage reaches at each site. A summary table of breaching flows will be developed for each site incorporating any revisions made this year.

4. Water Surface Elevations - Water surface elevations will be evaluated in the side channels in areas influenced by ground water and will be obtained by staff gage measurements. Water surface elevations will also be obtained in the mainstem in areas adjoining the side channel study sites. These water surface elevations will also be obtained by staff gage measurements except during periods of ice cover. During periods of ice cover, water surface elevations will be obtained using the survey technique of differential leveling relative to a temporary bench mark.

5. Inmigrating and outmigrating juvenile salmon will be monitored in Trapper Creek side channel on a daily basis. Juvenile salmon will be captured with fyke nets and marked with a left ventral fin clip for inmigrating fish and right ventral fin clip for outmigrating fish. The length and species of each fish will be recorded, as will scale samples be obtained for each species for each length class. Cold branded fish will be recorded. Wire tagged fish will be preserved.

F. Budget:

FY 85

This task had no specific budget in FY 85. All effort was in conjunction with other tasks. Costs are estimated as:

	TASK 36		DATA PROCESSING	ADMIN. SUPPORT
Line:	100	300	100	300
	19,500	2,500	5,000	600

FY 86

Line 100	FB II	9mm	38.7
	FB I	9mm	32.0
	FB I	8mm	29.2
	DPC III	0.8mm	2.3
Line 200	Travel and Per Diem		1.0
Line 300	Contractual Services		17.0
Line 400	Commodities		8.0
Line 500	Equipment		0.0
		TOTAL	128.2

G. Literature Cited:

Barrett, et al. 1985. Adult Salmon Investigations: May-October 1984. Susitna Aquatic Studies Program. Report No. 6. Alaska Department of Fish and Game, Anchorage, Alaska.

Blakely, et al. 1985. Salmon Passage Validation Studies (August-October 1984). Susitna Aquatic Studies Program. Addendum to Report No. 3, Chapter 6. Alaska Department of Fish and Game, Anchorage, Alaska.

APPENDIX

Table 1. Summary of chum salmon spawning observations in lower river sloughs and side channels.

YEAR	NUMBER FISH	RIVER MILES	SURVEY PERIOD
1981	72	68.3 - 97.0	9/2 - 10/9
1984	3,600 - 4,900	57.0 - 98.6	-----
1985	1,400[1/]		8/8 - 9/10

1/ This number represents the peak counts of chum salmon for the period of 8/8 - 9/10. Total salmon observed from surveys for same period is 1,590 and includes chum, sockeye, and coho.

Table 2a. Summary of outmigrating juvenile salmon observations in lower river side channel habitats April-May 1985. Task 9 Technical memorandum.

	SPECIES				
SIDE CHANNEL	CHINOOK	COHO	SOCKEYE	CHUM	PINK
Trapper Creek	372	436	671*	32	45
Sunset	2	4	0	165	2
Circular	310	143	36	131	1
Birch Creek	2	2	0	1	1

* Includes six 1+ sockeye tagged as 0+ in the middle river during the 1984 season; an estimated 250 additional sockeye were released uncounted.

Table 2b. Summary August-September of juveniles salmon observations in Trapper Creek side channel. Task 9, 1985.

	INMIGRANT SPECIES				
	CHINOOK	COHO	SOCKEYE	CHUM	PINK
Total Fish Passing Inmigrating Aug. 26-Sept. 11	240	373	118	2	0
Fish With Ventral Clip[1/]	4	11	1	0	0
Total Fish Passed Outmigrating Aug. 29-Sept. 11	80	114	16	0	1
Fish With Ventral Clip[2/]	6	21	2	0	0

1/ Fish were clipped when observed outmigrating.
2/ Fish were clipped when captured inmigrating.

Table 3. Summary of lower Susitna River study sites to be evaluated for passage conditions during the 1985 open water season.

STUDY SITE	RIVER MILE	SALMON UTILIZATION
Circular Side Channel[1/]	75.3	Chum
Sunset Side Channel[1/]	86.9	Chum
Birch Creek Side Channel	87.0	Chum, Sockeye, Coho
Birch Camp Area	88.5	Chum
Trapper Creek Side Channel	96.0	Chum, Sockeye, Coho
Upper Cache Side Channel	99.0	Chum, Sockeye, Coho

1/ Turbid water has precluded an accurate count of fish in these side channel. Field observations from 1984 have shown these side channel to have over 100 chum salmon spawning. Present surveys have noted salmon in Sunset Side Channel.

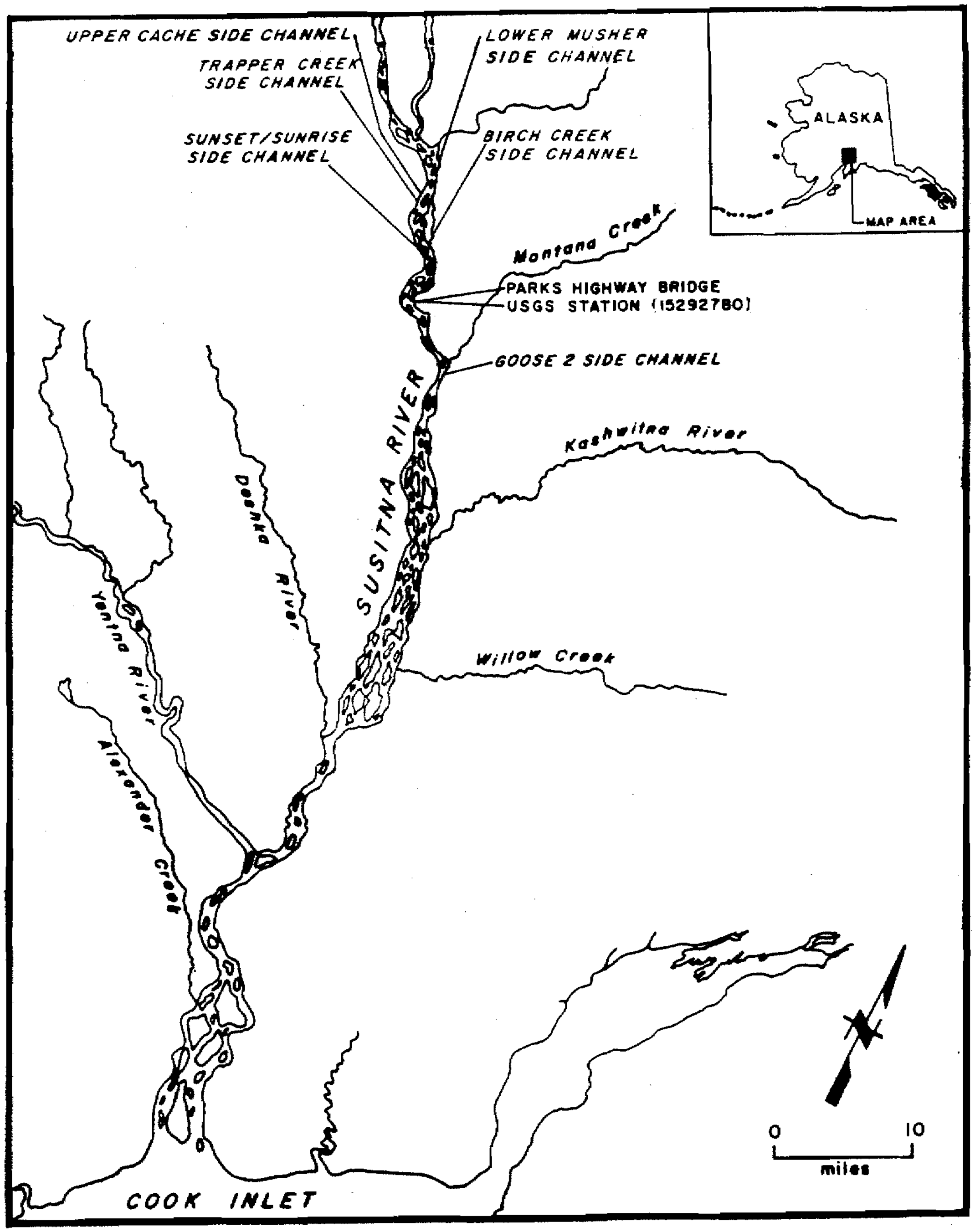


Figure 1. Side channel and slough habitats surveyed for spawning chum salmon in the lower Susitna River (mile 28 to mile 98.6) 1985. Task 9.

Table 4. Main channel and side channel salmon areas surveyed to date in the lower reach of the Susitna River between RM 28.0 and 98.6, for 1985. Other side channels have been observed to have fish but due to flow conditions, spawning counts have not been possible.

SITE	RIVER MILE
Upper Cache Side Channel	99.0
Trapper Creek Side Channel	96.0
Lower Musher Side Channel	95.2
Birch Creek Side Channel	87.0
Sunset Side Channel	86.9
Goose East Side Channel	70.0

B-5 Middle River Resident Fish Study

EXECUTIVE SUMMARY

Project Title: Middle River Resident Fish Monitoring; Susitna Aquatic Studies Tasks 2 and 6

1. Task 2: Completion of FY 85 Task 34: Winter Studies of Resident and Juvenile Anadromous Fish

2. Task 6: Middle River Resident Fish Monitoring

Task 2 Project Supervisor: Stephen Hale

Task 6 Project Supervisor: Larry Bartlett

Task 2 and 6 Task Manager: Richard Sundet

FY 86 Allocation:

Task 2	0.8K (only Line 300 and 400)
Task 6	67.0
Task Manager Salary (w/benefits)	51.6

Spent to Date:

Task 2	0.4
Task 6	30.0
Task Manager	17.2

Problem Statement:

Population and habitat characteristics of resident fish species in the Susitna River below Devil Canyon are. It is anticipated resident fish will be affected by the proposed hydroelectric development on the Susitna River.

Objectives:

1. Define the seasonal distribution and relative abundance of resident fish in the Susitna River between Cook Inlet and Devil Canyon. (Stated in the 1981 RSA.)

2. Characterize the seasonal habitat requirements of selected resident species within the study area. (Stated in the 1981 RSA.)

3. Quantify the important habitat parameters associated with spawning and rearing (growth) of resident fish species such as rainbow trout and burbot; and measure fish density in these habitats to provide an estimate of habitat quality. (Stated in the 1983 RSA.)

4. Describe the distribution and habitat associated with overwintering rainbow trout in the mainstem Susitna River below the Chulitna River confluence. (Stated in the 1984 RSA.)

5. Estimate the response of rainbow trout overwintering habitat at selected sites to hydraulic changes during the winter period (assuming habitat response parallels open channel hydraulics). (Stated in the 1984 RSA.)

6. Provide long-term baseline data on the distribution and abundance of resident fish in the middle reach of the Susitna River. (Stated in the 1985 RSA.)

Overview of Methods:

Since 1982, sampling efforts have primarily focused on the middle river rather than the lower river. Resident fish are collected primarily by boat electrofishing. In the middle river, most boat electrofishing efforts has been at 13 index sites. In the lower river, less boat electrofishing has been expended and these efforts have been focused at tributary mouths and several randomly chosen mainstem sites.

Secondary gear types used are hook and line, baited trotlines and hoop nets, gill nets, and beach seines. In addition, resident fish catches at outmigrant traps and fishwheels are recorded. Radio tags have been implanted in rainbow trout, burbot, and Arctic grayling to monitor seasonal movements and document spawning areas.

Conclusions to Date:

1. Resident fish relative abundance studies on the middle river show the most important rainbow trout summer rearing tributaries are: Whiskers Creek, Lane Creek, Fourth of July Creek, Indian River, and Portage Creek. Arctic grayling are found most often at Indian River and Portage Creek compared to other middle river areas. Round whitefish are found most often above RM 136.7 compared to other areas. CPUE data show burbot are more numerous in the lower than the middle Susitna River.

2. Modal gill raker counts show Coregonus pidschian is the species of the humpback whitefish complex found in the Susitna River. This species appears to be anadromous in the lower river. Anadromous Bering cisco migrate into the Susitna River in September.

3. Rainbow trout and Arctic grayling move into middle river tributaries with clear water in mid-May. Middle river Arctic grayling usually spawn in late May and rainbow trout usually spawn in early June. Studies suggest much of the middle river rainbow trout population originates from lakes which drain into Fourth of July and Portage creeks.

   Round whitefish and longnose suckers use the mainstem Susitna as well as tributary mouths for spawning. Round whitefish spawn during mid-October (freeze-up) and longnose suckers spawn during late May to early June. Lower river burbot spawn up to TRM 25.0 of the Deshka River. Burbot in both reaches of river are believed to use the mainstem Susitna for spawning. Burbot spawn during late January. Bering cisco spawn in mid-October near RM 77 in the mainstem Susitna River.

4. Radio telemetry and CPUE data shows most middle river adult resident species migrate into tributaries from the mainstem Susitna during the spring for summer rearing; then begin to migrate back to the mainstem during the fall for overwintering. Limited data shows similar behavior occurs in the smaller, lower river east side tributaries. Burbot is one species which is found primarily year-round in the mainstem Susitna. Summer rearing rainbow trout show a close association with spawning salmon.

5. Microhabitat suitability criteria were generated in the summer of 1983 for adult rainbow trout, Arctic grayling, round whitefish, and longnose sucker, and juvenile round whitefish in mainstem influenced areas of the middle Susitna River. Microhabitat criteria were generated for rainbow trout in middle river clear water tributaries. Turbidity appeared to have the most effect on fish species distribution. Adult rainbow trout, Arctic grayling, and round whitefish appear to avoid turbid Susitna water ($>$ 30 NTU). Adult longnose suckers and juvenile round whitefish avoid clear water ($<$ 30 NTU). Rainbow trout in clear water tributaries preferred pools with velocities $<$0.5 fps and depths $>$2.0 ft. An abundance of cover also appeared to be tied to rainbow distribution in clear water tributaries.

6. Instantaneous survival rates calculated in 1983 for four middle river species (however, burbot were pooled from the lower and middle rivers) ranged from 33.3 percent for rainbow trout to 70.5 percent for burbot. Data suggests the lower rainbow trout survival rate is due to high overwintering and post-spawning mortalities. Also, overall rainbow trout populations are low probably because of low reproduction and/or low egg and juvenile survival.

7. Population estimates were generated for four adult resident species from the middle Susitna River in 1984 using the Jolly-Seber model. The population estimates of these species for the year 1983 are the following:

Rainbow trout	1,036
Arctic grayling	6,783
Round whitefish	7,264
Longnose sucker	7,613

Appendix A provides further information on the 1984 Jolly-Seber population estimates.

8. Population estimates were generated in 1983 for rainbow trout in Fourth of July Creek (RM 131.1, TRM 0.0-0.8: 107 fish $>$ 150mm) and for burbot in the mainstem Susitna River (RM's 138.9-140.1: 15 fish $>$ 300mm).

9. Radio telemetry studies indicate lower river rainbow trout prefer to overwinter under ice cover in side channels which have low to moderate water velocities and depths. Radio telemetry studies also show middle river rainbow trout overwinter in areas usually downstream and within

four miles of the tributary where the fish was tagged. These areas are characterized by no anchor ice and low to moderate water velocities. After the middle river freeze over in mid-January, rainbow trout appear to use surface ice as cover.

Recommendations:

1. Continue boat electrofishing at 16 middle river index sites to monitor trends in relative abundance. Boat electrofishing has proven to be the most effective capture method for resident fish in mainstem Susitna influenced areas. Biological information should also be collected from captured resident fish.

2. Continue to capture fish by secondary gear methods such as gill netting and baited traps to supplement boat electrofishing data. These data will supplement inherent mark-recapture data problems generated from boat electrofishing capture data such as fish avoiding the electric field and low recaptures.

3. Continue the mark-and-recapture program to generate middle river population estimates and to further define migrational patterns of selected resident fish species.

4. Continue to make a yearly population estimate (in late July) for rainbow trout in Fourth of July Creek as a long term index site.

5. Continue to collect habitat data of selected spawning resident fish to further document their spawning locations, timing, and habitat characteristics.

6. In 1986, collect habitat data to further define the microhabitat suitability criterias of selected middle river resident fish.

7. Continue to record adult resident fish catches in fishwheels and juvenile fish catches in outmigrant traps to assist in evaluating trends in fish populations.

Literature Cited:

Manly, B.F.J. 1984. Obtaining confidence limits on parameters of the Jolly-Seber model for capture-recapture data. Biometrics 40: 749-758.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin of the Fisheries Research Board of Canada. Bulletin 191. Ottawa, Canada.

Sundet, R.L. and S.D. Pechek. 1985. Resident fish distribution and life history in the Susitna River below Devil Canyon. Part 3 In: D.C. Schmidt, S.S. Hale, and D.L. Crawford, editors. Resident and Juvenile Anadromous Fish Investigations (May-October 1984). Susitna Aquatic Studies Program. Report No. 7. Alaska Department of Fish and Game, Anchorage, Alaska.

APPENDIX A

The 1984 Jolly-Seber population estimates for middle river resident fish were made using multiple-year data from four catch periods (1981-1984). Each catch period was one year. The methodology behind the Jolly-Seber model is the following: on time 1(1981), the fish were marked; on times 2(1982), 3(1983), and 4(1984), unmarked fish were recorded as well as recaptured fish from previous years. The Jolly-Seber model can also be used when sampling is longer than four catch periods. Therefore, in 1985, recaptured fish from years 1981-1984 can be used.

Included is an excerpt from Sundet and Pechek (1985) on methods, results and discussion of the Jolly-Seber population estimates done in 1984.

Methods

Population estimates were made of adult rainbow trout, Arctic grayling, round whitefish, and longnose sucker populations in the middle river using the multiple-year (1981-1984) tagging and recapture data. Since only adult fish have been tagged, population estimates are applicable only for fish above 199 mm fork length. The Jolly-Seber and Bailey methods (Ricker 1975) were set up on a commercial microcomputer spreadsheet program. The 95 percent confidence interval for the Jolly-Seber population estimate was developed using the method of Manly (1984).

The number of recaptures of each species was adjusted by the tag retention rate for that species (Appendix A; Appendix Table D-2). Floy anchor tag retention rates were calculated in 1983 and 1984 for several resident fish species. This was done by comparing the number of fish recaptured with tags to the number of fish recaptured which showed a tag scar. Tag scars were not recorded for fish captured in 1982 so actual tag retention rates are unavailable for that year. However, since retention rates are known for 1983 and assuming there was little change in retention rates between years, 1983 retention rates were applied to recaptures made in 1982.

Results and Discussion

Population estimates presented in Appendix Table D-1 from the Jolly-Seber method and Bailey's method must be considered tentative at this time. The numbers of recaptures were low, leading to large confidence intervals on the population estimates using the Jolly-Seber method. One of the main problems was that there was a high mortality on the fish marked in 1981; hence the recapture rate of these fish was low in comparison to 1982 and 1983. The high mortality was caused by the use of gill nets in 1981; we changed in 1982 to boat electrofishing as the primary capture method. Round whitefish are particularly sensitive to gill nets; only one of the 48 fish marked in 1981 was ever recaptured. Because the Jolly-Seber method requires three marking periods, the 1981 data cannot be discarded from the estimate presented here. However, we will be able to discard the 1981 data after the 1985 field season, and use the 1982 to 1985 data.

Note that several of the confidence intervals (particularly in 1982, which was affected by the 1981 mortality) are so wide as to be meaningless. The 1983 estimates, however, give a general idea of the magnitude of the populations. We can conclude, for example, that it is unlikely that there are more than 15,000 Arctic grayling larger than 200 mm in the middle reach of the Susitna River, and that the true number is closer to 7,000. A similar type of conclusion can be made for round whitefish and longnose suckers.

For the long term monitoring program, efforts will be redirected so that we can get higher recapture rates and therefore better population estimates.

Appendix Table D-1. Population estimates, using the Jolly-Seber and Bailey methods, for four species of resident fish in the middle river, 1981-84.

DATE	POPULATION ESTIMATES: JOLLY-SEBER[a]	95% CONFIDENCE INTERVAL[d]	BAILEY[b]	S.D.	BAILEY[c]	S.D.	FISH NEWLY MARKED	FISH CHECKED FOR MARKS	RECAPTURES OF FISH MARKED AT 1981	1982	1983	TOTAL RECAPTURES
Rainbow Trout												
1981	NA	-	NA	-	-	-	92	NA	NA	NA	NA	NA
1982	1,408	548 - 6,661	1,450	1,148	NA	-	151	191	7	NA	NA	7
1983	1,036	312 - 29,667	NA	-	1,009	1,009	274	312	2	4	NA	6
1984	NA	-	-	-	NA	-	NA	204	0	1	16	17
Total Recaptures							NA	NA	9	5	16	30
Arctic Grayling												
1981	NA	-	NA	-	-	-	49	NA	NA	NA	NA	NA
1982	2,866	783 - 28,192	2,356	1,551	NA	-	400	425	6	NA	NA	6
1983	6,783	4,070 - 15,152	NA	-	5,787	2,329	765	911	3	30	NA	33
1984	NA	-	-	-	NA	-	NA	563	1	9	34	44
Total Recaptures							NA	NA	10	39	34	83
Round Whitefish												
1981	NA	-	NA	-	-	-	48	NA	NA	NA	NA	NA
1982	9,529	-	11,125	11,125	NA	-	720	787	0	NA	NA	0
1983	7,264	4,829 - 13,806	NA	-	6,204	2,006	1,079	1,172	1	50	NA	51
1984	NA	-	-	-	NA	-	NA	642	0	14	55	69
Total Recaptures							NA	NA	1	64	55	120
Longnose Suckers												
1981	NA	-	NA	-	-	-	80	NA	NA	NA	NA	NA
1982	6,930	837 - 261,062	8,602	6,922	NA	-	418	462	2	NA	NA	2
1983	7,613	4,003 - 20,439	NA	-	8,101	4,667	434	447	2	14	NA	16
1984	NA	-	-	-	NA	-	NA	223	0	5	7	12
Total Recaptures							NA	NA	4	19	7	30

[a] Population estimates made using 1981-84 data.
[b] Population estimates made using 1981-83 data.
[c] Population estimates made using 1982-84 data.
[d] See text for explanation.
NA = Not applicable.
S.D. = Standard deviation.

OPERATION PLAN FOR FY 86 TASK 6

MIDDLE RIVER RESIDENT FISH MONITORING

Prepared by Richard Sundet
September 1984

I. Problem Statement

Population and habitat characteristics of resident fish species in the Susitna River below Devil Canyon are not well defined. It is anticipated these populations will be affected by the proposed two-dam hydroelectric development on the Susitna River. A monitoring program should be implemented to determine what these effects are on resident fish populations.

A. Scope:

Resident fish will be captured in the middle Susitna River from mid-May to mid-October primarily by boat electrofishing at 16 index sites. Using these data, trends in relative abundance can then be made at these sites within the year and between years. A mark-and-recapture program will continue so population estimates can be generated and further information on fish movement behavior can be learned. The population estimate will be done by the Jolly-Seber model using multiple-year data.

B. Objective:

Provide long-term baseline data on the distribution and abundance of resident fish in the middle Susitna River.

C. Justification:

Past hydroelectric projects have produced both positive and negative effects on the nearby fisheries. The principal effects of the proposed Susitna dams that are expected to impact resident fish populations are changes in turbidities, temperatures, and fluctuations in mainstem discharge. The most positive post-project effect expected may be a decrease in summer sediment load and turbidity. This would likely manifest itself in the creation of more favorable resident fish rearing and spawning habitat for several resident fish species. Also, with warmer winter temperatures and higher discharge, the survival of some resident fish species could be expected to increase.

Negative effects of the proposed dams include an increase in water turbidity during the winter and possibly rapid water fluctuations if power-peaking flows were to occur. Although the mainstem Susitna River is the principal overwintering area of middle river resident fish, it is unknown what effect an increase in winter turbidity would have on middle river resident fish distribution. It is suspected that burbot and round whitefish spawning which currently occurs in the mainstem may be affected.

In addition, fishing pressure will almost certainly increase likely causing populations, and age and species composition of some resident fish species (most likely rainbow trout and Arctic grayling) to change.

Selected reaches of the mainstem middle Susitna River have been monitored during the summer for the past four years. Because various populations of resident fish use the mainstem for some summer rearing and much overwintering, a monitoring program should be implemented to provide a long-term index of the abundance and distribution of resident fish populations that use the middle river reach.

II. Project Narrative

A. Duration:

1. From ice-out (mid-May) to freeze-up (mid-October), the resident fish crew will boat electrofish at index sites twice per month. In 1986, sampling will be conducted as in 1983 where sites were divided into cells. This information will be used to generate microhabitat suitability criteria and supplement the criterias developed in 1983.

2. Between mid-May and mid-October, sampling will also be done with secondary sampling gear such as gill nets whenever possible and appropriate. This sampling will be done at Susitna influenced areas as well as at selected sites in important tributaries. Gill nets will not be set when large numbers of adult salmon are present.

3. A mark-and-recapture program using Floy anchor tags will be conducted on selected species of adult resident fish from mid-May to mid-October. Biological data of captured fish whether tagged or not will also be recorded during this time period.

4. During late July, sampling will be done on lower Fourth of July Creek to generate a population estimate of rainbow trout.

5. Between June 1 and September 15, sampling will be done in the mainstem middle Susitna River to generate population estimates of burbot.

B. Location:

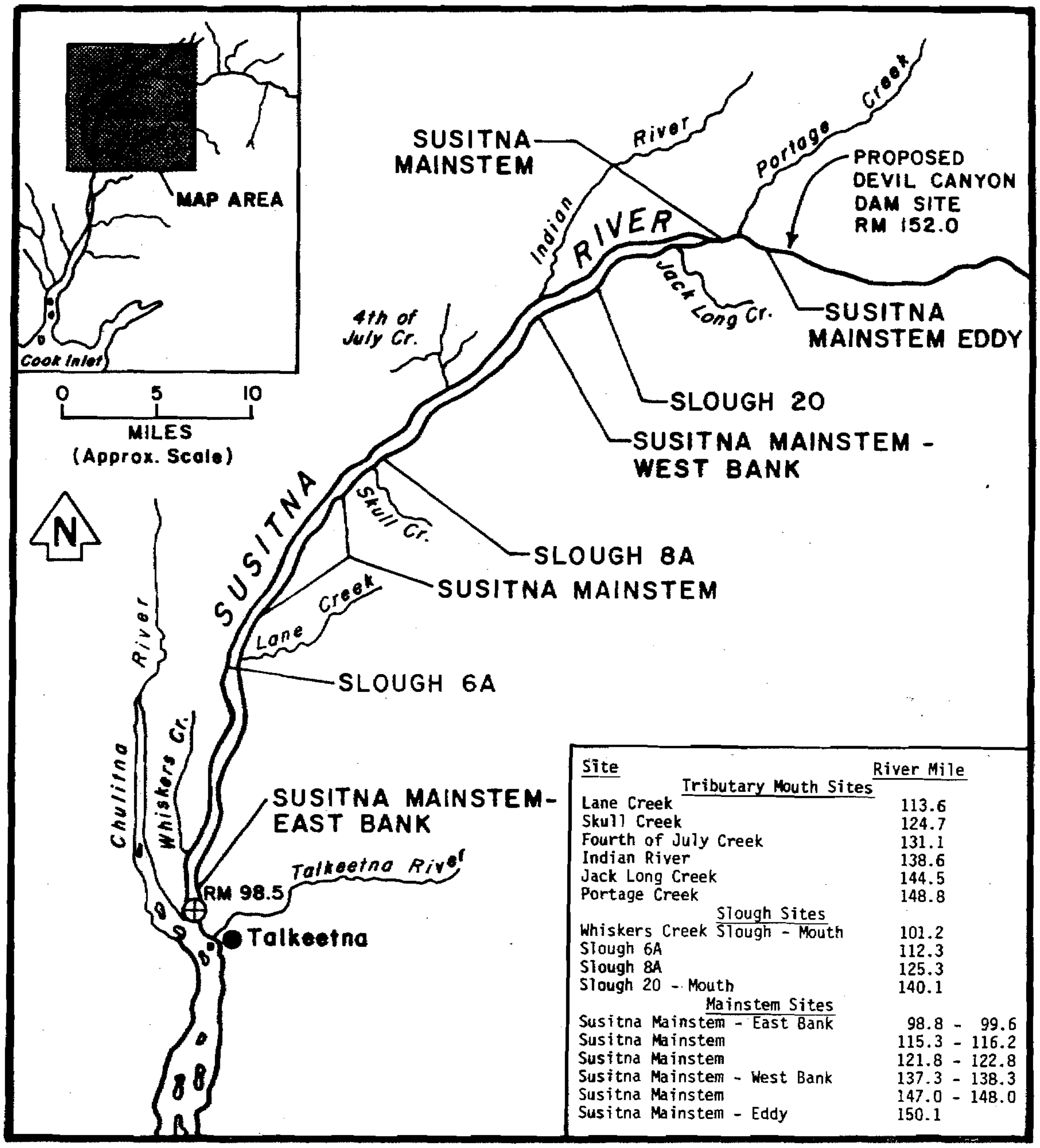
1. Sixteen middle river index sites will be sampled consistently during the summer (Figure 1). These sites are composed of three major macrohabitats influenced by the Susitna River. These macrohabitats are: mainstem, sloughs, and tributary mouths. Other middle river opportunistic sites will be sampled by boat electrofishing and other gear methods during the summer whenever possible and appropriate. These sites include Susitna influenced areas as well as in important tributaries such as Portage Creek.

2. A population estimate will be made for rainbow trout between tributary river miles (TRM) 0.0 and 0.8 of Fourth of July Creek.

3. Population estimates will be made for burbot during 1985 in five one mile reaches of the mainstem middle Susitna River. These one mile reaches of river will be within the following areas: RM's 98.5-110.0, 110.0-120.0, 120.0-130.0, 130.0-140.0, and 140.0-150.0.

C. Personnel:

The project supervisor will be Larry Bartlett (FB III) and the task manager will be Richard Sundet (FB II). A two man crew will conduct the resident fish sampling program. Between mid-May and June 1, Richard Sundet and one seasonal FB I will conduct sampling. Between June 1 and August 31, two FB I's will continue the sampling program. After August 1, Richard Sundet and one FB I will continue sampling until freeze-up.



Site	River Mile
Tributary Mouth Sites	
Lane Creek	113.6
Skull Creek	124.7
Fourth of July Creek	131.1
Indian River	138.6
Jack Long Creek	144.5
Portage Creek	148.8
Slough Sites	
Whiskers Creek Slough - Mouth	101.2
Slough 6A	112.3
Slough 8A	125.3
Slough 20 - Mouth	140.1
Mainstem Sites	
Susitna Mainstem - East Bank	98.8 - 99.6
Susitna Mainstem	115.3 - 116.2
Susitna Mainstem	121.8 - 122.8
Susitna Mainstem - West Bank	137.3 - 138.3
Susitna Mainstem	147.0 - 148.0
Susitna Mainstem - Eddy	150.1

Figure 1. Resident fish study sites on the Susitna River between the Chulitna River confluence and Devil Canyon, 1985.

Between June 1 and August 30, Richard Sundet will work on Task 2.

D. Assumptions:

1. Random mark-and-recapture effort.

2. Time does not affect recapture probabilities.

3. The population is closed geographically.

4. Population estimates limited to the older age classes of fish species are due only to insufficient sample sizes of smaller fish.

5. There is a random mixing of tagged fish with non-tagged fish.

6. Mortalities, due to capture and tagging are insignificant.

7. There is little difference in behavior between tagged and untagged fish.

8. There is little variability in sampling effort.

F. Procedures:

During the open water period, a two man crew will collect samples of resident fish on the Susitna River between the Chulitna River confluence and Devil Canyon for habitat and relative abundance studies and a radio telemetry-migrational study. River boats, fixed-wing aircraft, and helicopters will be used for support. Sampling methods to be used in this study area include boat and backback electrofishing, angling, trotlines, gill nets, and hoop nets. The crew will operate out of a tent camp located on the Susitna River at Gold Creek and at the ADF&G trailer at Talkeetna.

1. Habitat and Relative Abundance

Resident fish will be collected at Susitna mainstem, slough, and tributary mouth sites primarily with a boat mounted electrofishing unit. In addition, sampling will be done by secondary gear types in important tributaries.

Biological data (species, age, length, sex, and sexual maturity) will be collected as outlined in ADF&G (1983a). Scales for age determination will be taken from a representative sample of rainbow trout captured above the Chulitna River confluence. Scales will also be collected from spawning Arctic grayling and round whitefish to determine ages of spawners for these species.

Survival rates will be calculated for rainbow trout above the Chulitna River confluence as in 1983 and 1984 using catch and age data. These methods are presented in Everhart et al. (1975).

The following habitat parameters will be collected at all resident fish spawning sites: water temperatures, water depths, water velocities, conductivity, dissolved oxygen, pH, turbidity, and substrate composition.

The mark-and-recapture program to generate population estimates and monitor the seasonal movements of adult resident fish will be continued. In 1981 and 1982, 1,550 and 3,118 adult resident fish were Floy anchor tagged in the Susitna River between Cook Inlet and Devil Canyon (ADF&G 1981, 1983b). During 1983 and 1984, 3,037 and 2,287 adult resident fish were tagged in the same reach, respectively (Sundet and Wenger 1984; Sundet and Pechek 1985). Tagging crews will attempt to tag on additional 3,000 resident fish during the 1985-1986 field season. Tagging in 1985-1986 will be primarily conducted above the Chulitna River confluence, however, fishwheel crews below the Chulitna River confluence will also tag fish.

Floy anchor tags will be used to tag seven species of adult resident fish. Species to be tagged are humpback whitefish, round whitefish, burbot, longnose suckers, rainbow trout, Arctic grayling, and Dolly Varden.

All resident fish that appear healthy after capture and large enough to accommodate a tag will be tagged. Burbot with a total length (TL) greater than 225 millimeters (mm) will be tagged and other resident species with fork lengths (FL) greater than 225 mm will be tagged.

Floy anchor tags will be inserted between the lateral line and the posterior ray of the dorsal fin with a Floy tagging gun.

Tags will be recovered by the following means:

--- Resident fishery crew

--- The angling public will be requested to return recovered tags or report the tag number to the nearest office of the Alaska Department of Fish and Game with information regarding the location and date of catch, and if the fish was released with the tag intact. The public will be informed of the tagging program by Su Hydro staff and posters placed in conspicuous places frequented by anglers.

--- Adult Anadromous fishwheel operations

Population estimates will be made for rainbow trout, Arctic grayling, round whitefish, and longnose suckers greater than 225 mm in fork length in the middle river using the Jolly-Seber model incorporating multiple-year (1981-1985) tagging and recapture data. Population estimates will not be made for other species because past year's data show they are too infrequently captured.

Population estimates will be made for rainbow trout on Fourth of July Creek using a behavioral model from a computer program called CAPTURE. This program is described in Otis et al. (1978) and White et al. (1982). Population estimates will be made for burbot in selected mainstem reaches of the Susitna River by a multiple removal model. Rainbow trout will be captured by hook and line and burbot will be captured by baited hoop nets and trotlines.

2. Radio Telemetry

During May and June 1985, the resident fish crew will attempt to deploy the remaining 30 radio tags left over from 1984 studies.

Approximately 15 internal and 8 external radio tags will be implanted in or attached to, respectively, rainbow trout in the middle Susitna River for spawning and migrational studies. The remaining seven external tags will be attached to middle river Arctic grayling for the same studies.

The tagging crew will radio tag healthy adult resident fish collected within the proposed study area.

Tags to be internally implanted in rainbow trout during the 1985 radio telemetry study are Advanced Telemetry System's Model 10-35. Advanced Telemetry System's Model 625 external tag will be used to radio tag Arctic grayling and advanced pre-spawning rainbow trout.

The same procedures to surgically implant radio tags in resident fish that were described in Sundet and Wenger (1984) will be used in 1985. The external tag will be attached using the same methods used as in 1984 (Sundet and Pechek 1985). Radio tagged fish will be monitored through the winter of 1985-86 or until the batteries of their radio tags expire. In January, ground surveys will be conducted at locations of still functioning radio tags to determine the fate and habitat characteristics of the radio tagged fish.

F. Budget:

Task 2

Line 300	0.5
Line 400	0.3
TOTAL	0.8

Task 6

Line 100	29.5
Line 200	1.2
Line 300	20.7
Line 400	15.6
Line 500	0.0
TOTAL	67.0

Task Managers Salary for Tasks 2 and 6:	51.6
Grand Total for Tasks 2 and 6	119.4

G. Literature Cited:

Alaska Department of Fish and Game (ADF&G). 1981. Resident fish investigation on the Lower Susitna River (November 1980-October 1981). Susitna Hydro Aquatic Studies. Phase 1 final draft report. Subtask 7.10. Alaska Department of Fish and Game, Anchorage, Alaska.

Alaska Department of Fish and Game (ADF&G). 1983a. Aquatic studies procedures manual (1982-1983). Susitna Hydro Aquatic Studies. Phase 2. Subtask 7.10. Alaska Department of Fish and Game, Anchorage, Alaska.

Alaska Department of Fish and Game (ADF&G). 1983b. Resident and juvenile anadromous fish studies on the Susitna River below Devil Canyon, 1982. Susitna Hydro Aquatic Studies. Phase 2 basic data report. Volume 3 (1 of 2). Alaska Department of Fish and Game, Anchorage, Alaska.

Everhart, W.H., A.W. Eupper, and W.D. Youngs. 1975. Principles of fishery science. Cornell University Press. London, United Kingdom.

Otis, D.L., K.P. Burnham, G.C. White, and D.R. Anderson. 1978. Wildlife Monographs 62:1-135.

Sundet, R.L. and M.N. Wenger. 1984. Resident fish distribution and population dynamics in the Susitna River below Devil Canyon. Part 5 In: D.C. Schmidt, S.S. Hale, D.L. Crawford, and P.M. Suchanek, editors. Resident and juvenile anadromous fish investigations (May-October 1983). Susitna Hydro Aquatic Studies. Report No. 2. Alaska Department of Fish and Game, Anchorage, Alaska.

Sundet, R.L. and S.D. Pechek. 1985. Resident fish distribution and life history in the Susitna River below Devil Canyon. Part 3 In: D.C. Schmidt, S.S. Hale, and D.L. Crawford, editors. Resident and juvenile anadromous fish investigations (May-October 1984). Susitna Aquatic Studies Program. Report No. 7. Alaska Department of Fish and Game, Anchorage, Alaska.

White, G.C., D.R. Anderson, K.P. Burnham, and D.L. Otis. 1982. Capture-recapture and removal methods for sampling closed populations. Los Alamos National Laboratory. Los Alamos, New Mexico, U.S.A.

B-6 Aquatic Habitat Monitoring

Project Title: Aquatic Habitat and Instream Flow Investigations.

Project Supervisors: C. Estes, D. Vincent-Lang, and D. Schmidt.

Problem Statement: The Susitna River and its associated riparian lands support diverse and abundant populations of fish and wildlife resources which are of considerable commercial, cultural, and recreational value to the people of Alaska. The State of Alaska has proposed to build and operate hydroelectric power generation facilities on the Susitna River. A prerequisete for such development is the acquistion of a Federal Energy and Regulatory Commission (FERC) license and other associated state and federal permits. Integral to the acquistion of the license and associated permits is consideration of the impacts the development will have on the fish and wildlife resources of the river and mitigative measures that can be taken to alleviate these impacts.

The commonly accepted means for evaluating the impacts that a proposed hydroelectric development will have on fish and their associated aquatic resources in a river is to first detemine the spatial and temporal distribution of fish species according to their life phases within the various aquatic habitats of the river to be impacted. Once this information is obtained, the next step is to determine if and how these utilized habitats are influenced by variations in flow which would occur with the proposed hydroelectric development and whether and how these changes would influence the quality and quantity of the habitat avaiable to fish.

An advantange of evaluating habitat as opposed to fish directly is that the amount of habitat available in a given river can be modeled over a specified flow range. Because the habitat can be modelled over a range of flows, an quantitative assessment of flow-related changes can be made and thereby of the potential impacts expected. Also, an evaluation of the impact and mitigative potentials of alternative flow regimes can be tested.

For these reasons, an assessment of the baseline habitat conditions present in the Susitna River and their relationship to flow was undertaken. Flow of the mainstem river was chosen as an index for monitoring change of other habitat variables as it was thought to be the variable that was expected to change the greatest with construction and operation of the proposed dams and was thought to influence, to varying degrees, the other physical and water quality habitat variables of importance to the fish species/life stages that utilize the various habitats of the Susitna River.

Habitat Project Objectives:

1. To define the aquatic habitat types available to the anadromous and resident fish populations of the Susitna River and rank them according to the type and degree of impact expected.

2. To determine the seasonal utilization of the defined aquatic habitat types by the fish species/life stages that utilize them.

3. To describe the habitat conditions present in each of the aquatic habitat types and determine those which are limiting to selected critical fish species/life stages that utilize them.

4. To select target species/life stages and aquatic habitat types that will be impacted by the proposed project for detailed evaluation.

5. To evaluate the habitat conditions present in selected representative habitats of each target aquatic habitat type and to determine the relationship these habitat conditions have to discharge of the Susitna River.

6. To extrapolate the result of the site-specific representative habitat analysis to the the remaining impacted river segement.

7. To determine, based on the site-specific and extrapoliation results, the impacts that are expected to occur to fish and their habitats resulting from construction and operation of the proposed hydroelectric facilities.

8. To determine specific mitigation options available to aliveate expected impacts to fish and their habitats.

Overview of past work and conclusions drawn to date:

1. Using a macrohabitat approach, the river segment thought to be impacted by hydroelectric development was divided into unique reaches depending on selected macrohabitat characteristics such as channel morphology and gradient, watershed characteristics, riparian habitat characteristics, and the type and degree of impacts expected. Based on this approach, three reaches were defined:

Lower Reach - This reach extends from the three rivers confluence downstream to the estuary. The river in this reach is typically multiple or braided in nature and less confined within its floodplain. Due to a lower reach gradient, lower channel velocities and smaller, less-armoured substrates are present in the reach. Lesser impacts were expected in this reach due to the aleviating flows of the unimpacted Chulitna, Talkeetna, and Yentna rivers.

Middle Reach - This reach extends from Devil Canyon downstream to three rivers (Chultina, Talkeetna, and Susitna Rivers) confluence. The river in this reach is typically single or multiple channel confined by less steep canyon walls. It has a steep gradient which results in high channel velocities and large well-armoured substrates. Many peripheral-type habitat occur in this reach. Significant impacts were expected to occur in this reach as flows in this reach will primarily be influenced by dam outflows.

Upper Reach - This reach extends from the Tyone River downstream to Devil Canyon. The river in this reach is typically single channel and confined by steep canyon walls. It has a relatively steep gradient which results in high channel velocities and large well-armoured substrates. Significant impacts were expected in this reach as the river will be changed from a free-flowing (lotic-type) to lentic-type habitat.

Because the upper reach was expected to have impacts that are not reconciable and because the lower reach was expected to have impacts that were less than those of the middle reach, the middle reach was selected for intial detailed habitat investigations on a multi-year prioritization basis.

Habitat investigations were, however, conducted in the upper and lower reaches. The investigations conducted in the upper reach centered on quantifying the amount of habitat that would be lost to inudation and thus would need to be mitigated for. The investigations conducted in the lower reach were similar to those conducted in the middle reach as discuused below, but on a less detailed basis.

2. The aquatic habitat types that were present in each of the reaches were then delineated based on selected hydrological, hydraulic, and water quality characteristics (i.e., streamflow, temperature, channel gradient and geometry, turbidity, substrate composition, etc.). Hydrological and hydraulic characteristics were selected as the basis for delineation as these were the characteristics of these habitats which would most likely change with construction and operation of the proposed hydroelectric facilities.

Using this process, seven aquatic habitat types were defined and ranked according to the degree of impact expected on the habitat type (see attachment for a description of the aquatic habitat types defined). These aquatic habitat types, with the degree of physical and water quality impact expected to occur, include:

Mainstem - High degree of physical and water quality impact.

Side Channel - High degree of physical and water quality impact.

Side Slough - Moderately high degree of physical and water quality impact.

Upland Slough - Moderate degree of physical and water quality impact.

Tributary Mouth - Moderate degree of physical and water quality impact.

Tributary - Impact only for those tributaries to be impouned.

Lake - Impact only for those lakes to be impounded.

3. Selected physical (discharge/flow, channel gradient and geometry, substrate, ice, and upwelling) and water quality (dissolved oxygen, conductivity, pH, turbidity, and surface and intragravel temperature) variables were monitored in each of the seven aquatic types to determine baseline habitat conditions in each of the seven habitat types and any relationship they may have to mainstem discharge.

4. The seasonal utilization of each of the seven aquatic habitat types in each reach by anadromous and resident fish species during each stage of their life cycle was then determined. Important findings include:

Mainstem habitat - Little utilization by anadromous species other than as a migrational corridor, with the exception of eulachon and Bering cisco which use it as their primary spawning habitat. Supports limited chum and sockeye salmon spawning and chinook and chum rearing. Used primarily as an overwintering habitat by resident fish although some use does occur year-round (i.e., burbot).

Side channel habitat - Moderate utilization by chum, sockeye, and pink salmon for spawning and incubation. High degree of utilization by juvenile chinook salmon for summer rearing and overwintering (if not dewatered). Moderate utilization by resident fish for rearing and overwintering.

Side slough habitat - Significant utilization by chum and sockeye salmon for spawning, incubation, and early rearing. Significant seasonal utilization by juvenile chinook and coho salmon for rearing and overwintering. Moderate utilization by resident fish for rearing.

Upland slough habitat - Little utilization by salmon for spawning. Significant utilization by juvenile coho and sockeye salmon for rearing and utilization. Moderate utilization by resident fish as a rearing area.

Tributary mouth habitat - Moderate utilization by chum and pink salmon for spawning and incubation. High seasonal degree of utilization by rearing juvenile salmon during periods of high food availability and outmigration. High degree of utilization by rearing resident fish.

Tributary habitat - Very high utilization by chinook, coho, chum, and pink salmon for spawning, incubation, and rearing. High degree of utilization by resident fish for spawning and rearing.

5. Evaluation species and life phases were then selected for those aquatic habitat types that were expected to be impacted and that had significant fish utilization. Selection of evaluation species was based on the occurance of a species/life stage in a critically impacted habitat and on the relative importance of a species in terms of its economic, cultural, and recreational value. Selection of target aquaitc habitat types was based on the degree of physical and water quality impact expected and the degree of utilization by the species/life phase of interest. Species/life phases selected for evaluation in such critical aquatic habitat types were:

Chum and sockeye salmon spawning and incubation in side slough/side channel habitats.

Chum salmon spawning in tributary mouth habitats.

Chinook, chum, and coho salmon rearing in side channel/side slough and upland slough habitats.

Other species/life phases and habitats were also evaluated, but because of limited time time, will not be discussed here. These include chum, pink, and sockeye salmon rearing in side and upland slough habitats, chum and sockeye salmon spawning and incubation in mainstem habitats, resident fish rearing in mainstem, side channel and side and upland slough habitats, and eulachon and Bering cisco spawning in mainstem habitats. The reader is referred to the Su Hydro report series for information on these species/life phases and habitat evaluations (see attached bibliography).

6. Based on the baseline habitat data collected in support

of 3, important habitat variables for each of the evaluation species/life stages in each of the critical habitat types were then determined. The habitat variables determined to be critical included:

> Depth, velocity, substrate, and upwelling for chum and sockeye salmon spawning in side slough/side channel and tributary mouth habitats;
>
> Upwelling, temperature, and substrate for chum and sockeye salmon incubation in side slough/side channel and tributary mouth habitats; and,
>
> Velocity, cover/turbidity, and depth for chinook, chum, and coho salmon rearing in side channel/side slough and upland slough habitats.

7. Representative habitats in each of the critical aquatic habitat types were then selected for detailed habitat investigations. Selection of representative habitats was based on the representativeness of particular habitats in terms of their habitat characteristics and fish utilization patterns. In general, representative sites selected for study were those sites which had fish utilization by the species/life phase of interest and which were representative of other similar habitats, in terms of their habitat characteristics, that had fish utilization by the species/life phase of interest. The representative habitat types selected for detailed investigations in the middle river reach based on these criteria were:

> Chum and sockeye salmon spawning in side slough/side channel habitats - Sloughs 8A, 9, and 21 and Side Channels 10A, Lower and Upper 11, and 21.
>
> Chum and sockeye salmon incubation in side slough/side channel habitats - Side Sloughs 10, 11, and 21and Side Channels 10, Upper 11, and 21.
>
> Chum salmon spawning in tributary mouth habitats - Lane and Fourth of July Creek tributary mouths.
>
> Chinook and chum salmon rearing in side slough/side channel habitats - Side Sloughs 8, 9, 21, and 22, and Whiskers Creek Side Slough and Side Channels 10A, Lower 11, Upper 11, and 21.
>
> Chinook and coho salmon rearing in upland slough habitats - Upland Sloughs 5 and 6A.

8. Methods were then selected for use in evaluating the representative habitat types. Selection of a method depended on:

> a. The abiltiy of the method to describe the response of the critical habitat variables at the

representative study sites to changes in discharge of the river expected with construction and operation of the hydroelectric facilities.

b. The abiltiy of the method to describe the habitat responses of the target species/life phases to changes in discharge of the mainstem Susitna River.

Based on these criteria, the methods selected for use and rationale for their selection were:

Chum and sockeye salmon spawning in side slough and side channel habitats - U.S. Fish and Wildlife Service (USF&WS) Instream Flow Incremental Methodology (IFIM) Physical Habitat Simulation Modelling (PHABSIM) methods (IFG 1980, Bovee 1982). USF&WS IFIM PHABSIM methods were selected because:

-The method is a legally accepted means of quantifying habitat changes as a function of flow.

-The input variables into the models which form the basis of this methodology are the variables which limit the species/life phases under study,

-The method is able to predict the incremental responses of habitat in these habitat types in terms of the limiting habitat variables to changes in flow ranging from the current to expected post-project flows, and

-The method provides the required information about habitat changes over time to allow an evaluation of project impacts and mitigation options.

-For a detailed discussion of the underlying assumptions in this methodology refer to Vincent-Lang et al, 1984 and Estes, 1984.

Chum salmon incubation in side channel and side slough habitats - Whitlock-Vibert Box methods.

-A quantitative methodology such as IFIM to assess the availabiltiy of incubation habitat in terms of flow was not available at the time of the study.

-For this reason and monetary and personnel restrictions, the assessment of incubation habitat was limited to a more qualitatively-based assessment of incubating embyro development and survival in terms of selected critical habitat variables through the use of in situ egg incubation chambers. These methods, however, did not allow for a quantitative assessment of the effects of flow on the availabiltiy of incubation habitat. For this reason, only qualitative assessments could be made.

Chum salmon spawning in tributary mouth habitats - An adaptation of Washington methods (Collins 1972, 1974). Washigton-type methods were selected as the basis for analysis because:

-The USF&WS IFIM PHABSIM methods could not be applied as the tributary mouth habitats did not have fixed boundaries and are thus not amenable to modelling with the IFIM approach.

-An adaptation of the Washington methodology was the most applicable method available to estimate the response of habitat as a function of observed flow. Because the method is not emprically predictive, evaluations outside the observed flow range must be extraploiated based on professional judgement. For this reason, the method could only be used to estimate expected impacts but not to quantify them or to evaluate flow related mitigative measures quantitatively.

Chinook, chum, and coho salmon rearing in side channel and side and upland slough habitats - USF&WS IFIM PHABSIM methods and Schmidt et al RJHAB methods (Schmidt et al, 1984). These methods were selected for these analyses as:

-The USF&WS IFIM methods were selected for analysis for the same reasons they were chosen for the chum and sockeye spawning habitat assessment in side sloughs and side channels as outlined above.

-It was felt, however, that the IFIM methods may not always accurately assess rearing habitat in these habitat types as rearing fish density may not be solely a function of the factors integral to the models which form the basis for the method (i.e., depth, velocity, substrate cover may not be sole limiting habitat variables).

Further, the IFIM methods do not effectively model backwater ares with little flow which appear to be utilized by juvenile salmon for rearing

For these reasons and due to manpower limitations, a more generalized approach was also developed and applied to assess rearing habitat changes as a function of flow in these habitat types. This method, called the RJHAB method, better evaluated changes in habitat in terms of large scale catastrophic hydraulic events and the availability of cover in terms of turbidity. These factors were considered to be the dominant variables influeing the quality of habitat for rearing by chinook and coho salmon juveniles. RJHAB models cannot, however, simulate physical conditions and therefore cannot be used to predict habitat conditions outside the range of flows evaluated, only extrapoliated. Such predictive quantitative assessments were made with the IFIM approach.

-For a detailed discussion of the limitations of the RJHAB model and a discussion of its comparision to USF&WS IFIM methods see Schmidt et al (1984).

8. The representative habitats were then evaluated using the respective methods described above to define the responses of habitat in each representative habitat type in terms of the critical habitat variables to changes in discharge of the mainstem river. Important findings include:

-The baseline amount of chum and sockeye salmon spawning habitat in side slough and side channel habitat types was found to be dependent on the amount of upwelling surface area present at a specific study habitat. Above this baseline, the amount of habitat available was found to peak near the breaching discharge of the specific study habitat indicating, that up until breaching, the amount of wetted surface area (i.e., depth) present in a site is the factor limiting the amount of usable spawning habitat after which velocity becomes limiting. Additionally, the availability of the habitat in these habitat types was found to be dependent on the accessabiltiy of the habitat in the sites. Accessibility was found to be a function of the depth at the study sites which itself was found to be dependent on both the specific channel geometry and discharge/site flow characteristics of the sites. For details, refer to Vincent-Lang et al (1984) and Sautner et al(1984).

-The amount of chum salmon spawning habitat in tributary mouth habitats was found to be a function of both the tributary flow and mainstem discharge depending on the type on confluence the tributary has with the mainstem river (i.e., sheer or non-sheer). At sheer type confluences, the amount of available usable habitat generally decreased with increasing mainstem discharge regardless of tribuary flow, whereas at non-sheer type confluences the amount of available usable habitat incresed with both increasing mainstem and tributary discharges. For details, refer to Sandone et al (1984).

-The largest demonstrated cause of incubating embyro mortality within side channel, side slough, and tributary mouth habitats was found to be due to dewatering and subsequent freezing of the streambed. The effect was greatest in side channels and least in side slough habitats and was directly related to the presense or absence of upwelling. Thus, the amount of incubation habitat within these habitats appeared to be a function of the amount of upwelling that persisted within the habitats throughout the incubation period of the embyros. Other factors that were also found to be important included temperature of the upwelling water source, the degree of upwelling present, and the occurance of breaching winter flows. For details, refer to Vining et al (1985).

-The amount of chinook salmon rearing habitat in side slough and side channel habitats was modelled for turbity levels above and below 30 NTU's as turbidity appeared to be the major variable influencing the distribution of juvenile chinook salmon in these habitat types. In general, the amount of available usable habitat in these habitat types was greatest under turbid conditions when the velocity was moderate. For this reason, usable habitat in the modelled habitats peaked just after the modelled study sites became breached by the mainstem flow. The reason for this appeared to be based in the use of turbidity as suitable cover. Under low turbidity conditions, the amount of usable habitat was found to be dependent largely on the amount of object cover present. Coho salmon did not appear to utilize to any large extent the turbid-water mainstem-influenced side slough and side channel habitats for rearing.

In contrast, upland slough habitats appeared to be highly suitable habitat for coho salmon juvenile rearing and less suitable habitat for chinook salmon juvenile rearing. The reason for this is that upland sloughs are typically clear and have slow moving waters and object cover which are preferred by coho salmon juveniles but not by chinook salmon juveniles. The amount of coho salmon rearing habitat in upland slough habitats was found to be largely a function of the surface area of those habitats. For details, refer to Schmidt et al (1984).

9. The results of the ADF&G site-specific habitat investigations are currently being extrapoliated by E. W. Trihey and Associates, with the input of ADF&G, to the overall set of habitats that the representative habitats were intended to represent. The extrapoliation is concentrating on the target species selected by the Alaska Power Authority which are chum salmon spawning in side channel and side slough habitats and chinook salmon rearing in side channel habitats. Included in the extrapoliation process is consideration of the relative utilization of specific evaluated and non-evaluated habitats by the species/life stages that utilize them and of the influence the limiting habitat variables have on the utilization of these habitats. Also considered is the relationship of other life phases on the target life phase such as effects of passage restrictions on spawning.

10. After the extrapoliation is completed, a detailed impact assessment will be conducted by Harza-Ebasco to determine specific impacts expected with specific discharge regimes of the proposed hydroelectric facilities.

11. The results of the impact assessments will then be used in conjunction with the aquatic habitat evaluations to develope a mitigation plan to alliveate expected impacts.

12. Work similar to that discussed above for the middle reach has also been initiated for the lower river reach. This work is centering on describing the relationship that juvenile salmon rearing habitat in lower river side channels has to lower river discharge. Initial findinds show the response of juvenile salmon habitat to changes in discharge in the lower river to be generally the same as for the middle river with the exception that after breaching, usable habitat in side channels did not always fall as it did in the middle river. The reason for this is likely tied to the increses in surface area with increases in mainstem dischage that are usable in terms of velocity.

Work is also progressing on evaluating the response of chum salmon spawning and incubation habitat and juvenile sockeye salmon overwintering habitat in lower river side channels to changes in lower river discharge. Important findings to date include:

-A significant population of spawning chum salmon utilize lower river side channels for spawning and incubation.

-The availability of the habitat is a function of mainstem discharge. The relationship of these factors is currently being investigated.

-The success of incubating embyros in the side channels is tied to the maintenance of upweeling groundwater which appears to be related to mainstem ice staging conditions.

-Significant juvenile sockeye salmon overwintering may occur in selected lower river habitats.

The results of these site specific will also be extrapoliated to the overall lower river using similar approaches developed for the midle river. Based on the results, an impact assessment will be conducted and mitigation plan developed for the lower river.

References cited:

Bovee, K.D. 1982. A guide to stream habitat and analysis using instream flow incremental methodology. Instream Flow Information Paper No. 12. Coop. Instream Flow Service Group. USF&WS. Colorado.

Collings, M.R. 1972. A methodology for determing instream flow requirements for fish. pp. 72-86. In Proc., Instream Flow Methodology Workshop. Washington State Department of Ecology, Olympia, Washington.

_____. 1974. Generalization of spawning and rearing discharges for several PAcific salmon species in western Washington. U.S. Geological Service Open File Report. 39 pp.

Estes, C.C. and D.S. Vincent-Lang, editors. Aquatic Habitat and instream flow investigations, May-October 1983 (10 volumes: Chapters 1-10). Susitna Hydro Aquatic Studies. Report No. 3. Alaska Department of Fish and Game, Anchorage, Alaska.

Estes, C.C. 1984. Evaluation of methods for recommending instream flows to support spawning by salmon. M.S. Thesis. Washington State University, Pullman, WA.

Instream Flow Group (IFG). 1980. The incremental approach to the study of instrem flows. USF&WS. W/IFG-89W31. Fort Collins, Colorado.

Sandone, G., D.S. Vincent-Lang, and A. Hoffmann. 1984. Evaluation of chum salmon spawning habitat in selected tributary mouth habitats on the middle Susitna River. Chapter 8 in: C.C. Estes and D.S. Vincent-Lang, eds. Aquatic Habitat and instream flow investigations, May-October 1983. Susitna Hydro Aquatic Studies. Report No. 3. Alaska Department of Fish and Game, Anchorage, Alaska.

Sautner, J., L.J. Vining, and L.A. Rundquist. 1984. An evaluation of passage conditions for adult salmon in sloughs and side channels of the middle Susitna River. Chapter 6 in: C.C. Estes and D.S. Vincent-Lang, eds. Aquatic Habitat and instream flow investigations, May-October 1983. Susitna Hydro Aquatic Studies. Report No. 3. Alaska Department of Fish and Game, Anchorage, Alaska.

Schmidt, D.C., S.S. Hale, D.L. Crawford, and P. Suchanek. 1984. Resident and juvenile anadromous fish investigations (May-October 1983). Susitna Hydro Aquatic Studies. Report No. 2. Alaska Department of Fish and Game, Anchorage, Alaska.

Vincent-Lang, D.S., A. Hoffmann, A.E. Bingham, C.C. Estes,

D. Hilliard, C. Steward, E.W. Trihey, and S. Crumley. 1984. An evaluation of chum and sockeye salmon spawning habitat in sloughs and side channels of the middle Susitna River. Chapter 7 in: C.C. Estes and D.S. Vincent-Lang, eds. Aquatic Habitat and instream flow investigations, May-October 1983. Susitna Hydro Aquatic Studies. Report No. 3. Alaska Department of Fish and Game, Anchorage, Alaska.

Vining, L.J., J.S. Blakely, and G. Freemann. 1985. An evaluation of the incubation life phase of chum salmon in the middle Susitna River, Alaska. Volume 1 in: C.C. Estes, J. Sautner, and D.S. Vincent-Lang, editors. Winter aquatic investigations (September 1983-May 1984). Susitna Aquatic Studies Program. Report No. 5. Alaska Department of Fish and Game, Anchorage, Alaska.

B-7 Long Term Monitoring Strategies

RESIDENT FISH LONG TERM MONITORING

Problem:

Hydroelectric development may alter the population structures of resident fish in the middle Susitna River reach.

Natural conditions are characterized by:

1. low, clear winter flows
2. high turbid summer flows

With-project conditions will be characterized by:

1. high, relatively turbid and warmer winter flows
2. delayed ice formation
3. lower and clearer summer flows

Objective:

Assess the positive and negative with-project effects to resident fish populations in the Susitna River by comparing these populations' densities and distributions from pre- to with-project.

Procedures:

We propose a continuation of the basic procedures now in place. The pre-project data will be compared to the post-project data. Changes will be documented and reported.

The procedure for long term resident fish monitoring is divided into:

<u>Pre-project</u> (natural conditions)

1. Below Devil Canyon

<u>With-project</u>

1. Below Devil Canyon

2. Impoundment

Pre-Project:

Below Devil Canyon

1. Continue to electrofish by boat at the 16 middle river index sites to make pre- to with-project comparisons in catch and CPUE. These sites are composed of three major habitats and comparisons in resident fish catches can also be made between macrohabitats.

2. Continue to use secondary gear types such as gill nets and hook and line to supplement boat electrofishing data. Also, continue to record fishwheel and out-migrant resident fish catches.

3. Continue to collect biological data from resident fish to observe for trends in age compositions.

4. Continue the mark-and-recapture program to generate population estimates and determine migrational patterns of selected resident fish species. Population estimates will be made for adult rainbow trout, Arctic grayling, burbot, round whitefish, and longnose sucker in the middle river. Population estimates will also be made separately for rainbow trout > 150 mm in Fourth of July Creek.

   Fish movement data will be provided by analysis of tag recoveries. Species that will be tagged are rainbow trout, Arctic grayling, burbot, Dolly Varden, round and humpback whitefish, and longnose suckers.

5. Every third year beginning in 1986, generate microhabitat suitability criteria curves to supplement microhabitat data gathered during previous years.

With-Project:

A. Below Devil Canyon

1. Continue boat electrofishing at middle river index sites and use of secondary gear types as described in the with-project procedure.

2. Continue to collect biological data as described in the with-project procedure.

3. Continue the mark-and-recapture program as described in the with-project procedure.

4. The radio telemetry program should be re-instituted for two years during construction and for at least three years after construction to provide better movement data on middle river rainbow trout, Arctic grayling, and burbot.

5. Microhabitat suitability criteria for adult middle river resident fish should be generated each year during construction and for at least two years after construction to determine how these fish have adapted to with-project changes.

B. Impoundment

1. Re-institute the mark-and-recapture program during construction and continue the program for at least two years after construction to:

    a) generate population estimates for Arctic grayling, and

    b) determine movement patterns of selected fish species in the eight major clear water tributaries.

    Tagging and subsequent recapture of Arctic grayling will also be done in the upper reaches of Deadman Creek. This area has a much greater frequency of large Arctic grayling compared to other areas in the upper Susitna drainage. One access proposal to the dam site is the building of a road nearby upper Deadman Creek. Because of easier access, fishing pressure is expected to increase and thereby substantially alter the Arctic grayling population structure in the now "trophy" Arctic grayling area.

2. Continue to collect biological data from resident fish to observe for trends in age structures.

3. Radio tag Arctic grayling for at least two years to provide better information than gathered by tag recoveries on with-project Arctic grayling movement behavior.

Assumptions:

1. Random mark-and-recapture effort.

2. Time between sampling does not affect recapture probabilities.

3. The population is closed geographically.

4. Gear efficiency varies with the size of fish.

5. There is a random mixing of tagged with non-tagged fish.

6. Mortalities due to capture and tagging, are insignificant.

7. There is little difference in behavior between tagged and untagged fish.

8. The variability in sampling remains constant within and between years.

Recommendations:

1. With the expected increase in fishing pressure at middle river and impoundment clear water tributaries, a creel census program could possibly be instituted to monitor the effects of fishing mortality on populations and to provide biological data. This method may also provide an alternative to sampling in the post-project phase.

2. Data suggests much of the middle river rainbow trout population originates from lakes draining into clear water tributaries, and that there is a low existing reproduction of rainbow trout in the middle river. In several middle river lakes, there is known good spawning habitat. Middle river rainbow trout populations may be enhanced by stocking existing lakes with access to middle river tributaries that currently have no rainbow trout. Also, suitable stocking lakes with limited access to middle river tributaries could be altered to provide better access. This scheme may ultimately increase the numbers of rainbow trout in the middle river.

MIDDLE RIVER LONG TERM WATER QUALITY PARAMETER
AND DISSOLVED GAS MONITORING PROGRAM

Problem:

Development and operation of the proposed hydroelectric facilities on the Susitna River is expected to alter the natural habitat conditions. Changes in water quality conditions which influence habitat are expected to include changes in downstream dissolved gas concentrations, turbidity levels, and water temperatures. This task will implement a long-term monitoring of these water quality parameters.

Objective:

To monitor selected water quality parameters (water temperature, dissolved gas concentrations, turbidity levels, suspended sediments, dissolved oxygen, and pH) for the development of a historical data base.

Methods:

1. Temperature

Surface water temperature will be monitored on a continuous basis from May-October 1985 at the following locations:

SITE	RM	HABITAT
Mainstem upstream of Parks Highway Bridge	86.6	Mainstem
Talkeetna Station	103.0	Mainstem
Curry Station	120.7	Mainstem
Fourth of July Creek	131.1	Tributary
Mainstem downstream of Gold Creek Bridge	135.8	Mainstem
Indian River	138.6	Tributary
LRX 53	140.1	Mainstem
Portage Creek	148.8	Tributary
Mainstem downstream of Devil Canyon	150.1	Mainstem
Mainstem at Watana Dam Site	184.2	Mainstem

Surface water temperatures will be obtained on a continuous basis using Omnidata two channel datapod recorders. These temperature recorders are capable of monitoring water temperature simultaneously from each of the two channels. Both channels will be used to monitor surface water temperatures to ensure as complete a record as possible. In addition to the datapod recorders, Ryan thermographs will be installed as backup units in the event the datapod recorder malfunctions.

2. Turbidity

Turbidity samples will be obtained on a daily, weekly, or bi-monthly schedule from seven mainstem locations extending from just upstream of the Parks Highway Bridge to Devil Canyon at river mile 150.1. These sites are as follow:

SITE	RM	SAMPLING SCHEDULE
Mainstem upstream of Parks Highway Bridge	86.2	Weekly
Talkeetna Station	103.0	Daily
Curry Station	120.7	Daily
Mainstem upstream of Curry Station	120.9	Weekly
Mainstem downstream of Gold Creek Bridge	135.8	Weekly
Mainstem upstream of Portage Creek	149.4	Weekly
Mainstem at Watana Dam Site	184.2	Bi-Monthly

Both 250 ml and two liter water samples will be obtained in the field for turbidity analysis. Turbidity samples obtained in 250 ml bottles will be analyzed in the field on a HF Instruments DRT-15 turbidity meter according to instructions outlined in Appendix IX of the Phase I ADF&G Su Hydro Aquatic Studies Procedure Manual (ADF&G 1981). The two liter water samples will be returned to Anchorage within 24 hours for analysis by Northern Testing Laboratories, Inc. All turbidity samples will be analyzed as Nephlometric Turbidity Units (NTU).

3. Total Dissolved Gas Concentrations

Dissolved gas will also be monitored on a continuous basis for the 1985 open water field season at four mainstem locations restricted to the reach of river extending from Curry Station (RM 120.7) to the proposed Watana Dam Site (RM 184.2). These sites are as follows:

SITE	RM
Curry Station	120.7
Mainstem downstream of Gold Creek Bridge	135.8
Mainstem downstream of Devil Canyon	150.1
Mainstem at Watana Dam Site	184.2

Total dissolved gas concentrations will be continuously monitored using a Common Sensing model TGT-F tensionometer. Long term monitoring of dissolved gas should normally be from May-October. The sites selected for installation are areas of steep banks and well mixed mainstem water.

4. <u>Dissolved Oxygen, pH, and Suspended and Settleable Solids</u>

The water quality parameters of dissolved oxygen, pH, and suspended and settleable solids will be obtained on a weekly basis from five mainstem locations with the exception of the Watana Dam site sampling location where only dissolved oxygen and pH will be obtained. These samples sites are as follow:

SITE	RIVER MILE	D.O.	pH	SUSPENDED AND SETTLEABLE SOLIDS
Mainstem upstream of Parks Highway Bridge	86.2	X	X	X
Talkeetna Station	103.0	X	X	X
Mainstem upstream of Curry Station	120.9	X	X	X
Mainstem downstream of Gold Creek Bridge	135.8	X	X	X
Mainstem upstream of Portage Creek	149.4	X	X	X
Mainstem at Watana Dam Site	184.2	X	X	

a. Dissolved Oxygen and pH

The water quality parameters of dissolved oxygen (D.O.) and pH will be measured using a Hydrolab model 4041 portable multiparameter meter using procedures outlined in the FY 84 ADF&G Procedures Manual (ADF&G 1984). Measurements will be made on an instantaneous basis in areas considered to be well mixed.

b. Suspended Solids and Settleable Solids

Water samples will be collected on a weekly basis at selected sites in areas observed as being well mixed. These water samples will be obtained by submersing two one-liter nalgene bottles simultaneously. These water samples will provide ample water for analysis to be performed by Northern Testing Laboratories, Inc. Both suspended solids and settleable solids will be reported as mg/l.

Conclusions Drawn to Date:

Temperature

Surface water temperature recording at the seven mainstem sites from upstream of the Parks Highway Bridge (RM 86.6) to the Watana Dam site (RM 184.2) provide a good temperature evaluation for that reach. Installation of temperature recorders on the smolt traps has improved the continuity of data collection needed at those sites.

Water temperature data are retrieved from the datapod temperature recorders as six-hour minimum, mean, and maximum temperatures. These six-hour bases are edited and corrected for storage errors and anomalous data. From these corrected data bases, the daily and monthly mean, minimum, and maximum temperatures are calculated and reported in tables and plots. Examples of these tables and plots are presented in Attachments 1 and 2.

Turbidity

Turbidity has been measured in the field daily at four sites; by Northern Testing Laboratories, Inc. and ADF&G weekly at four sites and bi-monthly at one site. The data will be put in table form for comparison and plotted against time and/or mainstem discharge. No conclusions have been derived to date.

Total Dissolved Gas

Dissolved gas is being measured at four mainstem sites from RM 120.7 to 184.6. These sites appear adequate to describe changes in dissolved gas within this reach. After a data base is established (possibly by November 1986) at these sites, one or more of the sites may need to be moved to evaluate a longer reach. Tables and plots will be made to include total dissolved gas, dissolved oxygen, time and mainstem discharge at Gold Creek.

Data collected in 1982 by Dr. Dana Schmidt indicates that total dissolved gas concentrations greater than 100 percent occur naturally in Devil Canyon and decay at a steady rate downstream approximately as far as Gold Creek.

Dissolved Oxygen (D.O.)

This parameter is being measured weekly at six mainstem sites from RM 86.2 to 184.2. These sites are adequate but sampling should be more often so a wider range of mainstem discharges could be encompassed. In addition to being analyzed with total dissolved gas, monthly averages will be tabulated and plotted.

Suspended Solids and Settleable Solids

Suspended solids and settleable solids are being measured from samples collected at five mainstem sites from RM 86.6 to 149.4. These samples are processed by a lab in Anchorage. This arrangement has worked well. These data and the turbidity of the samples will be tabulated and plotted with time and/or mainstem discharge.

Recommendations:

1. Surface Water Temperature

a. To establish a historical data base for the reach from Talkeetna to Watana, the six mainstem sites should be continued at least two more years.

b. Temperature sites at the smolt traps should continue as long as the traps are used.

c. If temperature needs to be described for the reach below Talkeetna, sites should be chosen for that purpose.

2. Turbidity

a. Past turbidity data and this years should be carefully examined to determine whether daily sampling is useful and whether field methods are adequate.

3. Total Dissolved Gas

Recommendation should await the input of more data.

4. Dissolved Oxygen, pH, Settleable Solids, Suspended Solids

These parameters should continue to be sampled weekly at the present sites for at least two more years to establish a data base. Sampling of these parameters should be done more often if manpower and funding allow.

DIVISION OF COMMERCIAL FISHERIES
SUSITNA AQUATIC STUDIES

Proposal Of

LONG TERM MONITORING STRATEGY

For

WATER QUALITY AND DISSOLVED GAS MONITORING

October 1985

Project Title: Middle River Long-Term Water Quality Parameter and Dissolved Gas Monitoring Program

Project Supervisor: Larry Bartlett

Task Manager: Tim Quane

Budget:

	Allocated	Spent To Date
Line 100	80.0	25.0
Line 200	0.5	0.2
Line 300	8.5	1.0
Line 400	11.0	4.0
Line 500	0.0	0.0
TOTAL	100.0	30.2

Problem Statement:

Develop and operation of the proposed hydroelectric facilities on the Susitna River is expected to alter the natural habitat conditions currently utilized by fish in the various aquatic habitat types present. Changes in water quality conditions which influence habitat are expected to include changes in downstream dissolved gas concentrations, turbidity levels, and water temperatures. This task will implement a long-term monitoring of these water quality parameters. The data collected can be used on the short-term basis for impact and mitigation analyses and for developing a historical data base. On a long-term basis, the data collected can be used to ensure the project is operated under licensed guidelines.

Objective:

To monitor selected water quality parameters (water temperature, dissolved gas concentrations, turbidity levels, suspended sediments, dissolved oxygen, and pH) over a short-term basis for use in impact and mitigation assessments and over a long-term basis for the development of a historical data base.

Overview of Methods:

1. Temperature

Surface water temperature will be monitored on a continuous basis from May-October 1985 as the following locations:

SITE	RM	HABITAT
Flathorn West Channel	22.4	Mainstem
Flathorn East Channel	25.1	Mainstem
Mainstem upstream of Parks Highway Bridge	86.6	Mainstem
Talkeetna Station	103.0	Mainstem
Curry Station	120.7	Mainstem
Fourth of July Creek	131.1	Tributary
Mainstem downstream of Gold Creek Bridge	135.8	Mainstem
Indian River	138.6	Tributary
LRX 53	140.1	Mainstem
Portage Creek	148.8	Tributary
Mainstem downstream of Devil Canyon	150.1	Mainstem
Mainstem at Watana Dam Site	184.2	Mainstem

Surface water temperatures will be obtained on a continuous basis using Omnidata two channel datapod recorders. These temperature recorders are capable of monitoring water temperature simultaneously from each of the two channels. Both channels will be used to monitor surface water temperatures to ensure as complete a record as possible. In addition to the datapod recorders, Ryan thermographs will be installed as backup units in the event the datapod recorder malfunctions.

2. Turbidity

Turbidity samples will be obtained on both a daily and weekly schedule from seven mainstem locations extending from Flathorn Station (RM 22.4) to Devil Canyon at river mile 150.1. These sites are as follow:

SITE	RM	SAMPLING SCHEDULE
Flathorn West Channel	22.4	Daily
Flathorn East Channel	25.1	Daily
Mainstem upstream of Parks Highway Bridge	86.2	Weekly
Talkeetna Station	103.0	Daily
Curry Station	120.7	Daily
Mainstem upstream of Curry Station	120.9	Weekly
Mainstem downstream of Gold Creek Bridge	135.8	Weekly
Mainstem upstream of Portage Creek	149.4	Weekly
Mainstem at Watana Dam Site	184.2	Bi-Monthly

Both 250 ml and two liter water samples will be obtained in the field for turbidity analysis. Turbidity samples obtained in 250 ml bottles will be analyzed in the field on a HF Instruments DRT-15 turbidity meter according to instructions outlined in Appendix IX of the Phase I ADF&G Su Hydro Aquatic Studies Procedure Manual (ADF&G 1981). The two liter water samples will be returned to Anchorage within a 24 hour period for analysis by Northern Testing Laboratories, Inc. All turbidity samples will be analyzed as Nephlometric Turbidity Units (NTU).

3. Total Dissolved Gas Concentrations

Dissolved gas will also be monitored on a continuous basis for the 1985 open water field season at four mainstem locations restricted to the reach of river extending from Curry Station (RM 120.7) to the proposed Watana Dam Site (RM 184.2). These sites are as follows:

SITE	RM
Curry Station	120.7
Mainstem downstream of Gold Creek Bridge	135.8
Mainstem downstream of Devil Canyon	150.1
Mainstem at Watana Dam Site	184.2

Total dissolved gas concentrations will be continuously monitored using a Common Sensing model TGT-F tensionometer. Time of installation for three of these meters in 1985 is dependent on the purchase of the instruments and the time necessary to ensure their compatibility with Omnidata datapod recorders. The fourth meter was installed at the Devil Canyon site on June 15, 1985. Long term monitoring of dissolved gas should normally be from May-October. The sites selected for installation are areas of steep banks and well mixed mainstem water.

4. Dissolved Oxygen, pH, and Suspended and Settleable Solids

The water quality parameters of dissolved oxygen, pH, and suspended and settleable solids will be obtained on a weekly basis from five mainstem locations with the exception of the Watana Dam site sampling location where only dissolved oxygen and pH will be obtained. These samples sites are as follow:

SITE	RM	D.O.	pH	SUSPENDED AND SETTLEABLE SOLIDS
Mainstem upstream of Parks Highway Bridge	86.2	X	X	X
Talkeetna Station	103.0	X	X	X
Mainstem upstream of Curry Station	120.9	X	X	X
Mainstem downstream of Gold Creek Bridge	135.8	X	X	X
Mainstem upstream of Portage Creek	149.4	X	X	X
Mainstem at Watana Dam Site	184.2	X	X	

a. Dissolved Oxygen and pH

The water quality parameters of dissolved oxygen (D.O.) and pH will be measured using a Hydrolab model 4041 portable multiparameter meter using procedures outlined in the FY 84 ADF&G Procedures Manual (ADF&G 1984). Measurements will be made on an instantaneous basis in areas considered to be well mixed.

b. Suspended Solids and Settleable Solids

Water samples will be collected on a weekly basis at selected sites in areas observed as being well mixed. These water samples will be obtained by submersing two one-liter nalgene bottles simultaneously. These water samples will provide ample water for analysis to be performed by Northern Testing Laboratories, Inc. Both suspended solids and settleable solids will be reported as mg/l.

Conclusions Drawn to Date:

Temperature

Surface water temperature recording at the seven mainstem sites from upstream of the Parks Highway Bridge (RM 86.6) to the Watana Dam site (RM 184.2) provide a good temperature evaluation for that reach. The three temperature sites from the mouth to Talkeetna do not adequately evaluate that reach. Installation of temperature recorders on the smolt traps has improved the continuity of data collection needed at those sites.

Water temperature data are retrieved from the datapod temperature recorders as six-hour minimum, mean, and maximum temperatures. These six-hour bases are edited and corrected for storage errors and anomalous data. From these corrected data bases, the daily and monthly mean, minimum, and maximum temperatures are calculated and reported in tables and plots. Examples of these tables and plots are presented in Attachments 1 and 2.

Turbidity

Turbidity has been measured in the field daily at four sites; by Northern Testing Laboratories, Inc. and ADF&G weekly at four sites and bi-monthly at one site. The data will be put in table form for comparison and plotted against time and/or mainstem discharge. No conclusions have been derived to date.

Total Dissolved Gas

Dissolved gas is being measured at four mainstem sites from RM 120.7 to 184.6. These sites appear adequate to describe changes in dissolved gas within this reach. After data base is established (possibly by November 1986) at these sites, one or more of the sites may need to be moved to evaluate a longer reach. Tables and plots will be made to include total dissolved gas, dissolved oxygen, time and mainstem discharge at Gold Creek.

Data collected in 1982 by Dr. Dana Schmidt indicates that total dissolved gas concentrations greater than 100 percent occur naturally in Devil Canyon and decay at a steady rate downstream approximately as far as Gold Creek.

Dissolved Oxygen (D.O.)

This parameter is being measured weekly at six mainstem sites from RM 86.2 to 184.2. These sites are adequate but sampling should be more often so a wider range of mainstem discharges could be encompassed. In addition to being analyzed with total dissolved gas, monthly averages will be tabulated and plotted.

Suspended Solids and Settleable Solids

Suspended solids and settleable solids are being measured from samples collected at five mainstem sites from RM 86.6 to 149.4. These samples are processed by a lab in Anchorage. This arrangement has worked well. These data and the turbidity of the samples will be tabulated and plotted with time and/or mainstem discharge.

Recommendations:

1. Surface Water Temperature

a. To establish a historical data base for the reach from Talkeetna to Watana, the six mainstem sites should be continued at least two more years.

b. Temperature sites at the smolt traps should continue as long as the traps are used.

c. If temperature needs to be described for the reach below Talkeetna, sites should be chosen for that purpose.

2. Turbidity

a. Past turbidity data and this years should be carefully examined to determine whether daily sampling is useful and whether field methods are adequate.

3. Total Dissolved Gas

Recommendation should await the input of more data.

4. Dissolved Oxygen, pH, Settleable Solids, Suspended Solids

These parameters should continue to be sampled weekly at the present sites for at least two more years to establish a data base. Sampling of these parameters should be done more often if manpower and funding allow.

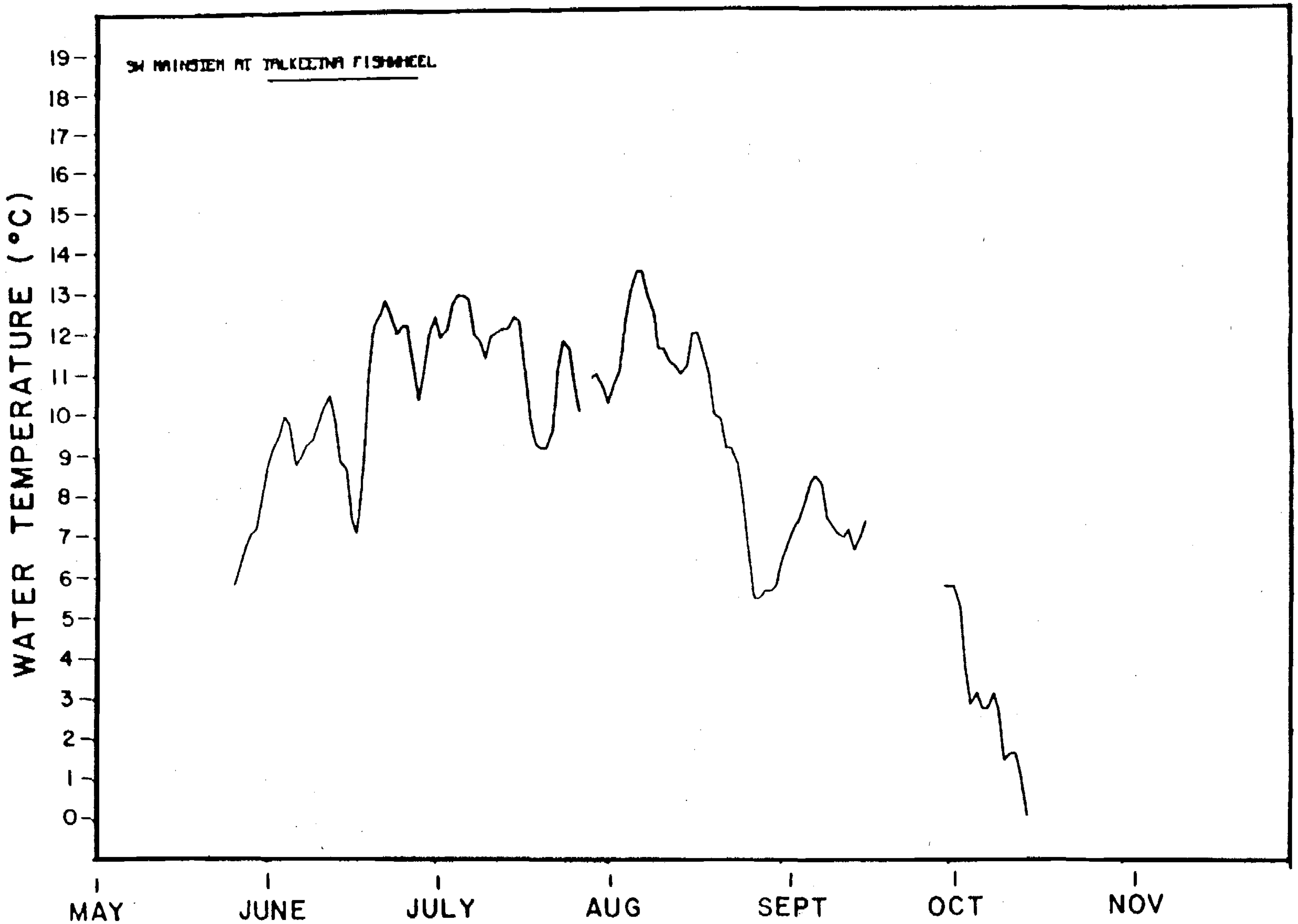
ATTACHMENT 1

Datapod temperature recorder data summary: intragravel and surface water temperatures (C) recorded at Fourth of July Creek - Site 3, RM 131.1, TRM 0.2.

OCTOBER 1984

	INTRAGRAVEL			SURFACE WATER		
DATE	MIN.	MEAN	MAX.	MIN.	MEAN	MAX.
841010	2.0	---	2.6	1.8	---	2.4
841011	2.2	2.7	3.4	1.9	2.5	3.1
841012	2.1	2.6	3.2	1.9	2.4	3.0
841013	0.0	.9	2.6	1.2	---	2.4
841014	-0.2	.1	.6	---	---	---
841015	-0.3	0.0	.7	---	---	---
841016	-0.3	0.0	.4	---	---	---
841017	-0.3	-0.2	0.0	---	---	---
841018	-0.3	-0.2	-0.1	---	---	---
841019	-0.2	-0.2	-0.1	---	---	---
841020	-0.2	.1	.8	---	---	---
841021	.7	1.4	2.2	---	---	---
841022	1.0	1.4	2.0	---	---	---
841023	-0.2	.2	1.1	---	---	---
841024	-0.2	-0.2	-0.1	---	---	---
841025	-0.3	-0.2	-0.1	---	---	---
Monthly Value	-0.3	---	3.4	1.2	---	3.1

--- Data not available



Attachment 2. Mean daily surface water temperature recorded at Mainstem Susitna River at Talkeetna Fishwheel Camp (RM 103.0) during the 1984 open water season.

DIVISION OF COMMERCIAL FISHERIES
SUSITNA AQUATIC STUDIES

Proposal Of

LONG TERM MONITORING STRATEGY

For

BENDIX SONAR EVALUATION

October 1985

Project Title: Evaluation of Long-Range, Side-Scan Sonar Counters as an Alternative to Tag and Recapture Program

Project Supervisor: Larry Bartlett

Task Manager: Mike Thompson

FY 86 Allocation:

Approximately 20.0K in FY 85 carry over funds.

Spent To Date: None

Problem Statement:

Tag and recapture methods are currently used by ADF&G Su Hydro to estimate adult salmon escapements in the Susitna River. Estimates obtained by this method are extremely labor intensive and costly. For the development of a long term monitoring program, it would be preferable to have a more cost-effective method of enumerating adult salmon escapements. Hydroacoustic techniques may provide this alternative. Recent developments in hydroacoustic technology extend the effective counting range and negate the use of an artificial substrate, both of which were problems encountered using earlier model side scan sonar counters in the Susitna River.

Objective:

To evaluate the Bendix long range side scan sonar in the turbid Susitna River as a possible cost effective alternative to tag and recapture programs.

Overview of Methods:

Two Bendix long range side scan sonars will be deployed off each bank near the Parks Highway Bridge at approximately RM 83. These units will be operated with a tag/recapture program at Sunshine Station (RM 80). The tag/recapture escapement estimates will be used as a basis to judge the accuracy of the side scan sonars. Two fishwheels will also be deployed, one near each sonar unit, to provide species composition data to apportion the sonar counts.

Conclusions:

None. The experiment is scheduled for June 1986.

Recommendations:

The Bendix sonar, although designed for salmon, has a limited range in the Susitna River (approximately 120 feet). A BioSonics sonar should be used for one season at the site to determine if mid-channel migration paths are used.

DIVISION OF COMMERCIAL FISHERIES
SUSITNA AQUATIC STUDIES

Proposal Of

LONG TERM MONITORING STRATEGY

For

RESIDENT FISH POPULATIONS

October 1985

Problem Statement:

Hydroelectric development is proposed for the Susitna River at Devil Canyon (RM 152) and Watana Canyon (RM 184). With project changes in seasonal discharge, temperature and turbidity are predicted to occur. These changes may alter the population structures of resident fish. Pre-project (natural) conditions are characterized by low winter flows and high summer flows. Under pre-project conditions, resident fish characteristically overwinter in the mainstem river and summer in the clear-water tributaries. With-project conditions will be characterized by higher and warmer winter flows, with a delay in ice formation, and lower summer flows. The resident fish populations must be monitored under natural (pre-project) conditions for comparison against with-project conditions.

Objective:

Assess the positive and negative with-project effects to resident fish populations in the Susitna River by comparing these populations' densities and distributions from pre- to with-project.

Procedure:

To monitor the resident fish populations during pre- and with-project river and impoundment area conditions, we propose a continuation of the basic procedures that have been in place since the beginning of the project. The pre-project baseline data will be compared to the with-project data to document any changes in resident fish populations that are detected.

Pre-Project:

Below Devil Canyon

1. Continue to electrofish by boat at the 16 middle river index sites to make pre- to with-project comparisons in catch and CPUE. These sites are composed of three major habitats and comparisons in resident fish catches can also be made between macrohabitats.

2. Continue to use secondary gear types such as gill nets and hook and line to supplement boat electrofishing data. Also, continue to record fishwheel and outmigrant resident fish catches.

3. Continue to collect biological data from resident fish to observe for trends in age compositions.

4. Continue the mark-and-recapture program to generate population estimates and determine migrational patterns of selected resident fish species. Population estimates will be made for adult rainbow trout, Arctic grayling, burbot, round whitefish, and longnose sucker in the middle river. Population estimates will also be made separately for rainbow trout $>$150 mm in Fourth of July Creek.

Fish movement data will be provided by analysis of tag recoveries. Species that will be tagged are rainbow trout, Arctic grayling, burbot, Dolly Varden, round and humpback whitefish, and longnose suckers.

6. Every third year beginning in 1986, generate microhabitat suitability criteria curves to supplement microhabitat data gathered during previous years.

With-Project:

A. Below Devil Canyon

1. Continue boat electrofishing at middle river index sites and use of secondary gear types as described in the with-project procedure.

2. Continue to collect biological data as described in the with-project procedure.

3. Continue the mark-and-recapture program as described in the with-project procedure.

4. The radio telemetry program should be re-instituted for two years during construction and for at least three years after construction to provide better movement data on middle river rainbow trout, Arctic grayling, and burbot.

5. Microhabitat suitability criteria for adult middle river resident fish should be generated each year during construction and for at least two years after construction to determine how these fish have adapted to with-project changes.

B. Impoundment

1. Re-institute the mark-and-recapture program during construction and continue the program for at least two years after construction to generate population estimates for Arctic grayling, and determine movement patterns of selected fish species in the eight major clear water tributaries.

   Tagging and subsequent recapture of Arctic grayling will also be done in the upper reaches of Deadman Creek. This area has a much greater frequency of large Arctic grayling compared to other areas in the upper Susitna drainage. One access proposal to the dam site is the building of a road nearby upper Deadman Creek. Because of easier access, fishing pressure is expected to increase and thereby substantially alter the Arctic grayling population structure in the now "trophy" Arctic grayling area.

2. Continue to collect biological data from resident fish to observe for trends in age structures.

3. Radio tag Arctic grayling for at least two years to provide better information than gathered by tag recoveries on with-project Arctic grayling movement behavior.

Assumptions:

1. Random mark-and-recapture effort.

2. Time does not affect recapture probabilities.

3. The population is closed geographically.

4. Population estimates limited to the older age classes of fish species due only to insufficient sample sizes of smaller fish.

5. There is a random mixing of tagged with non-tagged fish.

6. Mortalities due to capture and tagging, are insignificant.

7. There is little difference in behavior between tagged and untagged fish.

8. There is little variability in sampling effort.

Recommendations:

1. With the expected increase in fishing pressure at middle river and impoundment clear water tributaries, a creel census program could possibly be instituted to monitor the effects of fishing mortality on populations and to provide biological data. This method may also provide an alternative to sampling in the post-project phase.

2. Data suggests much of the middle river rainbow trout population originates from lakes draining into clear water tributaries, and that there is a low existing reproduction of rainbow trout in the middle river. In several middle river lakes, there is known good spawning habitat. Middle river rainbow trout populations may be enhanced by stocking existing lakes with access to middle river tributaries that currently have no rainbow trout. Also, suitable stocking lakes with limited assess to middle river tributaries could be altered to provide better access. This scheme may ultimately increase the numbers of rainbow trout in the middle river.

LONG TERM MONITORING ADULT AND JUVENILE SALMON

Problem:

Hydroelectric development has been proposed for the Susitna River. A long term monitoring plan to monitor natural and with-project variation in the numbers of salmon utilizing the middle river reach needs to be developed.

The design must be cost effective and fit within the overall RSA appropriation of 1.1 to 1.5 million dollars.

Objective:

To develop a long term monitoring plan which will provide the capability to detect hydroelectric development related impacts to middle Susitna River reach.

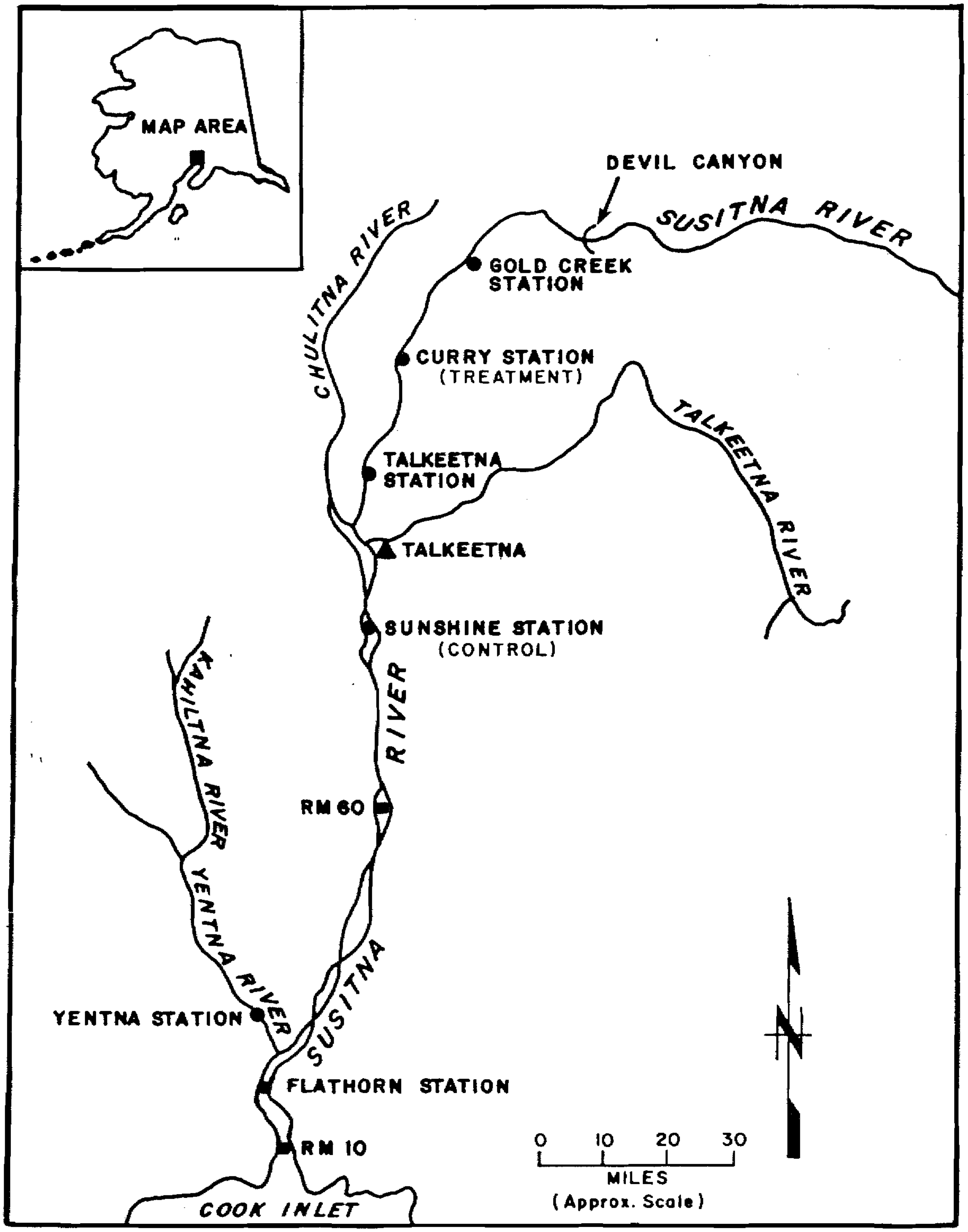
Rationale:

1. Natural variation in pre-project adult escapement and juvenile outmigration needs to be defined and quantified to detect with-project impacts.

2. Strategy suggests that natural variation can be detected by calculating a Survival Monitoring Index (SMI) based on fry to adult ratios.

3. Plan requires the collection of CPUE at two points, a "treatment" and a "control". The objective is a comparison...

4. After several years monitoring natural variation, the assumption is that any post dam (with-project) change outside the natural variation would be a result of the dam(s).



MAP AREA
DEVIL CANYON
SUSITNA RIVER
CHULITNA RIVER
GOLD CREEK STATION
CURRY STATION
(TREATMENT)
TALKEETNA RIVER
TALKEETNA STATION
TALKEETNA
SUNSHINE STATION
(CONTROL)
KAHILTNA RIVER
RIVER
RM 60
YENTNA RIVER
SUSITNA
YENTNA STATION
FLATHORN STATION
RM 10
COOK INLET
0 10 20 30
MILES
(Approx. Scale)
N

The Plan:

Treatment:

1. Adult CPUE data from Curry (RM 120).

   5 years data from this site.

2. Juvenile CPUE data from Talkeetna (RM 103) or Curry.

   4 years data from Talkeetna (Curry proposed to facilitate logistics)

Control:

1. Adult CPUE data from Sunshine (RM 80).

   5 years data from this site.

2. Juvenile CPUE data from near the Parks Highway Bridge.

   No data from this site.

Methods:

1. Adult CPUE from fishwheels.

2. Juvenile CPUE from incline plane traps.

   a. stationary (bank) traps
   b. mobile traps

      1. cable suspended
      2. powered sweep
      3. powered horizontal

Calculations:

Adult to fry ratio based on CPUE index:

$$\text{Fry/Adult Ratio} = \frac{\text{Outmigrant Index}}{\text{Inmigrant Index}}$$

Problem of how to calculate:

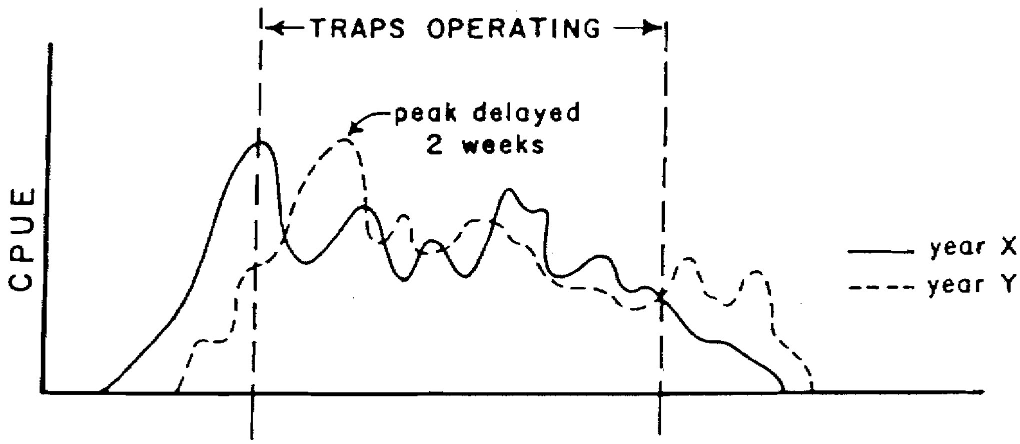
Adults:

Period of fishwheel operation must span peaks of migration.

Convert CPUE to 24 hour CPUE and then sum over entire season.

Juveniles:

The period of operation should also span the peaks of outmigration.



However, we can't be certain of operating the traps to detect the peak outmigration every year.

a. climate changes timing
b. some juveniles outmigrate under the ice
c. mid-winter redistribution of juveniles is possible

Resolution of juvenile problems:

1. Select an empirically derived percentage of the peak 24 hour CPUE for the entire season.

2. Summarize all days when CPUE exceeds percentage.

Survival Monitoring Index (SMI):

Calculation of juvenile and adult annual indices would be done for both the treatment and control populations.

Then, one number, the Survival Monitoring Index (SMI) would be calculated by:

$$SMI = \frac{\text{Fry/Adult Ratio for Treatment}}{\text{Fry/Adult Ratio for Control}}$$

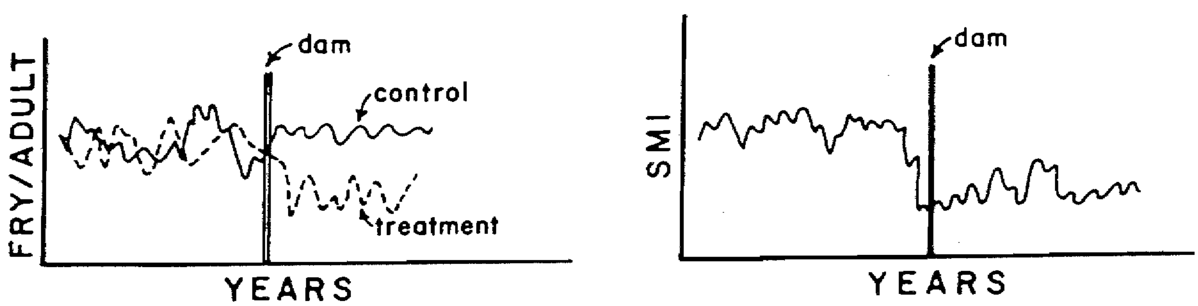
Will this method detect change?

Assumptions:

1. Sampling variance is the same for both the treatment and the control.

2. Factors affecting annual natural variation work equally on both ratios.

How a dam caused decrease in the treatment fry/adult ratio and SMI would look:



change

Important Questions:

Is the drop in the SMI significant?

Large variances mean only large change (impact) could be detected.

What percentage of change in the ratio is required before change can be statistically detected?

Percentage could be calculated beforehand (Shipman et al. 1985) if the variance structure of the ratio is known.

Several years of data may be required before the variance structure can be known. By then, if a large degree of variance between the years is evident, it is possible the model will not accomplish its objective.

Assumptions:

The following are assumptions which to a greater or lesser degree need to be valid for the SMI approach for detecting impacts to work.

1. The control is a valid control.

2. Salmon stocks in the Talkeetna, Chulitna, and that portion of the Susitna River in the control are subject to the same natural variability as the treatment portion of the Susitna River.

3. The Cook Inlet commercial fishery does not selectively fish for any stock or species migrating above Sunshine Station (the control).

4. That adult fishwheel CPUE is mostly related to total escapement regardless of the extent of milling.

5. The peak of juvenile outmigration for all species occurs during the open water period.

6. Smolt trap and fishwheel efficiency remains constant. For example, a change in the position of the fishwheels as a result of with-project flows must not affect the efficiency of the wheels.

7. The number of outmigrants are related to the number of inmigrants.

8. Any with-project change outside the natural variation of the ratio would be a dam-caused effect.

Problems:

1. It is not very likely that the control, will be subject to the same variability as the treatment.

    a. The control (Sunshine) is not a true control because it includes treatment effects. The Talkeetna River may be a better control and should be considered.

    b. The treatment and the control experience different and varying milling rates.

    c. Gear efficiency varies with discharge, debris loading, catch rates, etc.

2. Adult milling is not considered in the CPUE ratio equation.

3. The peak migration of some species and age classes may occur before it is physically possible to place outmigrant traps in the river (i.e., under the ice or with break-up).

4. The variance in the natural ratio may be so large it will be impossible to detect a with-project effect (until a catastrophic impact has occurred). Since work on the diversion tunnel will begin in 199~~1~~, this may not have been enough years of pre-project data to detect the full range of the natural variation.

? 1992 ?

Options/Alternatives:

1. Time series analysis where the natural variability at one site (Curry) is used for both the treatment and the control. This method has a problem where several years would pass before a change could be detected unless projected physical parameters regimes were linked to an index (survival, adult inmigration, juvenile outmigration) with a transfer function model.

2. Evaluate habitat for a specific life stage (for example, incubation) in conjunction with the adult inmigration and juvenile outmigration.

EVALUATION OF LONG-RANGE SIDE-SCAN SONAR COUNTERS AS AN ALTERNATIVE TO TAG AND RECAPTURE PROGRAM

Problem:

Tag and recapture methods are currently used by ADF&G Su Hydro to estimate adult salmon escapements in the Susitna River. Estimates obtained by this method are extremely labor intensive and costly. For the development of a long term monitoring program, it would be preferable to have a more cost-effective method of enumerating adult salmon escapements. Hydroacoustic techniques may provide this alternative. Recent developments in hydroacoustic technology extend the effective counting range and negate the use of an artificial substrate, both of which were problems encountered using earlier model side scan sonar counters in the Susitna River.

Objective:

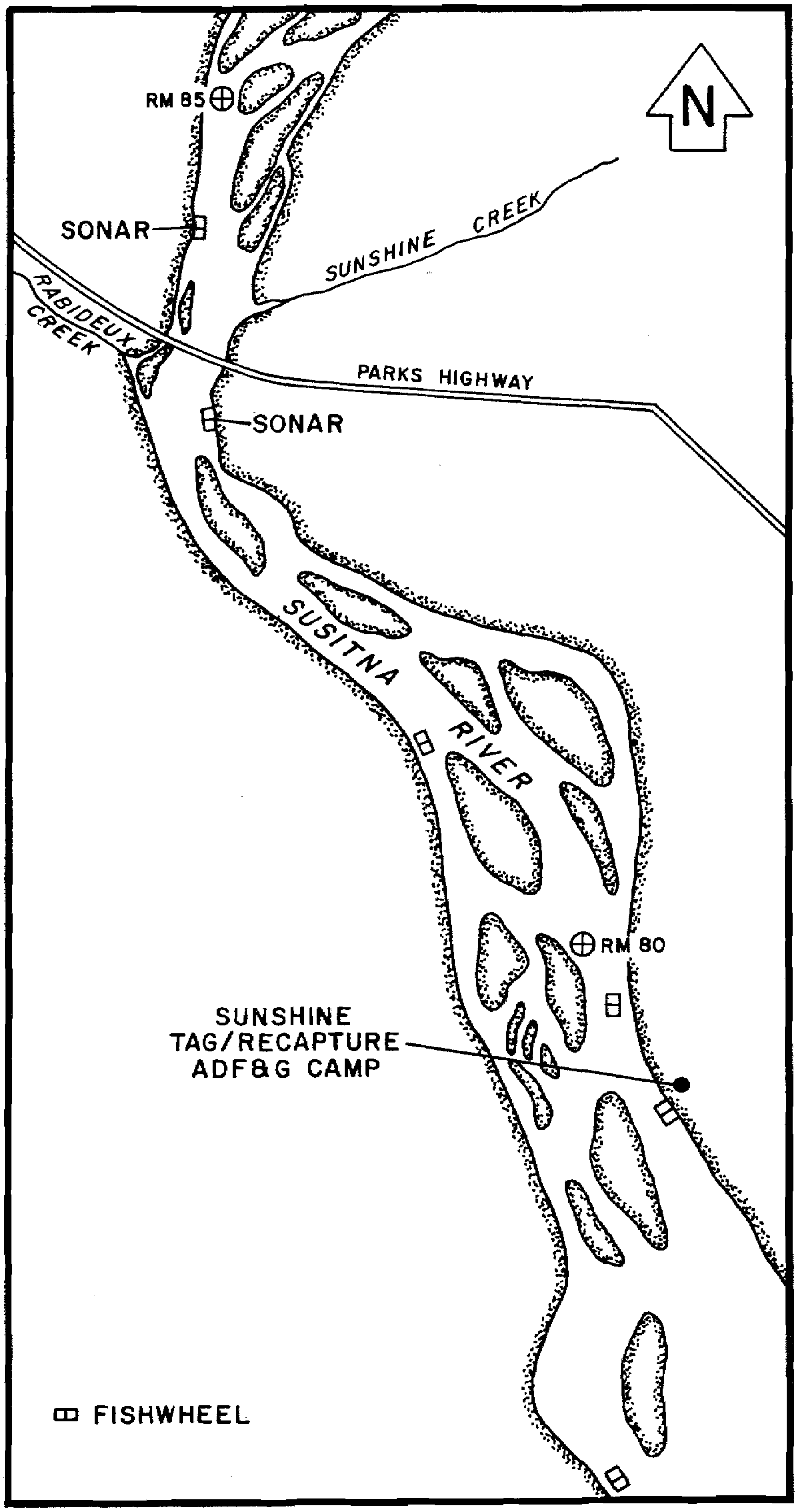
To evaluate the Bendix long range side scan sonar in the turbid Susitna River as a possible cost effective alternative to tag and recapture programs.

Methods:

Two Bendix long range side scan sonars will be deployed off each bank near the Parks Highway Bridge at approximately RM 83. These units will be operated with a tag/recapture program at Sunshine Station (RM 80). The tag/recapture escapement estimates will be used as a basis to judge the accuracy of the side scan sonars. Two fishwheels will also be deployed, one near each sonar unit, to provide species composition data to apportion the sonar counts.

Recommendations:

The Bendix sonar, although designed for salmon, has a limited range in the Susitna River (approximately 120 feet). A BioSonics sonar should be used for one season at the site to determine if mid-channel migration paths are used.


N
RM 85
SONAR
SUNSHINE CREEK
RABIDEUX CREEK
PARKS HIGHWAY
SONAR
SUSITNA RIVER
RM 80
SUNSHINE
TAG/RECAPTURE
ADF&G CAMP
FISHWHEEL

DIVISION OF COMMERCIAL FISHERIES
SUSITNA AQUATIC STUDIES

Proposal Of

LONG TERM MONITORING STRATEGY

For

ADULT AND JUVENILE SALMON

October 1985

Problem Statement:

Hydroelectric development has been proposed for the Susitna River at Devil and Watana canyons. This development may impact the fish resources of the middle reach. A long-term plan to monitor natural variability in the numbers of salmon which utilize the middle reach needs to be developed. The design should provide an accurate measure of variability in Susitna River stocks under natural conditions which could ultimately be compared to variability under with-project conditions. The monitoring design must be cost effective in scope to fit the overall projected RSA appropriation of 1.1 to 1.5 million dollars in FY 87.

This strategy introduces a conceptual approach on how this task might be accomplished by monitoring the adult salmon inmigration and juvenile salmon outmigration from the middle river reach. Some additional conceptual approaches which could be explored are also mentioned.

Objective:

To develop a long-term monitoring plan which will provide the capability to detect hydroelectric development related impacts to middle Susitna River reach juvenile salmon.

Rationale:

The basis of this proposal is that the natural variation in pre-project adult escapement and juvenile outmigration needs to be defined and quantified so with-project impacts, if any, can be detected. With-project variation would have to be "outside" the pre-project variation to label the variation "project impact". This strategy suggests that pre-project variation can be detected by calculating a Survival Monitoring Index (SMI) based on fry to adult ratios. This plan would require the collection of CPUE data at two points, a "treatment" and a "control". The objective is to monitor the SMI in the middle reach of the Susitna River (the treatment) and compare it to the SMI of the control. The ratio of the treatment to the control would be monitored for several years under natural conditions. The assumption being, that any post dam (i.e., with-project) change in the ratio outside of the natural variation would indicate a dam-caused effect.

Sampling Locations: (The Plan)

Treatment:

Adult salmon CPUE data for the treatment population would be collected with fishwheels at Curry Station (RM 120). There already exists five years of adult data at this location. Juvenile CPUE data would be collected at either Curry or Talkeetna Station (RM 103). There exists four years of juvenile data at Talkeetna. The rationale for proposing that the outmigrant data collection be moved to Curry is simplicity of logistics. It is untested if the data from Talkeetna would be comparable to that of Curry if past data were to be used. Data should be collected at both points for several seasons to test the assumption they would be comparable.

Control:

Adult CPUE data for the control would be taken at Sunshine Station (RM 80) with fishwheels. There exists five years of adult data from this site. The juvenile data would be collected near the Parks Highway Bridge (RM 83) just upstream from Sunshine Station where the river flows through a single channel.

Calculations:

A probable way of calculating fry to adult ratios is to base the ratio on a CPUE index of the number of adult and juvenile salmon for the years in question. The equation would be:

$$\text{Fry/Adult Ratio} = \frac{\text{Outmigrant Index}}{\text{Inmigrant Index}}$$

The only problem is to decide how to calculate this index and how to estimate the variance. For adult salmon, the fishwheels are operating before the fish arrive and continue operating until after virtually all of the fish have passed by on their way upstream, so it is fairly easy to convert each day's CPUE to a 24 hour CPUE and then sum over the entire season. The period when the fishwheels are operating has been and should remain constant from year to year.

Developing a CPUE index for juveniles poses some additional problems. Ideally, the period for which the outmigrant traps were operated would be constant from year to year relative to the timing of outmigration (Figure 1). The peak outmigration would have to be detected annually. This may not be possible however, because climatic differences from year to year change the timing. There is evidence that some fry outmigrate under the ice before the outmigrant traps are placed.

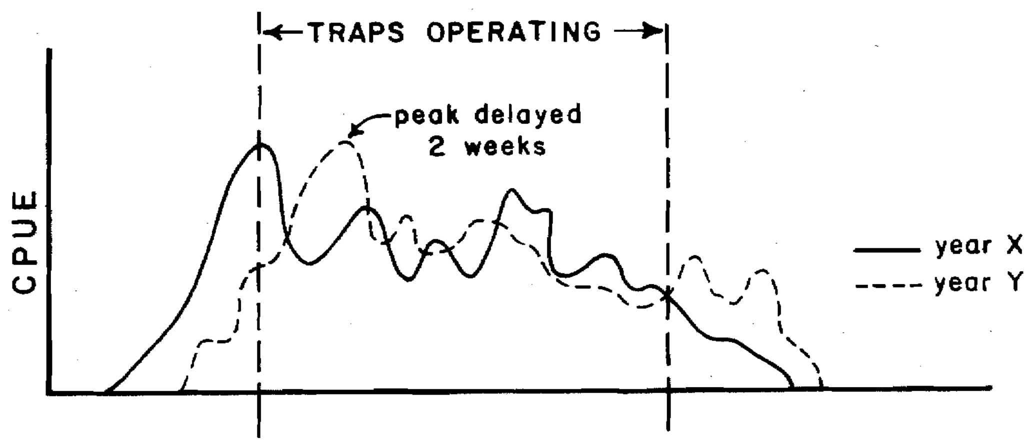


Figure 1. Operating Period.

To resolve this problem, one might summarize the CPUE by adjusting to a 24 hour period, for all those days when the CPUE exceeds an empirically derived percentage of the peak 24 hour CPUE for the entire season. This method would result in a index that would be comparable from year to year provided that the pre- or post- season outmigration rates did not exceed the percentage selected.

After several years of data have been collected, the inter-annual variance of either the adult on juvenile indicies could be estimated by using the variance of the mean of several years of indicies. This may best be approached by taking the mean of the index from 0-10 percent, 11-20 percent, etc. of the cumulative migration. Calculation of these adult and juvenile indicies would be done for both the treatment and the control populations; and then the one number which would be calculated each year is:

$$\text{Survival Monitoring Index} = \frac{\text{Fry/Adult Ratio for Treatment}}{\text{Fry/Adult Ratio for Control}}$$

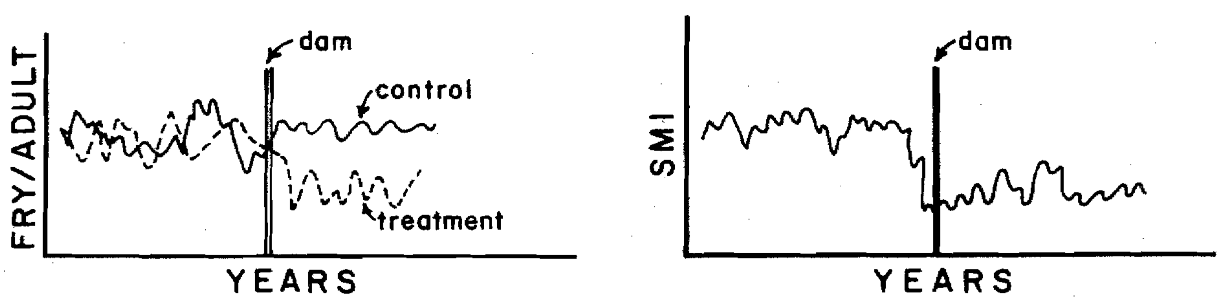
Will It Work?

Variance:

The ability to statistically detect a change is the basic goal of any monitoring program. It is hoped that it will be possible to detect change in the salmon populations of the middle Susitna River with this proposed methodology.

Variance arises from both natural processes and from sampling. We can probably assume that the sampling variance is the same for the treatment and the control because similar methods will be used at both areas. We also have to assume that the factors affecting year to year natural variation work equally on both important ratios.

The survival monitoring index (SMI), which is the ratio of the fry/adult ratio for the treatment to the fry/adult ratio for the control, is probably under natural conditions somewhere around one because survival in the two areas should be roughly equal. Let's assume for a moment that the dam did cause a substantial decrease in the fry/adult ratio for the treatment. The time series plots of the fry/adult ratios and the SMI would look like this:



The question we would want to ask then is whether the drop in the SMI was significant. If the fry/adult ratios for the treatment and the control have large variances, then only a large change over a long period of time in the SMI will be statistically detectable. It is not possible to "cancel" these large variances by dividing the two. So the question now is what percentage change in the treatment/control ratio is required before a change can be statistically detected? What this percentage is could easily be calculated before the fact (Shipman et al. 1985) if one knew the variance structure of the ratio. There is probably no good way to make this calculation until we have several years of data. We will have to calculate the index for several years and see how much it varies. If there is a large degree of variance between the years, the model will probably not accomplish the objective.

Assumptions:

The following are assumptions which to a greater or lesser degree need to be valid for the SMI approach for detecting impacts to work.

1. Salmon stocks in the Talkeetna, Chulitna, and that portion of the Susitna River in the control are subject to the same natural variability as the treatment portion of the Susitna River.

2. The Cook Inlet commercial fishery does not selectively fish for any stock or species migrating above Sunshine Station (the control).

3. That adult fishwheel CPUE is mostly related to total escapement regardless of the extent of milling.

4. The peak of juvenile outmigration for all species occurs during the open water period.

5. Smolt trap and fishwheel efficiency remains constant.

6. A change in the position of the fishwheels as a result of with-project flows will not adversely affect the efficiency of the wheels.

7. Any with-project change outside the natural variation of the ratio would be a dam-caused effect.

Problems:

1. It is not very likely that the control, will be subject to the same variability as the treatment.

    a. The control (Sunshine) is not a true control because it includes treatment effects. The Talkeetna River may be a better control and should be considered.

    b. The treatment and the control experience different and varying milling rates.

    c. Gear efficiency varies with discharge, debris loading, catch rates, etc.

2. Adult milling is not considered in the CPUE ratio equation.

3. The peak migration of chum and pink salmon may occur before it is physically possible to place outmigrant traps in the river (i.e., under the ice or with break-up).

4. The variance in the natural ratio may be so large it will be impossible to detect a with-project effect (until a catastrophic impact has occurred).

Options/Alternatives:

1. Time series analysis where the natural variability at one site (Curry) is used for both the treatment and the control. This method has a problem where several years would pass before a change were detected unless projected physical parameters regimes were linked to an index (survival, adult inmigration, juvenile outmigration) with a transfer function model.

2. Evaluate habitat for a specific life stage (for example, incubation) in conjunction with the adult inmigration and juvenile outmigration.

Literature Cited:

Shipman, J., M. Bowen, and P. Kinner. 1985 Natural variability in a long-term study and implications for impact monitoring. Abstracts for the Eight Biennial International Estuarine Research Conference, July 29 to August 2, 1985, University of New Hampshire, Durham.

Acknowledgements:

To Dr. Dana Schmidt and Mr. Bruce Barrett for their conceptual thought and planning. To Mr. Steve Hale for his statistical innovation and writing. To Mr. Mike Thompson and Allen Bingham for their editorial comment and assistance.