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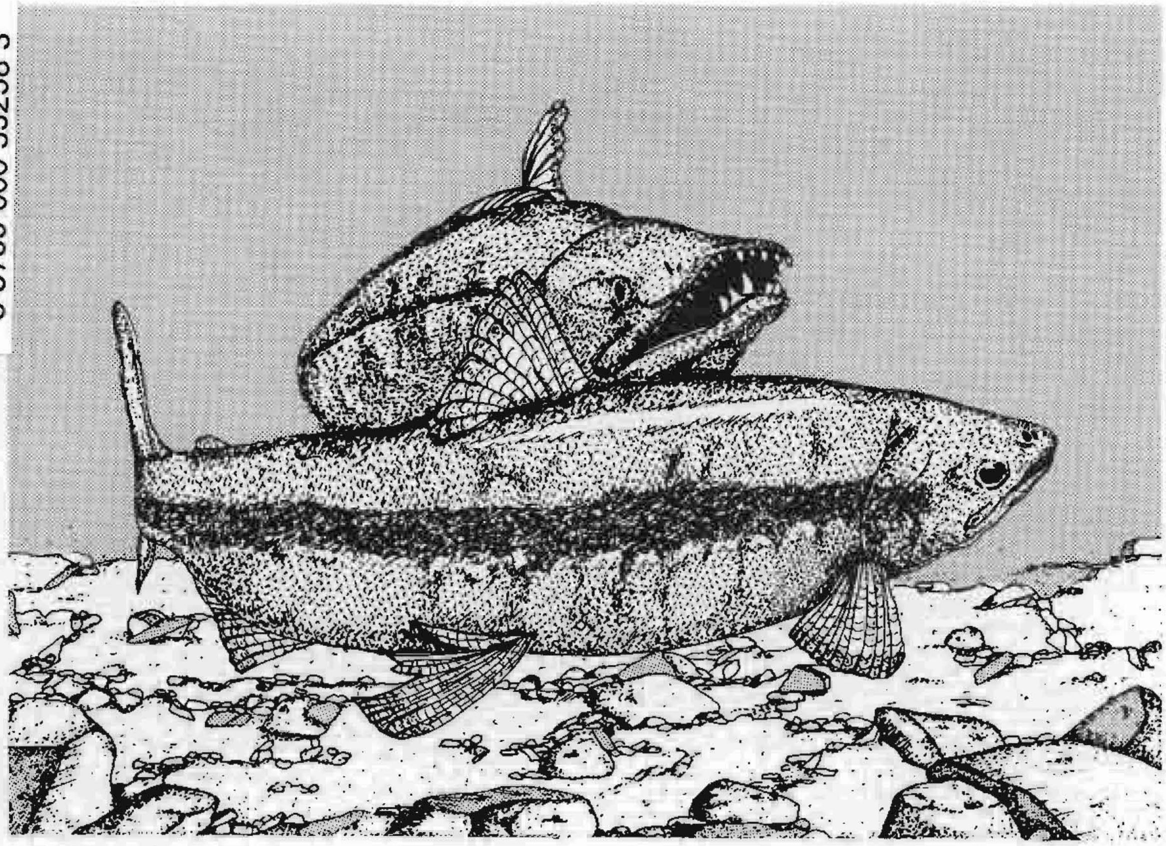

SUSITNA HYDRO AQUATIC STUDIES
PHASE II REPORT

Volume I: Summarization of Volumes 2, 3, 4; Parts I and II, and 5. Alaska Department Of Fish and Game Su Hydro Basic Data Reports, 1982.

ALASKA DEPARTMENT OF FISH AND GAME

SUSITNA HYDRO AQUATIC STUDIES
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by

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1983

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1.0 INTRODUCTION

1.1 Specific Project Objectives

This report is Volume One of a five volume report of the fisheries, aquatic habitat, and instream flow data collected by the Alaska Department of Fish and Game (ADF&G) Susitna Hydroelectric (Su Hydro) Feasibility Aquatic Studies Program during the 1981-82 (October-May) ice-covered and 1982 open water (May-October) seasons. These reports were prepared for the Alaska Power Authority (APA) and its principal contractor, Acres American (Acres), by the ADF&G and other contractors to assist the APA with evaluation of the feasibility of a Susitna hydroelectric project. This volume presents a synopsis of the information contained in the other four volumes. Volume Two also includes a comparison of 1981 and 1982 adult anadromous fisheries data. This report is intended for data transmittal to other Susitna Hydroelectric Feasibility Study participants. The topics discussed in Volumes Two through Five are illustrated in Figure 1.1.

An ADF&G data analysis report in preparation will include an analysis of the pre-project fishery and habitat relationships derived from volumes one through five and related reports prepared by other study participants. A review draft of this report will be circulated to study participants. The final report will be submitted to the APA for formal distribution to study participants, state and federal agencies, and the public. Also scheduled for completion on June 30, 1983 is the first

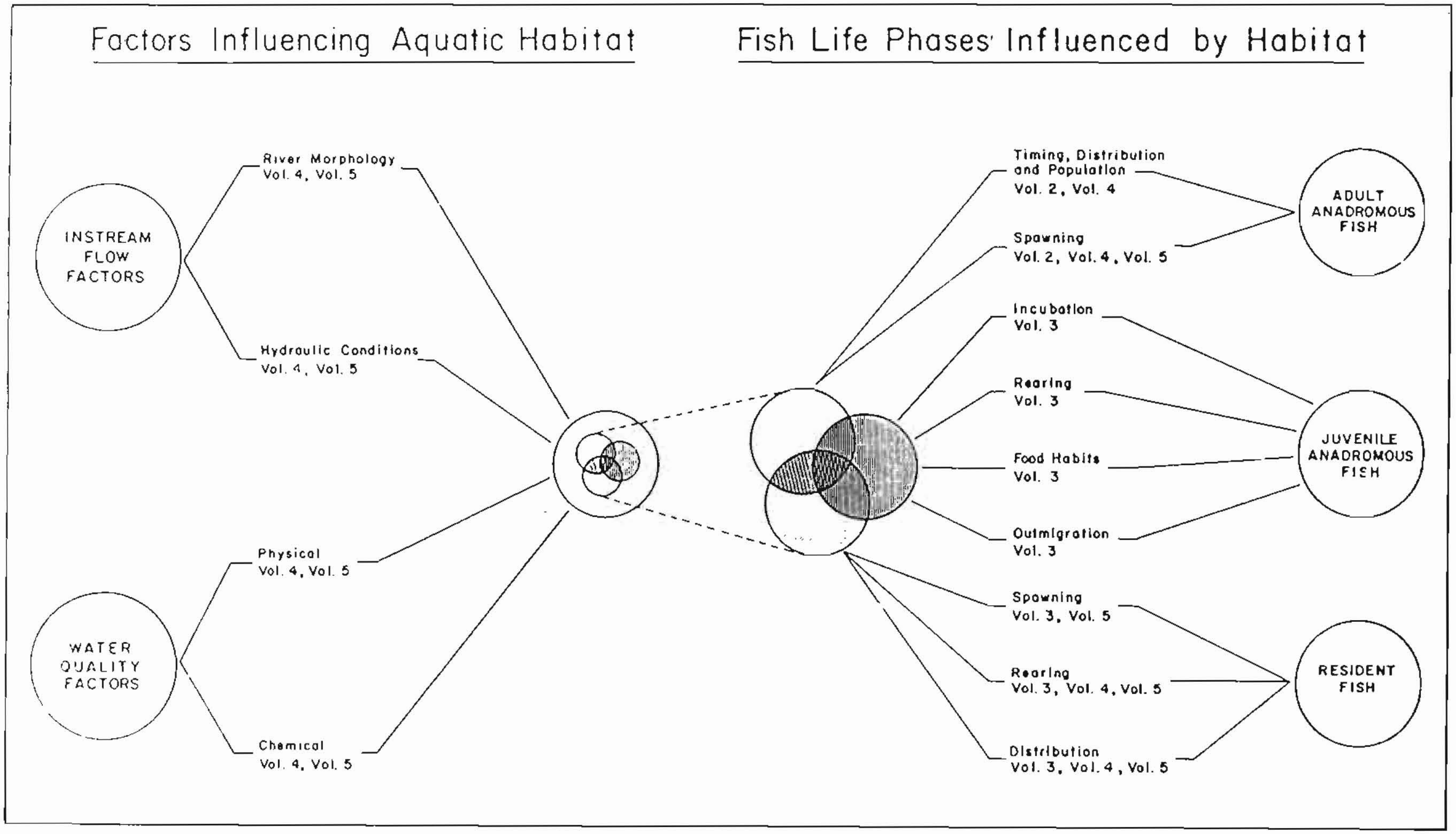

Figure 1.1 Integration of and relationships among the program elements presented in Volumes Two through Five.

draft of the ADF&G 1982-83 ice-covered season basic data report. This report will also include a presentation of 1982-83 incubation and other fishery and habitat data.

These and other ADF&G reports (1974, 1976, 1977, 1978, 1979, 1981a, b, c, d, e, f, 1982) and information reported by others will be summarized and analyzed by the Arctic Environmental Information and Data Center (AEIDC) to evaluate post-project conditions within the overall study area of the proposed project (Figure 1.2). Woodward Clyde Consultants will, in turn, use this information to support the preparation of the Federal Energy Regulatory Commission License Application for Acres.

1.1 Specific Project Objectives

The five year ADF&G Su Hydro Aquatic Studies program was initiated in November 1980. It is subdivided into three study sections: Adult Anadromous Fish Studies (AA), Resident and Juvenile Anadromous Fish Studies (RJ), and Aquatic habitat and Instream Flow Studies (AH).

Specific objectives of the three sections are:

1. AA - determine the seasonal distribution and relative abundance of adult anadromous fish populations produced within the study area (Figure 1.2);

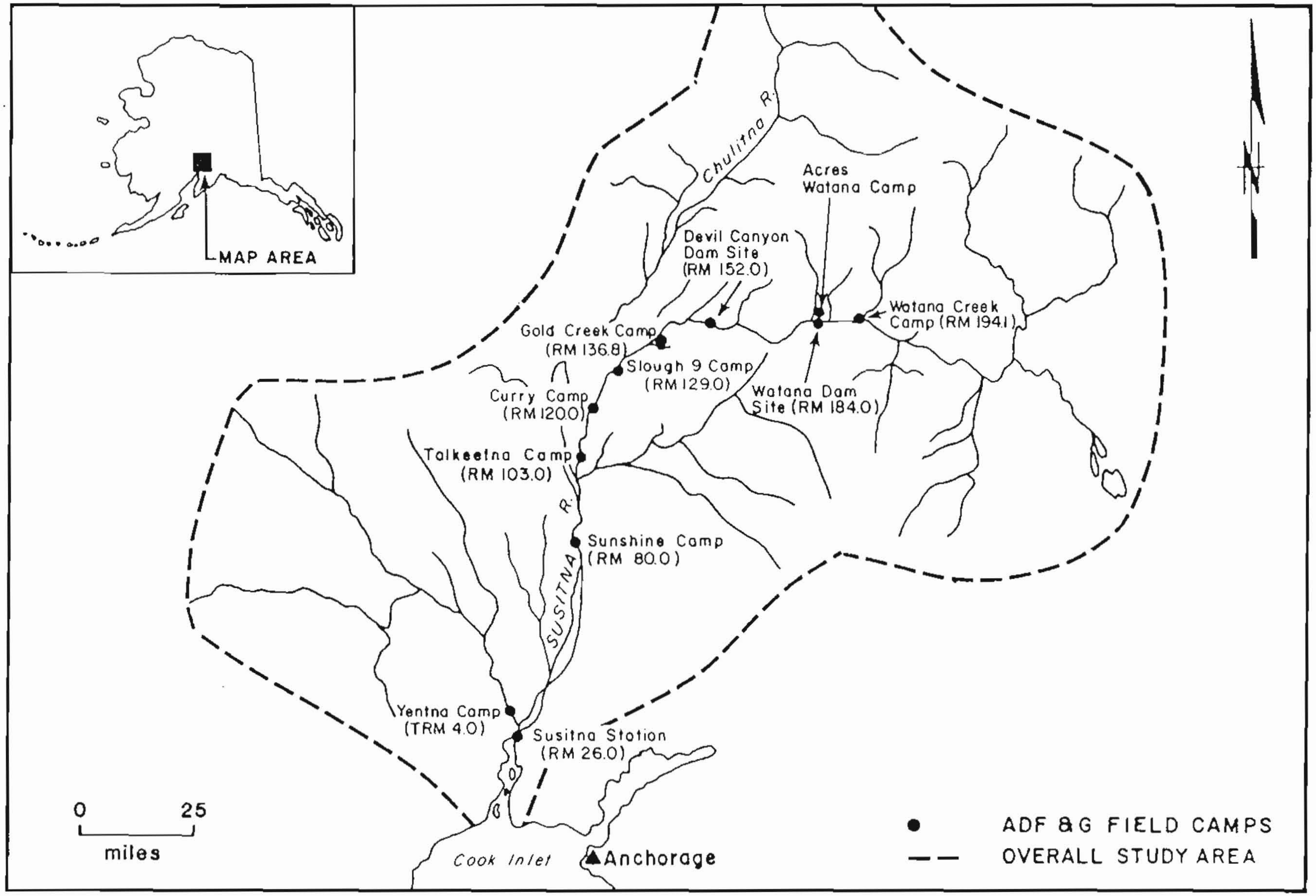

Figure 1.2 Overall study area of the Susitna Hydroelectric Feasibility Study Program.

2. RJ - determine the seasonal distribution and relative abundance of selected resident and juvenile anadromous fish populations within the study area; and

3. AH - characterize the seasonal habitat requirements of selected anadromous and resident fish species within the study area and the relationship between the availability of these habitat conditions and the mainstem discharge of the Susitna River.

The 1981-82 ice-covered and 1982 open-water ADF&G study areas (Figures 1.3 and 1.4) were limited to the mainstem Susitna River, associated sloughs and side channels, and the mouths of major tributaries. Portions of tributaries which will be inundated by the proposed Watana and Devil Canyon reservoirs were also evaluated. Descriptions of study sites are presented in each of these volumes including the ADF&G reports (ADF&G 1981a, b, c, d, e, f).

The Susitna River is approximately 275 miles long from its sources in the Alaska Mountain Range to its point of discharge into Cook Inlet. The drainage encompasses an area of 19,400 square miles. The mainstem and major tributaries of the Susitna River, including the Chulitna, Talkeetna and Yentna rivers, originate in glaciers and carry a heavy load of glacial flour during the ice-free months (approximately May through October). There are many smaller tributaries which are perennially clear.

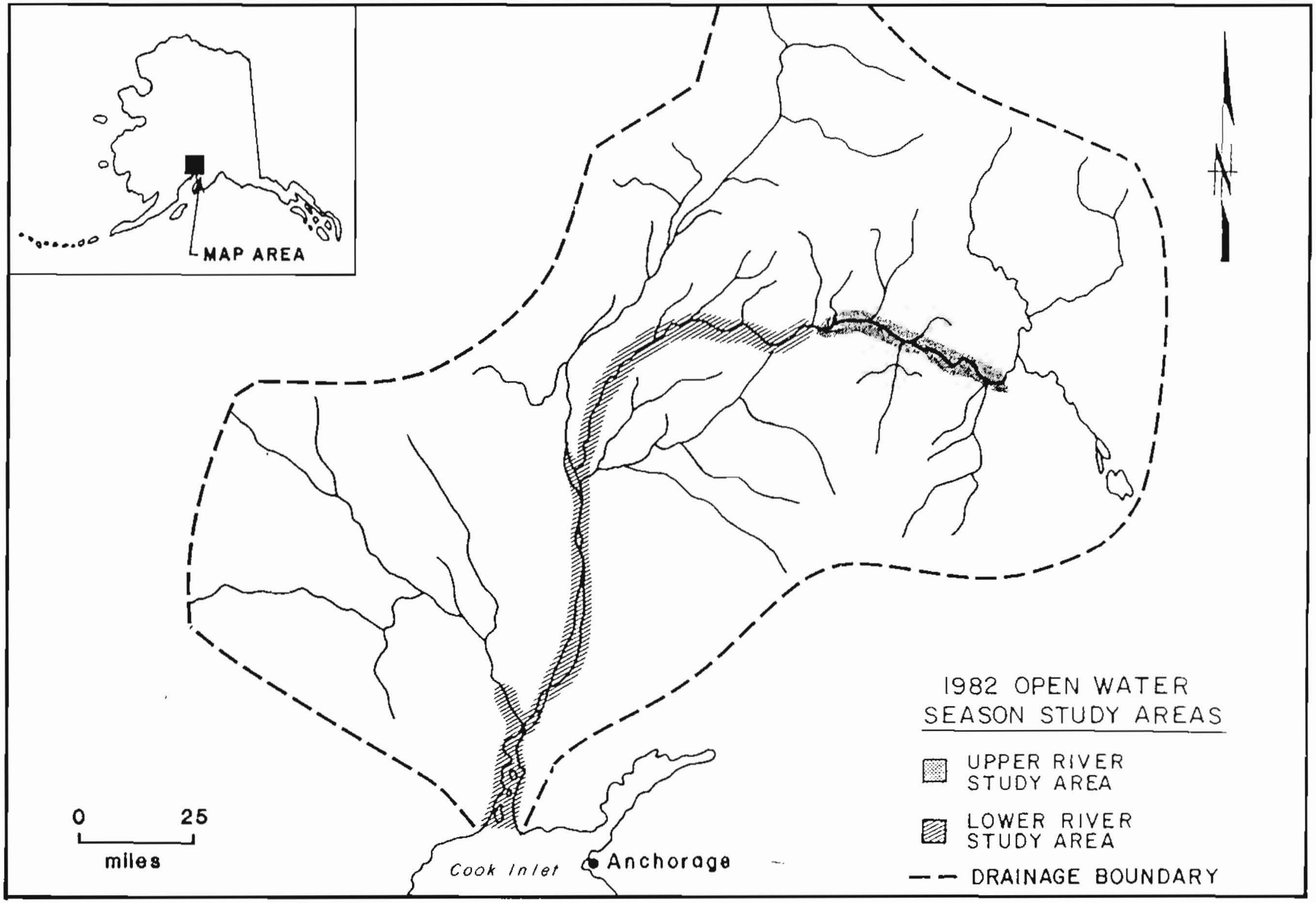

Figure 1.3. 1982 ADF&G open water season (May through October) study area.

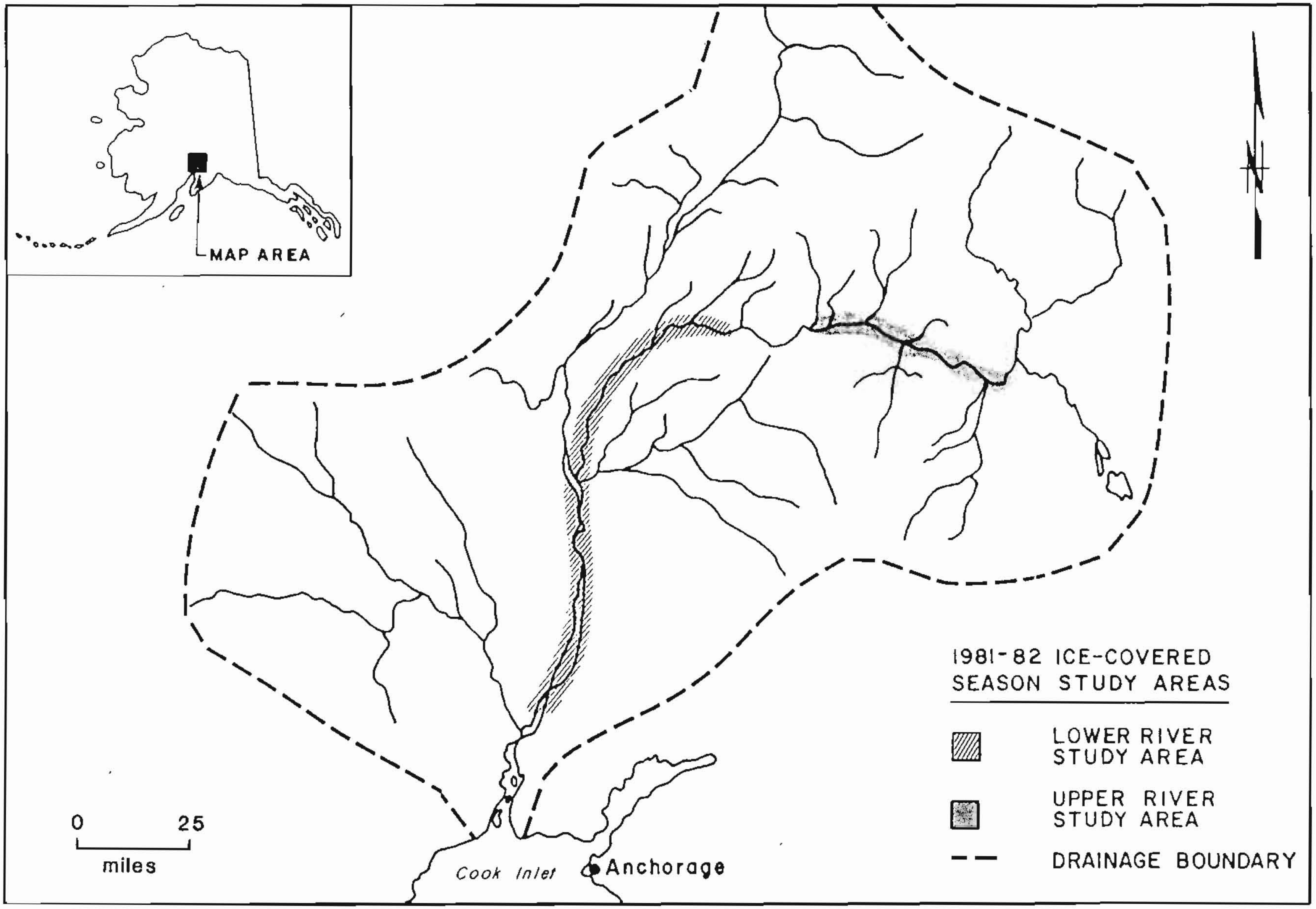

Figure 1.4. 1981-82 ADF&G ice-covered season (October through May) study area.

Questions concerning these reports should be directed to:

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2.0 VOLUME 2 SUMMARY - ADULT ANADROMOUS STUDIES

2.1 Eulachon (*Thaleichthys pacificus*)

Two runs of eulachon spawned in the Susitna River in 1982. The first run entered the estuary during the last two weeks of May and the second during the first week of June. The first eulachon run extended upstream to river mile (RM) 40.5 while the second run reached an upper limit of approximately RM 48.5. Spawning principally occurred in the Susitna River main channel areas near cut banks and in riffle zones with sand and gravel substrates. No spawning was documented in clear water streams, semi- placid main channel reaches of the Susitna River or slough habitats. The majority of the spawning activity by both runs took place in the main channel reach between RM 8.5 and the Yentna River confluence (RM 28).

In 1982, male eulachon outnumbered females by ratios of 1.6:1 in the first run and 1.3:1 in the second run. Three year old fish dominated both runs comprising approximately 80 percent of the catch samples with the remainder consisting of four year old fish. An analysis of eulachon length and weight data established that first run fish were significantly smaller than second run fish.

The combined 1982 escapement of first and second run eulachon was estimated to range in the millions. Sport fishermen harvested approximately 3,000 to 5,000 fish with the majority of the fishing effort observed between RM 10 and RM 30.

2.2 Adult Salmon (*Onchorhynchus sp.*)

Estimates of the 1981 and 1982 sockeye, pink, chum and coho salmon escapements into the Susitna River drainage are presented in Table 2-1. These estimates do not include escapements to systems between RM 6 and 77 but include the Yentna River (RM 28) escapements.

Table 2-1 Susitna River drainage escapement estimates by species for 1981 and 1982, Adult Anadromous Investigations, Su Hydro Studies, 1983.

Year		Escapement Estimate 1/		
	Sockeye 2/	Pink	Chum	Coho
1981	272,500	85,600	282,700	36,800
1982	265,200	890,500	458,200	79,800

1/ Defined as the summation of the Yentna River escapement recorded at Yentna Station and the Susitna River escapement recorded at Sunshine Station. These estimates do not include escapements to Susitna River tributaries above RM 6 and below RM 77 excluding the Yentna River (RM 28).

2/ Sockeye salmon escapement estimates do not include first run sockeye salmon escapements.

2.2.1 Chinook Salmon (*O. tshawytscha*)

Chinook salmon escapement estimates in 1982 were obtained by the Petersen tag/recapture method at Sunshine (RM 80), Talkeetna (RM 103) and Curry (RM 120) stations on the main channel Susitna River (Figure 1

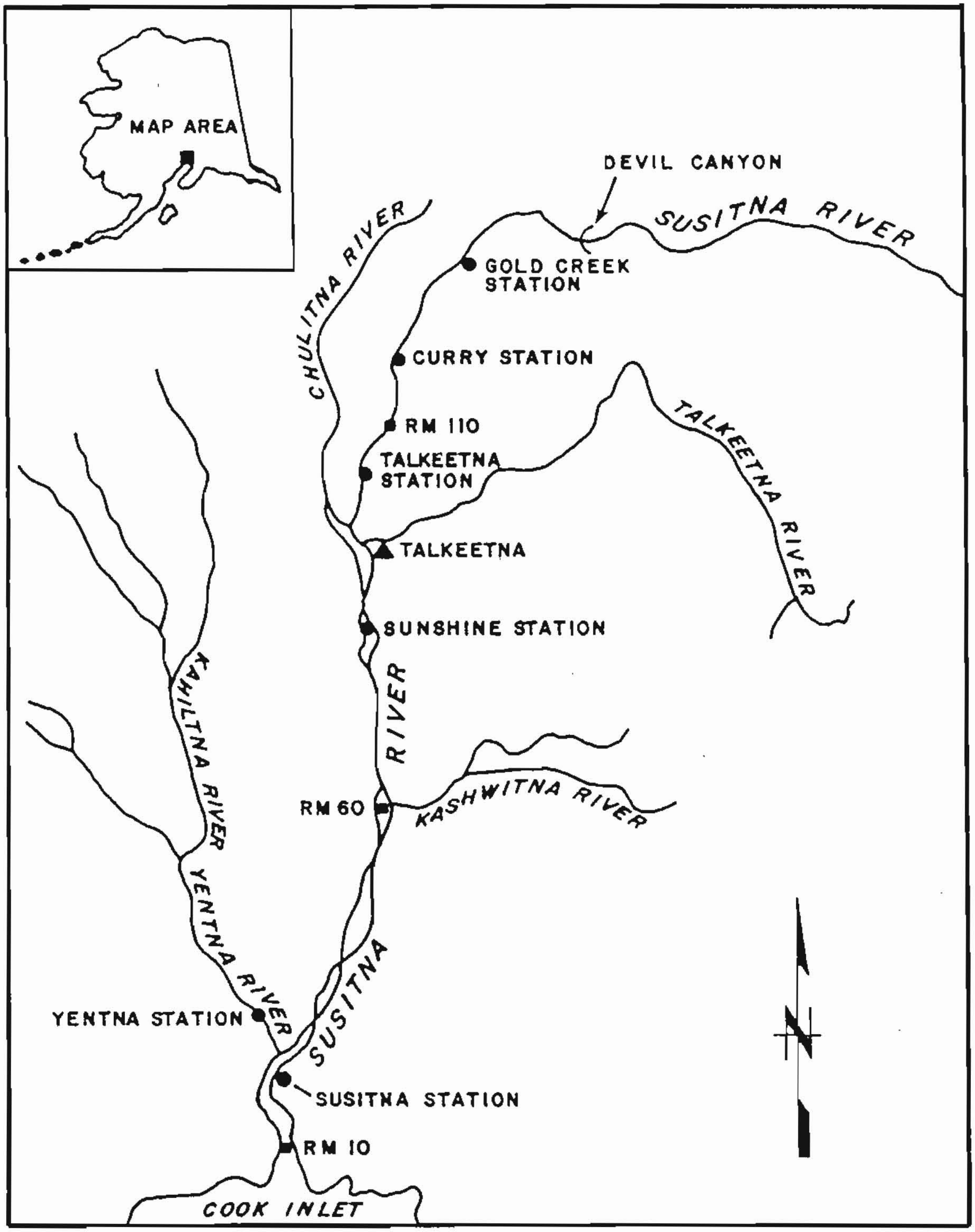

Figure 2-1. Susitna River basin map showing field stations and major glacial streams. Adult Anadromous Investigations, Su Hydro Studies, 1983.

and Table 2-2). A comparison of between year fishwheel catches at these sampling stations indicated that the 1981 chinook salmon escapement was less than one half the 1982 escapement level.

The chinook salmon migration at Sunshine (RM 80), Talkeetna (RM 103) and Curry (RM 120) stations occurred earlier in 1981 than in 1982 by about one week (Figure 2-2). The major period of movement past these locations occurred from the second week of June to the third week of July.

No chinook salmon spawning occurred in the Susitna River main channel between RM 7 and 150 in 1981 or 1982 based on intensive sampling with electroshocking and drift net gear.

Radio transmitter implants and fishwheel recaptures in 1981 and 1982 indicated significant milling activity by chinook salmon in the Susitna River main channel above Talkeetna (RM 97). The milling behavior noted can be characterized by fish ascending in the main channel Susitna River beyond their respective spawning streams and days or weeks later descending and spawning in streams downstream of the point of initial capture. Radio transmitter implants also established chinook salmon milling in lower Devil Canyon above RM 150.

In 1981 and 1982, chinook salmon spawning above Talkeetna (RM 97) occurred exclusively in stream habitats with the majority of the fish spawning in Indian River (RM 138.6) and Portage Creek (RM 148.9).

Table 2-2. Escapement by species and sampling location for 1981 and 1982. Adult Anadromous Investigations, Su Hydro Studies, 1983.

Sampling Location	River Mile	Escapement 1/									
		Chinook		Sockeye 4/		Pink		Chum		Coho	
		1981 2/	1982	1981	1982	1981	1982	1981	1982	1981	1982
Yentna Station	04		3/	139,400	113,800	36,100	447,300	19,800	27,800	17,000	34,100
Sunshine Station	80		52,900	133,500	151,500	49,500	443,200	262,900	430,400	19,800	45,700
Talkeetna Station	103		10,900	4,800	3,100	2,300	73,000	20,800	49,100	3,300	5,100
Curry Station	120		11,300	2,800	1,300	1,000	58,800	13,100	29,400	1,100	2,400

1/ Escapement estimates are derived from Petersen population estimates with the exception of the Yentna Station escapements which are represented by sonar counts.

2/ Chinook salmon were not monitored for escapement in 1981.

3/ Yentna Station sonar equipment was installed after the onset of chinook migration and total escapement was not estimated.

4/ Second run sockeye salmon escapement.

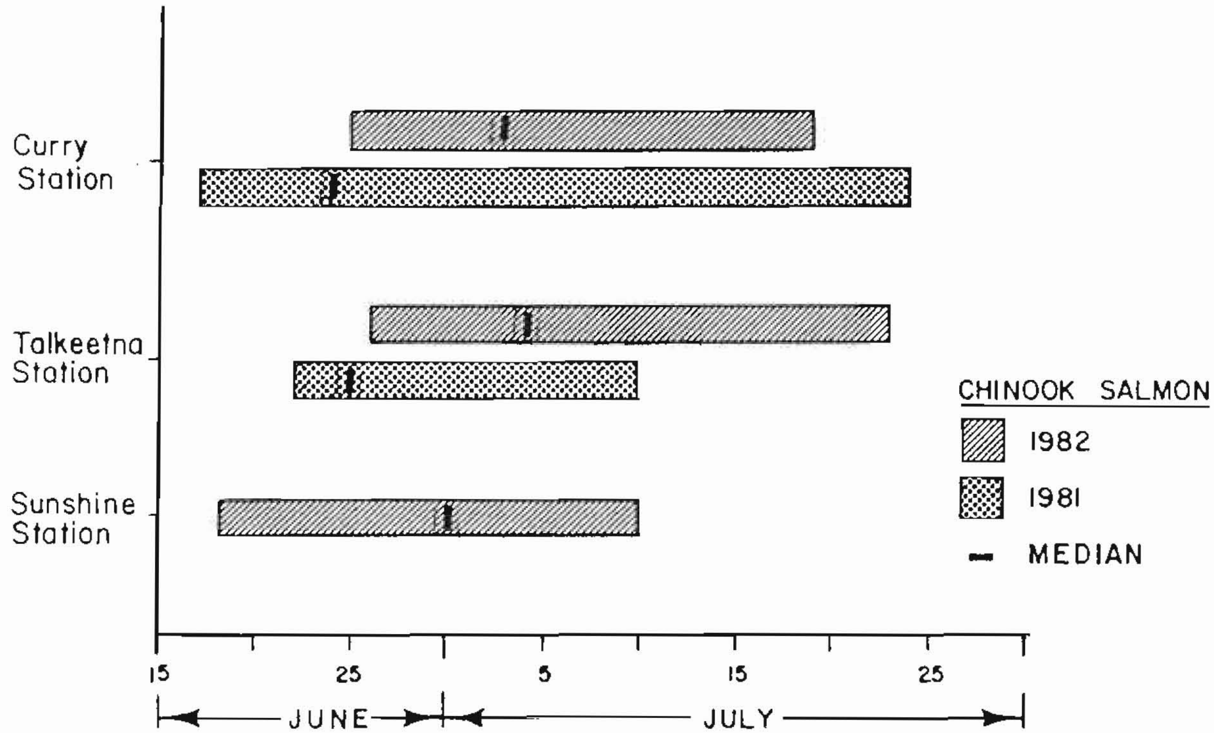

Figure 2-2. Migrational timing of chinook salmon at selected sampling locations in the Susitna River basin in 1981 and 1982, Adult Anadromous Investigations, Su Hydro Studies, 1983.

Two stream habitats in the Devil Canyon reach supported chinook salmon spawning in 1982. These streams were: Cheechako Creek (RM 152.4) and Chinook Creek (RM 157.0). Less than one percent of the total estimated chinook salmon escapement above RM 98.6 spawned in these streams.

2.2.2 Sockeye Salmon (*O. nerka*)

Two sockeye salmon runs with distinct timing differences spawn in the Susitna River drainage. In 1982, the first run escapement recorded past Sunshine Station (RM 80) was approximately 5,800 fish as determined by the Petersen tag/recapture method. The migration occurred between the first and fourth week of June and was primarily (90%) age 5_2 fish. Spawning occurred exclusively in a tributary of the Talkeetna River (RM 97). No comparative information for the 1981 first run escapement is available.

The second run sockeye salmon escapement into the Susitna River drainage was approximately 272,500 fish in 1981 and 265,000 fish in 1982. These estimates do not reflect escapements to systems between RM 6 and 77 but includes the Yentna River (RM 28) escapement.

Second run sockeye salmon escapements recorded at individual sampling locations on the Yentna River (RM 28) and main channel Susitna River for 1981 and 1982 are reported in Table 2. Corresponding, migrational timing data are provided in Figure 2-3. The data indicates that the second run sockeye salmon migration in the Susitna River began about one week earlier in 1981 than in 1982.

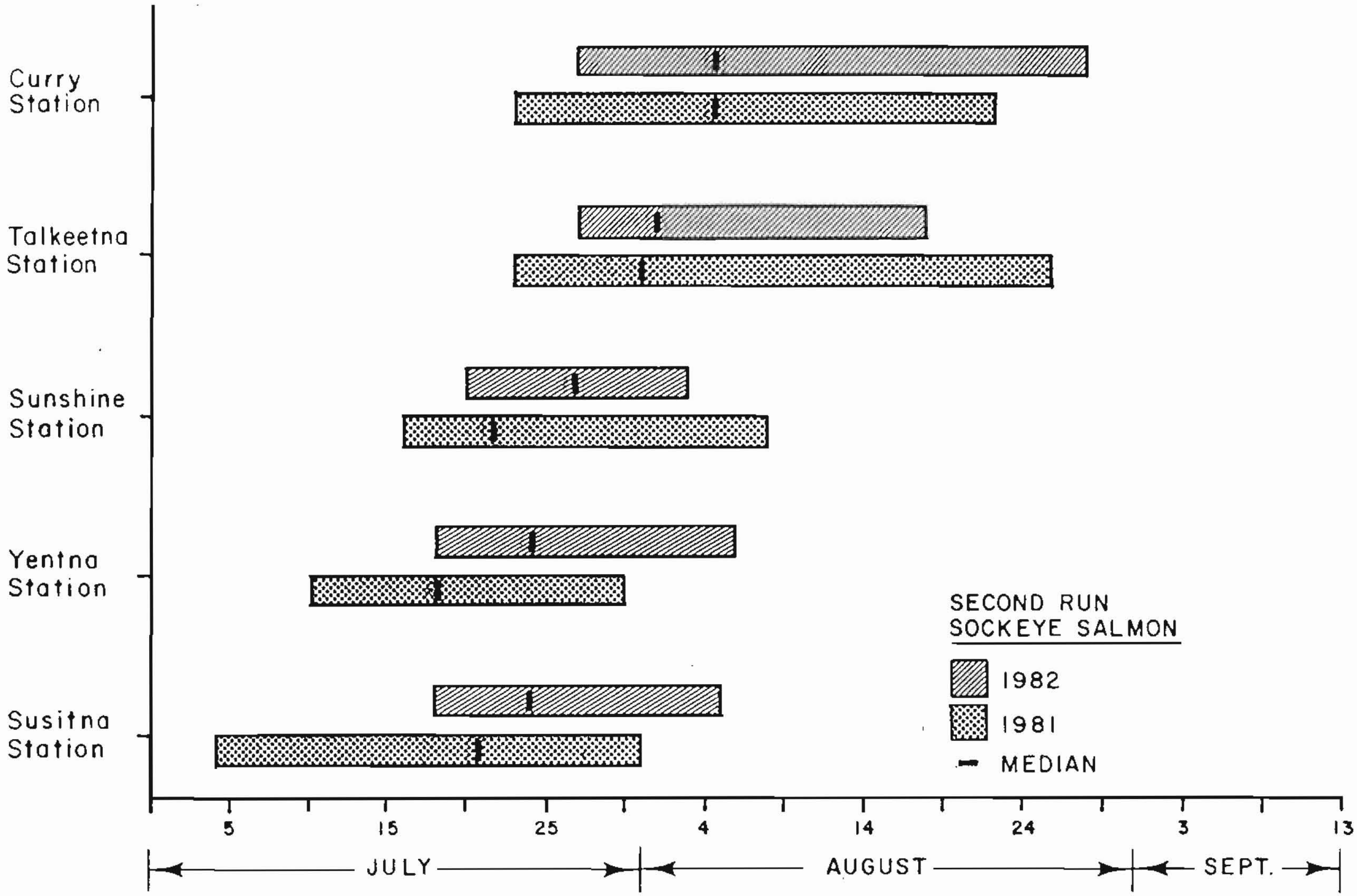

Figure 2-3. Migrational timing of second run sockeye salmon at selected sampling locations in the Susitna River basin in 1981 and 1982, Adult Anadromous Investigations, Su Hydro Studies, 1983.

Analysis of second run sockeye salmon escapement samples established that the majority of Susitna River fish in 1981 and 1982 were age 5_2 fish followed by age 4_2 fish. The overall male to female sex ratio in 1981 was 0.9:1 and in 1982 1.0:1 based on escapement sampling at Susitna Station (RM 26).

Results of gill netting and electroshocking the Susitna River main channel between RM 7 and RM 150 in 1981 and 1982 indicated that sockeye salmon do not utilize main channel habitat for spawning. It can also be concluded sockeye salmon were infrequently present in lower Devil Canyon (RM 150-151) between late July and early September in 1981 and 1982.

In 1981 and 1982 above RM 98.6, sockeye salmon of the second run spawned mainly, if not exclusively, in slough habitats associated with the Susitna River main channel as no main channel areas or stream habitats were found to support sockeye salmon spawning. Approximately 72 percent in 1981 and 75 percent in 1982 of the sockeye salmon spawning observed in slough habitats was recorded in Slough 11 (RM 135.3).

2.2.3 Pink Salmon (*O. gorbuscha*)

The Susitna River drainage escapement of pink salmon was estimated to be approximately 85,600 fish in 1981 and 890,500 fish in 1982 not including escapement returns in both years to systems between RM 6 and 77 but including the Yentna River (RM 28) escapement (Table 2-1). Escapements recorded at individual locations on the Yentna and Susitna rivers are provided in Table 2-2. A comparison of pink salmon migrational timing recorded at various main channel Susitna River locations, illustrated in Figure 2-4, indicates pink salmon were present in the river for a longer period of time in 1981 than in 1982.

Intensive sampling in 1981 and 1982 with drift gill nets and electroshocking equipment showed pink salmon were not spawning in the Susitna River main channel between RM 7 and 150.

Sampling efforts in the general area of RM 150 in lower Devil Canyon indicated that pink salmon were not present in lower Devil Canyon in 1981 and had only a minor presence in lower Devil Canyon during the second and third weeks of August in 1982.

Pink salmon spawned in slough and stream habitats in the Susitna River reach above RM 98.6. Pink salmon were found in 3 of 33 sloughs surveyed in 1981 and 10 of 34 sloughs surveyed in 1982. Comparatively, 9 of 15 streams surveyed upstream of RM 98.6 in 1981 and 14 of 19 streams in 1982 supported pink salmon. The majority of the pink salmon escapement above RM 98.6 spawned in stream habitats. The highest pink salmon counts in index areas were recorded in Chase Creek (RM 106.9) and Lane Creek (RM 113.6) in 1981, and Fourth of July Creek (RM 131.1) and Indian River (RM 138.6) in 1982. The highest counts of pink salmon spawning in slough habitats were recorded in Slough 8 (RM 113.7) in 1981 and Slough 15 (RM 137.2) in 1982. Peak spawning in slough habitats occurred in the third and fourth weeks of August in 1981 and 1982. In stream habitats, peak spawning periods were during the third and fourth weeks of August in 1981 and the second and third weeks of August in 1982.

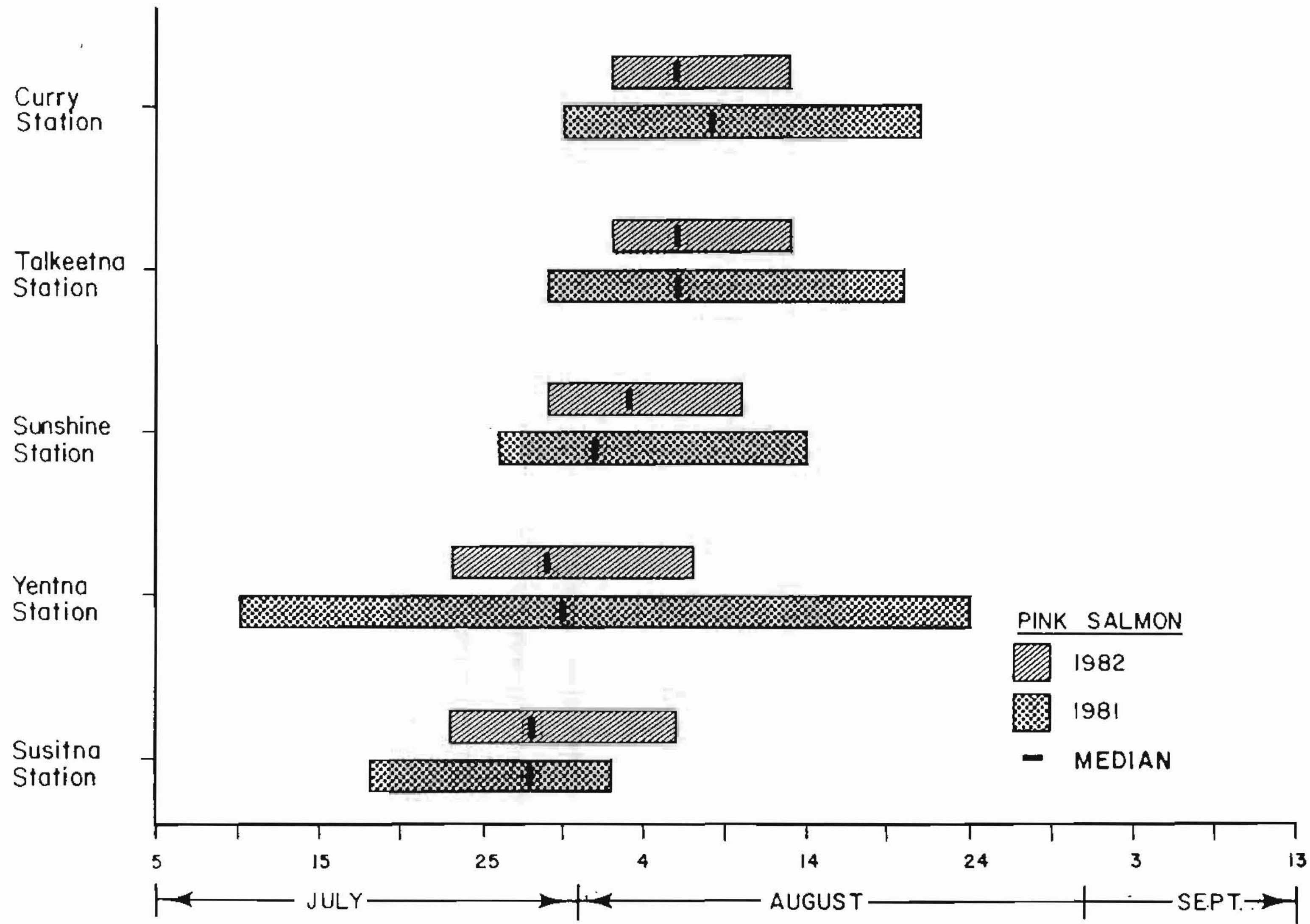

Figure 2-4. Migrational timing of pink salmon at selected sampling locations in the Susitna River basin in 1981 and 1982, Adult Anadromous Investigations, Su Hydro Studies, 1983.

2.2.4 Chum Salmon (*O. keta*)

Chum salmon escapement to the Susitna River drainage was approximately 282,700 fish in 1981 and 458,200 fish in 1982, not including escapement returns in both years to systems between RM 6 and 77 but including the Yentna River (RM 28) escapement (Table 2-1). Escapement estimates derived at four sampling stations, one on the Yentna River and three on the Susitna River main channel, are reported in Table 2-2.

The migration timing of the chum salmon escapement past Susitna Station (RM 26), Yentna Station on the Yentna River (RM 28), Sunshine Station (RM 80), Talkeetna Station (RM 103) and Curry Station (RM 120) is illustrated in Figure 2-5.

Three age classes of chum salmon, age 3_1, 4_1 and 5_1, were represented in the 1981 and 1982 escapement return to the Susitna River. Approximately 85 percent of the escapement return to the Susitna River in 1981 and 1982 were age 4_1 fish.

Tag recaptures and radio transmitter implants in chum salmon indicated that approximately 25 percent and 60 percent of the chum salmon that reached Talkeetna Station (RM 103) in 1981 and 1982 respectively, were not destined to upstream spawning areas but were milling fish. Milling behavior was also recorded among fish released at Curry Station (RM 120) in 1981 and 1982 but was not as notable as that recorded among the fish released at Talkeetna Station.

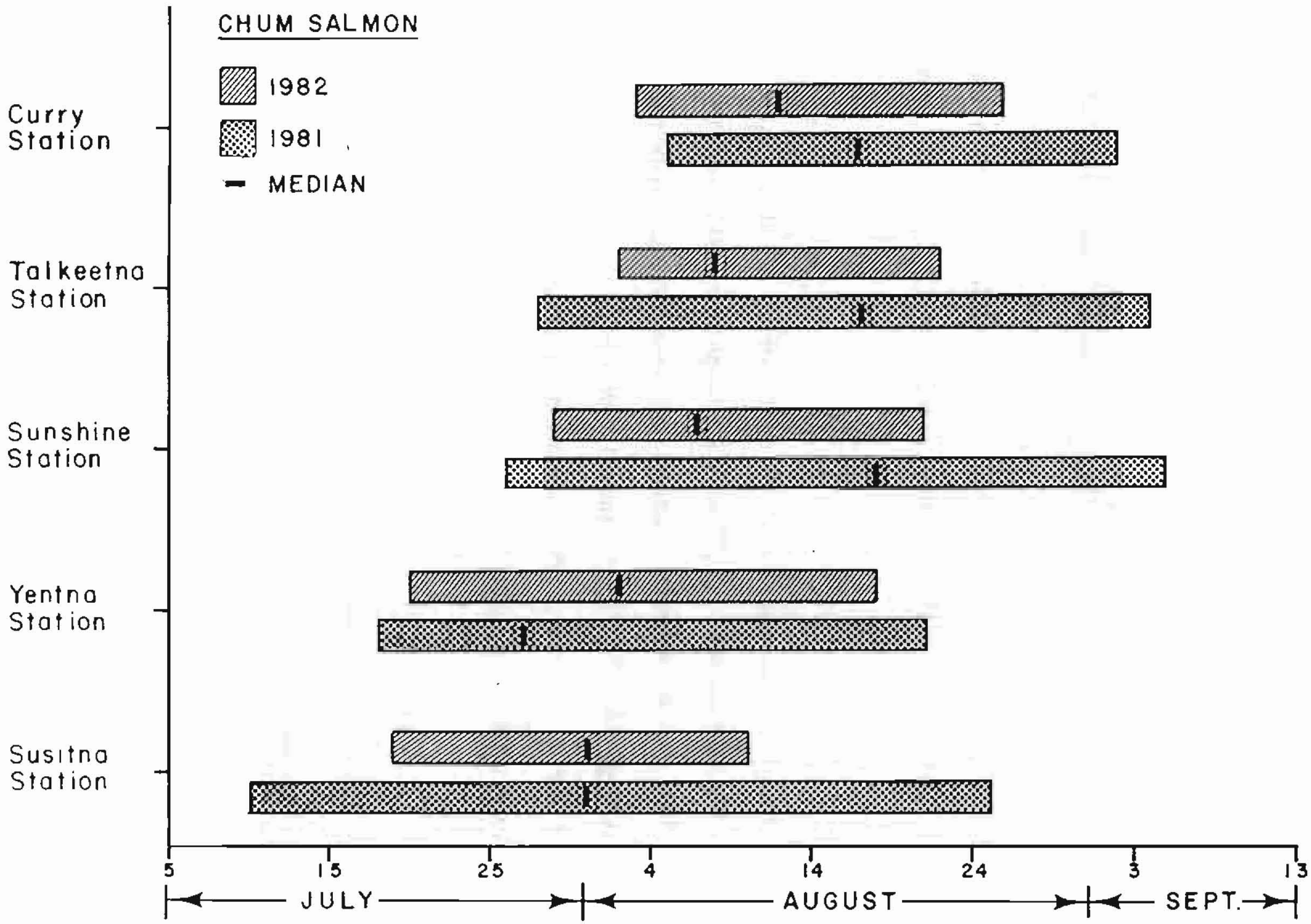

Figure 2-5. Migrational timing of chum salmon at selected sampling locations in the Susitna River basin in 1981 and 1982, Adult Anadromous Investigations, Su Hydro Studies, 1983.

Based on 1981 and 1982 set net and electroshocking catch results, chum salmon enter lower Devil Canyon (RM 150-151) and are abundant there during the last three weeks of August.

Chum salmon spawned in the Susitna River main channel reach between RM 7 and 150 in 1981 and 1982. Six spawning sites were found below Talkeetna (RM 97) in 1981. However, no main channel chum salmon spawning was found in this reach in 1982. Upstream of Talkeetna four main channel Susitna River spawning locations were identified in 1981 and nine in 1982.

Chum salmon spawning surveys conducted upstream of RM 98.6 resulted in the finding of chum salmon in 20 of 33 sloughs in 1981 and 17 of 34 sloughs in 1982. The highest numbers of chum salmon spawners were recorded in sloughs 8A (RM 125.1) and 11 (RM 135.3) in 1981 and sloughs 21 (RM 141.0) and 11 in 1982. Peak spawning in slough habitats occurred during the last week of August and the first week of September both in 1981 and 1982.

Eight of 15 streams above RM 98.6 in 1981 and 8 of 19 streams in 1982 supported chum salmon adults. The highest index counts were recorded in Fourth of July Creek (RM 131.1) and Lane Creek (RM 113.6) in 1981 and Indian River (RM 138.6) and Fourth of July Creek in 1982. The peak of chum salmon spawning in the stream habitats occurred from the second week of August to the second week of September in 1981 and from the third week of August to the second week of September in 1982.

2.2.5 Coho Salmon (*O. kisutch*)

Coho salmon escapement to the Susitna River basin was estimated at 36,800 fish in 1981 and 79,800 fish in 1982 not including returns to the systems between RM 6 and 77 with the exception of the Yentna River (RM 28) (Table 2-1).

Escapements of coho salmon recorded past Yentna Station (RM 04) on the Yentna River (RM 28) and Susitna River main channel at Sunshine Station (RM 80), Talkeetna Station (RM 103) and Curry Station (RM 120) for 1981 and 1982 are provided in Table 2-2. The migrational timing of coho salmon past these locations and Susitna Station (RM 26) are outlined in Figure 6. As indicated in Figure 2-6, coho salmon were abundant in the Susitna River reach between RM 26 and 80 from the third week of July to the fourth week of August both in 1981 and 1982. In the river reach between RM 80 and RM 120, coho salmon were abundant in the main channel through the month of August in both years.

Analysis of age data collected from escapement samples at Susitna Station (RM 26) indicate that the majority of the Susitna River coho salmon returns in 1981 and 1982 were age 3_2 and 4_2 fish with the latter age class representing approximately 70 percent of the fish in 1981 and 65 percent in 1982. Overall male to female sex ratio for the 1981 Susitna River coho salmon return was approximately 0.8:1 and in 1982, 0.6:1.

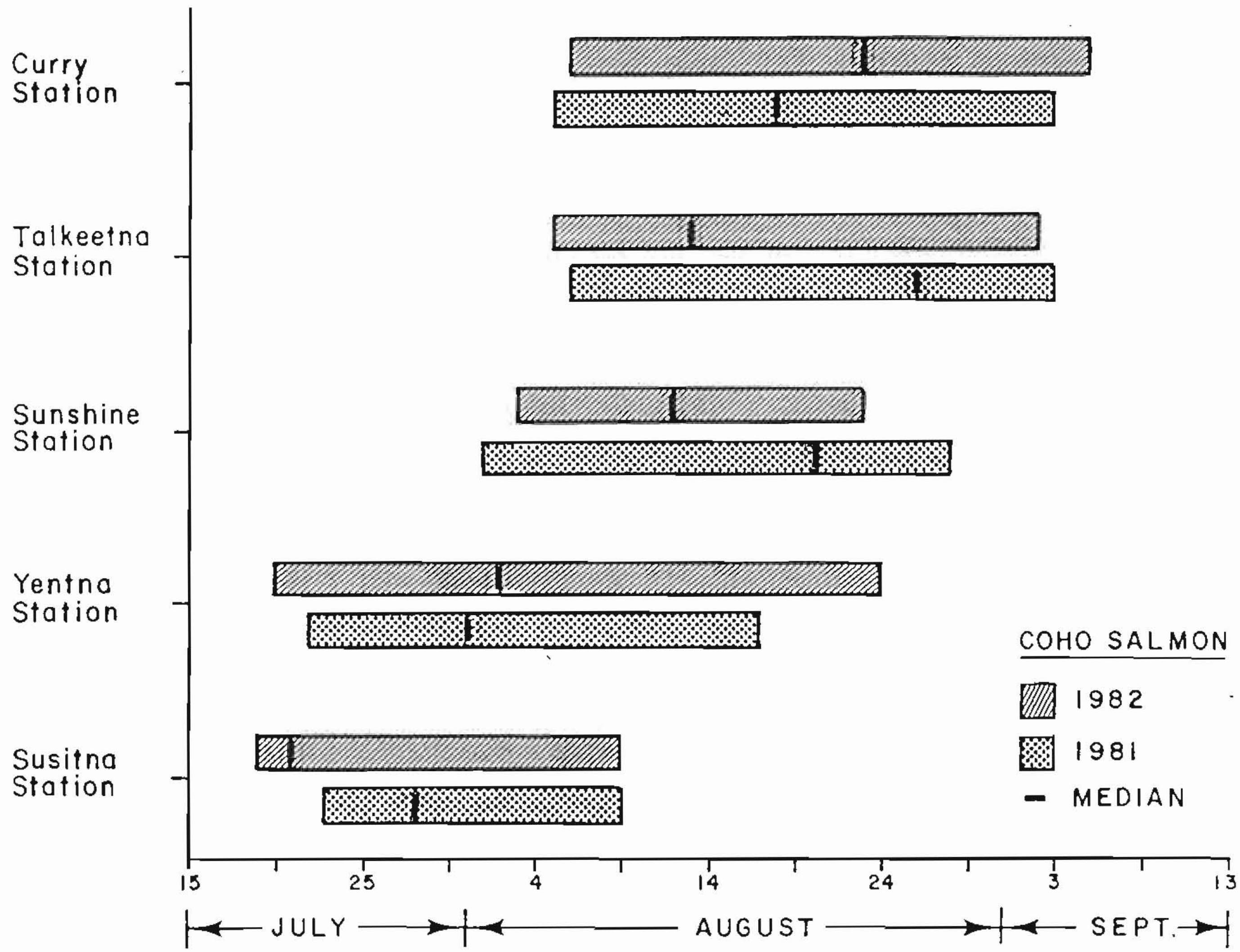

Figure 2-6. Migrational timing of coho salmon at selected sampling locations in the Susitna River basin in 1981 and 1982, Adult Anadromous Investigations, Su Hydro Studies, 1983.

Based upon tag recoveries and radio transmitter implants, over fifty percent of the coho salmon intercepted in fishwheels at Talkeetna Station (RM 103) were milling fish that later descended to spawning areas below Talkeetna Station. Nearly all of the radio tagged fish released at Curry Station (RM 120) in 1981 spawned below the station while in 1982 nearly all spawned in stream habitats above the station.

Test fishing results in lower Devil Canyon (RM 150-151) in 1981 and 1982 indicated that coho salmon occupy the lower canyon reach in the last week of August and first week of September.

Coho salmon surveys of the Susitna River main channel from RM 7 to 150 in 1981 and 1982 found one main channel spawning area located at RM 129.2 (1981).

In 1981 coho salmon were not observed spawning in slough habitats above RM 98.6 and in 1982 spawning was recorded in only one slough, Slough 8A (RM 125.1). The peak of coho salmon spawning in Slough 8A occurred between the fourth week of September and the first week of October in 1982.

2.3 Bering Cisco (*Coregonus laurettae*)

The first recorded (documented) presence of Bering cisco in the Susitna River drainage was made by ADF&G Su Hydro Staff in late August, 1981.

An estimate of the Bering cisco escapement into the Susitna River drainage for either 1981 or 1982 is not available. However, an index abundance based on fishwheel catches at Sunshine Station (RM 80) indicate that the 1981 escapement was approximately 2.4 times greater than in 1982.

The 1982 migration of Bering Cisco arrived at Susitna Station (RM 26) on August 7 and reached Sunshine Station on September 4. The arrival of Bering cisco at Sunshine Station in 1982, was four days earlier than in 1981. In both 1981 and 1982, the migration extended beyond suspension of Sunshine Station fishwheel operations on October 1.

Examination of several scales from a Bering cisco tagged on the spawning grounds in 1981 and recaptured in 1982 indicate that Bering cisco are capable of successive annual spawning.

Sex composition of the Bering cisco escapement in 1981 and 1982 showed male to female ratios of 1.0:1 and 1.4:1, respectively.

Based on fishwheel catches at Susitna (RM 26), Yentna (RM 04), Sunshine (RM 80), Talkeetna (RM 103) and Curry (RM 120) stations in 1982, the Bering cisco migration into the Susitna River drainage is limited to the main channel Susitna River reach below Talkeetna (RM 97). The Yentna River is utilized for occasional milling.

Surveys for Bering cisco spawning in the main channel Susitna River were conducted in 1981 and 1982 from RM 7 to 150. Three spawning locations were identified in 1981 between RM 75 and 79 and two in 1982 between RM 76 and 81. Peak spawning at these sites in both years occurred during the second week of October.

3.0 VOLUME 3 SUMMARY - RESIDENT AND ANADROMOUS JUVENILE FISH STUDIES

3.1 Distribution and Abundance Studies

In 1982, three approaches were used to determine the distribution and abundance of resident and juvenile anadromous species in the Susitna River between Cook Inlet and Devil Canyon. The approaches used were boat mounted electrofishing surveys, radio telemetry, and detailed studies on the influence of habitat on the distribution and abundance of fish at 17 specific sites.

Boat mounted electrofishing surveys were conducted throughout the Cook Inlet to Devil Canyon (RM 150.2). Some of the sites surveyed were sampled monthly to document seasonal changes in resident fish populations. However, most of the sites were sampled only once or possibly several times at random intervals. Biological data was collected on all resident fish captured. All adult resident fish were tagged with Floy anchor tags to monitor their movements. At all sites where adult resident fish spawning was documented, habitat measurements of water chemistry, water velocity, and substrate composition were recorded. Maps of these spawning sites and a listing of the habitat parameters found at each are presented in Volume 4, Part II.

A radio telemetry study on rainbow trout and burbot was initiated as a pilot program in the fall of 1981. Radio telemetry techniques were employed between October, 1981 and April, 1982 to monitor winter movements of five rainbow trout and five burbot in the Susitna River below the Chulitna River confluence.

The study of resident and juvenile anadromous species at specific habitat sites conducted through 1981 had progressed by 1982 to where it could be changed from the collection of broad-based distribution and biological data on resident and juvenile anadromous species to a more detailed study of the aquatic environmental factors which affect the distribution and relative abundance of these species. The sampling design for the study initiated in 1982 was based upon the hypothesis that the distribution of the resident and juvenile anadromous species is influenced by the effects of the mainstem stage on habitats associated with side sloughs and tributary mouths.

To implement the 1982 study program, 17 specific sites were chosen along the Susitna River between Goose Creek (RM 73.1) and Portage Creek (RM 148.8). The sites were chosen based on 1981 data which indicated that they could support sufficient numbers of resident and/or juvenile anadromous fish, or were important spawning areas for adult salmon. To further evaluate the relative biological importance of the sites during the open water season, each site was subdivided into zones based on the hydraulic conditions present and the water source. The zones were then sampled independently with a variety of gear including minnow traps, trotlines, beach seines, backpack electrofishing units, dip nets, fish traps, variable mesh gill nets, and hook and line. Comparisons of fish distribution among zones to determine the relative importance of each zone and its various habitat parameters to each species are presented in Volume 4, Part II.

Ten species of resident fish and five species of juvenile salmon were captured during the 1982 study and are listed below followed by a brief, general description of findings relevant to each species.

Resident Fish	Juvenile Salmon
Rainbow trout	Chinook salmon
Arctic grayling	Coho salmon
Burbot	Chum salmon
Round whitefish	Sockeye salmon
Humpback whitefish	Pink salmon
Longnose sucker	
Dolly Varden	
Threespine stickleback	
Slimy sculpin	
Arctic lamprey	

3.1.1 Rainbow Trout (*Salmo gairdneri*)

Rainbow trout were distributed throughout the Susitna River below Devil Canyon but were most commonly associated with tributaries above the Chulitna River confluence. Most adult rainbow trout move into the mainstem of the Susitna River in September from a clear water tributary and overwinter in the mainstem in close proximity to the mouth of that tributary. After the ice goes out, they move back into the tributary for spawning and summer residence. Catch data indicates that rainbows in the Susitna River drainage probably spawn in the tributaries between late May and June. After spawning, adult rainbows are thought to remain in the same general localities throughout the summer months until their September outmigration to their overwintering areas in the mainstem

Susitna. Some adult rainbow trout also make use of clear water sloughs in the Susitna River upstream from the mouth of Chulitna River during the summer.

Few juvenile rainbow trout have been captured in the mainstem Susitna River. The majority of those captured were taken in clear water sloughs and at tributary mouths. It is believed that most juvenile rainbow trout rear in the upper reaches of clear water tributaries, but no sampling was not conducted in these areas to confirm this hypothesis. Spawning is also thought to be limited to these upper reach areas.

3.1.2 Arctic Grayling (*Thymallus arcticus*)

Arctic grayling were found throughout the Susitna River below Devil Canyon, but were most abundant above the Chulitna River confluence. Immediately after breakup in May, adult Arctic grayling move into tributaries to spawn and remain there during the summer months. They then migrate out of the tributaries in September and overwinter in the mainstem Susitna. Analysis of recapture data indicates that between the spring spawning run and fall outmigration from tributaries, movements of adult Arctic grayling within the tributaries are minimal.

Many juvenile Arctic grayling (less than 200 mm) inhabitat the confluence areas of tributaries and sloughs. They were also found throughout the mainstem Susitna above the Chulitna River confluence between June and August. Young-of-the-year grayling remain in the upper reaches of tributaries until September when catch data at tributary mouths indicates that some of them have moved down.

3.1.3 Burbot (*Lota lota*)

Burbot are widely distributed throughout the mainstem Susitna River below Devil Canyon. Adults were found at tributary and slough mouths, and at a variety of mainstem sites. Observations of radio-tagged burbot and analysis of catch data indicate that burbot are relatively sedentary; however, some individuals in the Susitna River have moved as much as 70 miles during spawning migrations which begin in September. The exact timing and location of burbot spawning on the Susitna River have not been determined. Local residents on the Deshka River and Alexander River report that burbot congregate between November and February and spawn enmasse at the mouths of tributaries and sloughs in these areas.

Data collected during 1981 and 1982 indicate that both male and female burbot mature at age III or IV. Juvenile burbot were also captured at tributary mouths, clear water sloughs, and at mainstem sites. The presence of juvenile burbot in the Susitna River above the Chulitna River confluence also suggests that burbot spawning occurs in this reach of river.

3.1.4 Round Whitefish (*Prosopium cylindraceum*)

Round whitefish were captured most frequently in the Susitna River above the Chulitna River confluence. Adult round whitefish move into clear water tributaries in June where they reside for the summer. In August and September, adult round whitefish migrate out of the tributaries and gather in the mainstem Susitna and at the mouths of tributaries. The capture of sexually mature round whitefish in pairs and groups from mid-September to early October indicate that spawning probably occurs in October; however, it is not yet certain where this spawning takes place.

Large numbers of juvenile round whitefish (less than 200 mm) were found rearing during the summer months at clear water tributary and slough mouths, and in the mainstem Susitna above the Chulitna River confluence. Young-of-the-year (fork length 23 mm) were first observed in late June at the Rabideux Creek and Slough site and at Slough 9. Downstream migrant trap catches of young-of-the-year round whitefish in the mainstem Susitna peaked in early July.

3.1.5 Humpback Whitefish (*Coregonus pidschian*)

Humpback whitefish were distributed throughout the Susitna River drainage below Devil Canyon but were more abundant below the Chulitna River confluence. Adult humpback whitefish of fork length greater than 200 mm were often found at tributary or slough mouths and were not commonly captured in the mainstem Susitna except during their spawning run. The humpback whitefish spawning run occurred at the Sunshine fishwheels between August 16th and September 7th. Similar spawning runs of humpback whitefish occurred at the Yentna River fishwheels between August 8th and August 31st.

The catch of humpback whitefish at the Talkeetna and Curry fishwheels was considerably smaller than the downriver fishwheels, indicating that the majority of humpback whitefish spawn below the Chulitna River confluence. No spawning or spent humpback whitefish were captured in the mainstem Susitna River; consequently, they probably spawn in tributaries. All adult female humpback whitefish over 300 mm in fork length that were necropsied contained ripening eggs which indicates they may be consecutive year spawners.

Examination of gill raker counts indicates the species of humpback whitefish found in the Susitna River is Coregonus pidschian. Analysis of scales from 116 humpback whitefish showed that only one of the fish had spent part of its life in an estuary or salt water environment.

The downstream migrant trap operated at Talkeetna (RM 103.0) captured 47 young-of-the-year humpback whitefish. Most of these fry were captured in August. It is not currently known where these fry came from or where they rear. Limited captures from minnow traps, beach seines, and electrofishing suggest that juvenile humpbacks rear in the Susitna River below the Chulitna River confluence.

3.1.6 Longnose Suckers (*Catostomus catostomus*)

Longnose suckers were abundant at mainstem and tributary sites throughout the Susitna River below Devil Canyon. Adult longnose suckers spawn between late May and early June along gravel bars at the mouths of tributaries. Sexually mature and spent longnose suckers were captured by electrofishing crews at the Sunshine Creek and Slough site (RM 85.7) and at the mouth of Trapper Creek (RM 91.5). Captured male and female longnose suckers which were sexually mature were a minimum of five years of age.

Juvenile longnose suckers (fork length less than 200 mm) were found rearing at a variety of sloughs and a few tributary mouths. Juvenile suckers were especially abundant at the Goose Creek 2 and Side Channel site, Slough 6A, Slough 8, Slough 9, and Slough 22.

3.1.7 Dolly Varden (*Salvelinus malma*)

Dolly Varden, although common in certain tributaries, were one of the less frequently encountered resident species of the mainstem Susitna River. Fishwheel catches indicate that Dolly Varden were most abundant in the mainstem Susitna River in early June and September. Electrofishing crews found small numbers of adult Dolly Varden at tributary mouths during July and August. Most Dolly Varden are thought to reside in clear water tributaries during the summer months. Limited catch data indicate that adult Dolly Varden make use of the mainstem Susitna River from September through June; however, no specific wintering areas have been documented. Tagged Dolly Varden have exhibited upstream movements of up to 25 river miles over the summer season.

Adult Dolly Varden necropsied in September and October had enlarged gonads but were not yet sexually mature. Consequently, Dolly Varden in the Susitna River drainage below Devil Canyon probably spawn after mid-October.

Little is known about the habits of juvenile Dolly Varden in the Susitna River. Current sampling techniques have failed to catch juvenile Dolly Varden in significant numbers during summer or winter months. It is believed that juvenile Dolly Varden rear in tributaries well above the influence of the mainstem Susitna River.

3.1.8 Threespine Stickleback (*Gasterosteus aculeatus*)

Threespine stickleback were most abundant in the Susitna River below the Chulitna River confluence and were captured infrequently above RM 120.0. The numbers of threespine stickleback captured in 1982 were considerably less than in 1981. The reason for this decrease is unknown. In 1981, the catch of threespine stickleback was high at several sites sampled in June and then gradually decreased over the summer. During the 1982 season, the catch stayed consistently low all through the open water season.

Breeding male threespine stickleback were observed in spawning colors from mid-June to early August; however, peak spawning probably occurs in early July. Young-of-the-year threespine stickleback were found in late July and early August in the same areas that adults occupied. The catch of threespine stickleback fry in the downstream migrant trap at Talkeetna was highest in late August and September, suggesting a downstream movement of stickleback fry at this time.

3.1.9 Slimy Sculpin (*Cottus cognatus*)

Slimy sculpin were widely distributed throughout the Susitna River below Devil Canyon and occurred at almost all study sites. They were present year round and no specific movements or migrations have been documented for this species.

The catch of young-of-the-year slimy sculpin in late July suggested that spawning occurs in mid-June. Juvenile slimy sculpin were found in the same general areas occupied by adults.

3.1.10 Arctic Lamprey (*Lampetra japonica*)

Arctic lamprey were found in the Susitna River below the Chulitna River confluence; however, localized concentrations have been encountered above the Chulitna River confluence at the Whiskers Creek and Slough site (RM 101.2) and Gash Creek (RM 111.5). Arctic lamprey were encountered most frequently at tributary mouths in the mainstem Susitna River below RM 50.5.

Arctic lamprey spawning was observed at the Birch Creek and Slough site during late June. Ammoceotes were captured at the Whiskers Creek and Slough site and Gash Creek, suggesting that spawning also occurred at these sites.

Movements and migrations of Arctic lamprey in the Susitna River have not been documented. Length frequency data indicate that there are probably freshwater and anadromous populations of Arctic lamprey in the Susitna River drainage.

3.1.11 Chinook Salmon (*Onchorhynchus tshawytscha*) Juveniles

Chinook salmon juveniles were observed at all established sampling sites during the 1982 open water season between Goose Creek (RM 72.0) and Slough 21 (RM 142.0). Numbers of juvenile chinook captured were higher in the lower portion of this reach from Whiskers Creeks (RM 101.4) to Goose Creek. Juvenile chinook were most abundant from late June through July at sites below the Chulitna River confluence and in late June, late August and early September at sites above the confluence. The relative abundance of juvenile chinooks above the Chulitna River confluence was lower in 1982 than in 1981. The reason is not certain. A possible explanation for the low abundance could be related to high flows recorded during the summer of 1981, severe overwintering or ice scouring conditions experienced during the 1981-1982 winter, or reduction in habitat during the low flow period experienced during the summer of 1982.

Winter catches of chinook salmon juveniles collected from February to April, 1982 were quite low. Small numbers of chinook juveniles were captured at mainstem, slough, and side channel sites in the Susitna River below Devil Canyon throughout the winter. Whiskers Creek and Slough, Slough 10, and Slough 20 produced the highest catches of juvenile chinook during the winter of 1981-1982. High winter catches at these sites suggest their importance as winter rearing areas for juvenile chinook.

3.1.12 Coho Salmon (*O. kisutch*) Juveniles

Coho salmon juveniles were more abundant at sampling sites below the Chulitna River confluence. Above the Chulitna River confluence, juvenile coho salmon were more abundant at sites below Lane Creek (RM 113.6). During 1981 and 1982, coho salmon juveniles were most numerous at tributary mouths which are associated with sloughs and side channels. Although less abundant in 1982 than in 1981, the overall distribution of juvenile coho was similar.

Winter catches of coho salmon juveniles have been very low. With so few caught, it is difficult to draw any conclusions about the distribution and abundance of coho juveniles in winter. Presently, the only two sites where relatively high catches of juvenile coho have been taken in summer and winter are at the Whiskers Creek and Slough site and at Slough 6A (RM 112.3).

3.1.13 Chum Salmon (*O. keta*) Juveniles

Large numbers of well-developed chum salmon fry were observed in late winter, 1982, in ice free areas of sloughs where previous fall spawning was documented. This suggests that the fry of this species will emerge from the slough gravel as early as late February. Juvenile chum salmon were captured at these same sloughs through the month of June after which they were distributed throughout the sampling area from Slough 21 (RM 142.0) downstream to Birch Creek (RM 89.2). Chum salmon juveniles were captured in the Susitna River reach above the Chulitna confluence as late as mid-August.

3.1.14 Sockeye Salmon (*O. nerka*) Juvenile

Sockeye salmon juveniles were most abundant at slough sites in the Susitna River above the Chulitna River confluence. Sockeye salmon juveniles were most numerous between early June and late July, with the peak catch occurring during mid-July. Although the largest catch of juvenile sockeye was made at Slough 6A, no spawning of adult sockeye has been documented at this site. Therefore, it is probable that these juveniles move into Slough 6A from other upriver spawning areas and utilize this site for rearing.

3.1.15 Pink Salmon (*O. gorbuscha*) Juvenile

Only one pink salmon fry was captured during 1982 by distribution and abundance studies crews. This juvenile pink was captured in a beach seine on July 7th, at the Mainstem Susitna - Curry (RM 120.7).

3.2 Emergence and Outmigration Studies

Surveys of selected spawning areas were conducted monthly during March, April, and May of 1982 to collect baseline data on the emergence timing of juvenile salmon. An inclined plane downstream migrant trap was also operated on the mainstem Susitna River at RM 103.0 from June 18 through October 12. The trap was operated above the Chulitna River confluence to limit collection of fish to stocks which would most likely be impacted by the proposed hydroelectric development.

Emergence timing for chinook salmon juveniles was not clearly determined during the 1981 or 1982 surveys. However, data collected from Portage Creek during 1981 showed that emergence of chinooks had occurred prior to sampling conducted in mid-April.

Two age classes of juvenile chinook (age 0+ and age 1+) were present in the Susitna River. Outmigration of chinook salmon juveniles from the Susitna River above the Chulitna River confluence was observed primarily during May and June in 1981 and 1982. Outmigrants were comprised largely of age 1+ chinooks with average total lengths of 90 mm. Age 1+ chinook were absent from catches on the Susitna River above the Chulitna River confluence after mid-August but were still present below the Chulitna through early September. Age 0+ chinook were collected at Indian River (RM 138.6) as early as April in 1981, but this age class was not observed until early June in 1982. Age 0+ chinook salmon appear to redistribute themselves throughout the ice-free season from high density emergence areas to more optimum habitat for rearing and overwintering.

Surveys conducted during 1981 and 1982 did not determine a time of emergence for coho salmon fry. The lower range of coho salmon age 0+ lengths observed during June and July, 1982 indicates that the emergence time for this species extends over a wide period. Three age classes of coho juveniles (age 0+, age 1+, age 2+) from brood years 1979 through

1981 were observed in the Susitna River during 1982. Comparison of 1981 and 1982 data indicates that Susitna River coho salmon smolt following one to two years of freshwater rearing. Coho salmon smolts outmigrate throughout the summer season with the peak outmigration occurring in May and June.

Data collected during 1982 indicated that the major emergence of chum salmon fry occurred during late February and March. By the end of April, most emergent chums had completely absorbed their yolk sacs and had attained a length of 35 mm. The peak chum salmon juvenile outmigration was observed in June, although some chum juveniles remained in the Chulitna River to Devil Canyon reach through mid August. The observed increase in the mean lengths for chum salmon fry in the Susitna River between March and June indicates that chum juveniles are rearing in freshwater prior to their outmigration. By late July, the largest chum salmon fry was 62 mm long.

Comparisons of 1981 and 1982 data indicate that the major emergence of sockeye salmon fry occurs during March. Most sockeye juveniles had completely absorbed their yolk sac by late April and attained a length of 33 mm. A downstream redistribution of age 0+ sockeye from their natal streams and sloughs occurred throughout the open water season with a major downstream migration observed between early and mid-July. Age 0+ sockeye migrating down the Susitna from above the Chulitna River confluence may continue to the ocean as age 0+ smolts or they may migrate to more favorable overwintering habitat associated with sloughs, tributaries, and lake systems located in the lower Susitna River drainage.

Analysis of limited 1982 data indicated a peak outmigration of age 1+ sockeye salmon from the Susitna River above the Chulitna River confluence prior to late June. However, age 1+ sockeye accounted for a very small percentage of the juvenile sockeye catch in this reach.

Small numbers of pink salmon juveniles were collected during 1981 and 1982 surveys. Preliminary emergence studies indicate that pink salmon emerge as sac fry beginning in March and remain in the river system for only a short period of time after emergence. The downstream migrant trap caught seven juvenile pink salmon during 1982 from early to mid-July. Juvenile pinks outmigrating in the spring of 1982 were from the 1981 brood class which was an "odd year" for adult pink salmon returns. Odd year returns are smaller than even year returns; only an estimated 2,335 adult pinks passed through the Talkeetna fishwheels in 1981.

3.3 Food Habits and Distribution of Food Organisms

Because changes in the invertebrate fauna may lead to changes in the production potential for important fishery resources, a study was designed to provide initial information necessary for a data base capable of predicting the rearing potential of mainstem, side channel, and slough habitats under post-project flows. This pilot program was initiated in early August, 1982.

Field investigations for the Food Habits Study were conducted at seven sites in the Chulitna River confluence to Devil Canyon reach of the Susitna River that were considered to be representative of the major habitats preferred by rearing juvenile salmon. Collections of invertebrates and juvenile salmon stomachs were made every other week in August and September, 1982. Aquatic invertebrates were identified to Order or Family and terrestrial insects were identified only to Order.

Electivity indices suggest a positive selection for the larvae of aquatic midge (Family: Chironomidae) by all three species of juvenile salmon (chinook, coho, sockeye) examined. Adult midges, terrestrial invertebrates, aquatic nymphs and zooplankton also played important roles in food items.

The range and diversity of invertebrates in the diets of juvenile chinook and juvenile coho salmon indicate that they have an ability to adapt to varied diets. The number and kind of invertebrates available as food items may influence the density and perhaps the growth rate of juvenile salmon in a particular location but the availability of cover or water velocity may be more important factors in determining their overall distribution and abundance.

Juvenile sockeye were found to be feeding on a broad range of invertebrates in slough habitats. This species is characteristically associated with lake habitats with dense zooplankton populations.

Juvenile chum salmon food habits were not examined during the 1982 study because this species had largely outmigrated from the study area by August.

4.0 VOLUME 4 SUMMARY - AQUATIC HABITAT AND INSTREAM FLOW STUDIES

4.1 Introduction

Volume 4, the Aquatic Habitat and Instream Flow Draft Basic Data Report of the FY83 Aquatic Studies Basic Data Report, is divided into two parts. Part I, the Hydrologic and Water Quality Investigations, is a compilation of all physical data collected by the various sub-program elements of the Aquatic Studies Program. This data is arranged by variable for ease of access to user agencies. The combined data set represents the available physical habitat of the Susitna River. Part II, the Lower River Fisheries Habitat Investigations, describes the subset of available habitat that is utilized by the various species and life stage of fish studied in the lower Susitna River (downstream of Devil Canyon).

4.2 Part I Summary

4.2.1 Stage/Discharge Studies

Objectives of the stage/discharge monitoring program conducted during the 1982 open water field season were to:

1. determine the water surface elevations associated with various discharges of the mainstem Susitna River at selected mainstem, slough, and tributary locations from RM 73.1 (Lower Goose 2) to RM 148.8 (Portage Creek); and,

2. obtain baseline discharge data of tributaries in the Talkeetna to Devil Canyon reach to quantify their contributions to the flow of the Susitna River.

To meet these objectives, measurements of stage and discharge were obtained during the 1982 open water field season at representative mainstem, slough, and tributary sites within the Susitna River basin. The results of these findings are summarized below by river reach by habitat type.

4.2.1.1 Talkeetna to Devil Canyon

4.2.1.1.1 Mainstem Habitats

Periodic stage readings (which were converted to true water surface elevations) were obtained at 31 mainstem sites between Talkeetna and Devil Canyon from June to September 1982. The water surface elevation of the mainstem was observed to rise 1.5 to 2.0 feet as stream flows increased from 10,000 to 20,000 cfs. These data were plotted against the mainstem discharge obtained at the USGS Gold Creek gaging station to determine the relationship between water surface elevations and mainstem discharge at each site. The plots indicate that the relationship between water surface elevation and discharge of the mainstem is relatively well defined at most of the 31 stations for the range of mainstem flows from 8,000 to 30,000 cfs.

At the onset of the 1982 field season, it was intended to define the relationship of stage and discharge for the mainstem upstream of Talkeetna for the full range of discharges that normally occur during the open water season. However, abnormally low discharges during the summer, followed by high fall flows and an early freeze-up, precluded our ability to obtain the necessary field data to define water surface profiles for mainstem discharges in the 5,000 to 8,000 cfs or 30,000 to 45,000 cfs ranges.

4.3.1.2 Slough Habitats

Periodic measurements of stage (which were converted to true water surface elevations) and discharge were obtained at nine sloughs located between Talkeetna and Devil Canyon to:

1. determine the relationships between water surface elevations and flows in the sloughs;

2. determine the discharge of the mainstem required to breach the head of these sloughs; and,

3. determine the effects that discharge of the slough and mainstem have on the formation of backwater zones at the month of each slough.

Sloughs were characterized as either upland or side sloughs. Upland sloughs were defined as those having no connection to the mainstem other than at their mouth, with their water sources consisting primarily of ground water and/or surface water runoff. Side sloughs were defined as those connected to the mainstem at their mouth and, during periods of high mainstem flow, at their upstream juncture (head) with the mainstem. Based on these criteria, of the nine sloughs studied between Talkeetna and Devil Canyon, two (Sloughs 6A and 19) were characterized as upland sloughs and seven (Whiskers and Lane Creek Sloughs and Sloughs 11, 16B, 20, 21 and 22) were characterized as side sloughs.

To determine the relationship between water surface elevation and flow in the study sloughs, the stage and discharge data were used to construct preliminary rating curves. A sufficient data base at Whiskers Creek Slough and Sloughs 16B, 20, 21, and 22 permitted the development of rating curves at these sites. An insufficient data base at the other sloughs studied did not permit the development of rating curves.

Mainstem discharge levels required to breach the heads of side sloughs were determined from on site observations, cross section data obtained at the head of a slough as compared to water surface elevation of the mainstem, and comparisons of observed water surface elevation changes within the slough to change in mainstem discharge measured at the USGS Gold Creek gaging station. Mainstem discharges required to breach the study sloughs between Talkeetna and Devil Canyon ranged from 20,200 cfs for Slough 16B to 26,000 cfs for Slough 21.

Backwater areas where found at the mouths of a majority of the study sloughs. In general, these backwater areas were more extensive at higher mainstem discharges than at lower mainstem discharges.

4.2.1.1.3 Tributary Habitats

Periodic measurements of stage (which were converted to water surface elevations) and discharge were obtained at seven tributaries located between Talkeetna and Devil Canyon during the 1982 open water season to:

1. determine the relationship between water surface elevation and discharge in the study tributaries; and,

2. quantify the contributions of these tributaries to the flow of the mainstem Susitna River.

The tributaries studied included Whiskers Creek, Gash Creek, Lane Creek, Fourth of July Creek, an unnamed tributary at the head of Slough 20, Indian River, and Portage Creek.

Sufficient stage and discharge data were obtained at all the study tributaries except Fourth of July Creek to permit the development of preliminary rating curves. Insufficient data at Fourth of July Creek precluded the development of a rating curve. However, due to unseasonably low stream flows during the FY83 open water field season, sufficient data was not obtained over the full range of flows that normally occur during the open water field season in the study tributaries to quantify the contributions of these tributaries to the flow of the mainstem Susitna River.

4.2.1.2 Talkeetna to Cook Inlet

4.2.1.2.1 Mainstem Habitats

Periodic measurements of stage were obtained during the 1982 open water field season at two mainstem Susitna River sites below Talkeetna (at the Sunshine fishwheel site and adjacent to Lower Goose Creek 2 Slough) and one mainstem Yentna River site (at the Yentna River fishwheel site) to determine the ranges of water surface elevations associated with various levels of mainstem discharges. Sufficient data was not obtained to define the relationship of stage and discharge for any of the mainstem sites below Talkeetna.

Stage readings obtained nearly daily from July 1 to October 10, 1982 from the Susitna River at the Sunshine fishwheel site varied 5.60 ft over a corresponding range of mainstem Susitna River discharge (obtained from the USGS mainstem Susitna River gaging station at Sunshine) from 19,900 to 91,300 cfs. Stage readings obtained periodically in the mainstem Susitna River adjacent to Lower Goose Creek 2 Slough varied 2.35 ft over a corresponding range of mainstem Susitna River discharge (obtained from the USGS mainstem Susitna River gaging station at Sunshine) from 31,500 to 68,700 cfs.

Stage readings obtained periodically from June 30 to September 15, 1982 from the Yentna River at the Yentna River fishwheel site varied 3.61 ft over a corresponding range of discharge (obtained from the USGS Yentna River gaging station) from 30,000 to 61,00 cfs.

4.2.1.2.2 Slough Habitats

Periodic measurements of stage (which were converted into water surface elevations) and discharge were obtained at four sloughs below Talkeetna to:

1. determine the relationship between water surface elevation and flow in the sloughs;

2. determine the discharge of the mainstem Susitna River required to breach the head of these sloughs; and,

3. determine the effects that discharge of the slough and mainstem have on the formation of backwater zones at the mouth of each slough.

Sloughs studied were Lower Goose 2, Whitefish, Sunshine, and Birch Creek sloughs. All sloughs studied below Talkeetna had associated tributaries draining into them.

Sufficient stage and discharge data were collected at only one slough below Talkeetna (Birch Creek Slough) to permit the development of a preliminary rating curve. Insufficient data at the other sloughs precluded the development of rating curves.

Mainstem discharge levels required to breach the head of sloughs were determined from on-site observations and comparisons of observed water surface elevation changes within the slough to changes in mainstem discharge obtained at the USGS Sunshine gaging station. in general, higher mainstem flows were required to breach the head of sloughs below Talkeetna than above Talkeetna.Mainstem flows above 36,000 cfs were required to breach the heads of Birch Creek, Sunshine, and Lower Goose Creek 2 sloughs during 1982. The head of Whitefish Slough did not join with the mainstem and therefore breaching never occurred at this slough.

Backwater areas were found at the mouths of all of the study sloughs below Talkeetna. In general, the backwater areas at the mouths of sloughs below Talkeetna were more extensive than the backwater areas observed at mouths of sloughs above Talkeetna. The backwater areas became more extensive at higher mainstem discharges than at lower mainstem discharges, often extending into the associated tributary during high mainstem discharges.

4.2.1.2.3 Tributary Habitats

All tributaries studied downstream of Talkeetna confluenced with sloughs. Periodic measurements of stage (which were converted to water surface elevations) and discharge were obtained at four tributaries downstream of Talkeetna to:

1. determine the relationship between water surface elevation and discharge in the tributaries; and,

2. determine the effects that tributary flow had on the hydraulic characteristics of the associated sloughs.

The tributaries studied were Lower Goose Creek 2, Rabideux, Sunshine, and Birch creeks.

Sufficient stage and discharge data were collected at each of the four tributaries to permit the development of preliminary rating curves. Insufficient data, however, were collected to determine the effects that tributary flow had on the hydraulic characteristics of the associated sloughs over the full range of flows in tributaries expected for an open water season.

4.2.2 Thalweg Profile Studies

The thalweg can be defined as "the line following the deepest part or middle of the bed or channel of a river or stream" (Annette, 1975). Thalweg profiles were developed for sloughs 8A, 9, 11, and 21 using basic survey techniques of differential leveling. These profiles, presented in Volume 4 of this report, delineate discrete reaches defined by obvious changes in gradient within each slough. Included with each profile is a schematic drawing showing the gross morphological features of the slough and corresponding mainstem Susitna River. Significant features of each profile are discussed on a site by site basis.

4.2.3 Backwater Area Studies

Backwater areas are reaches of low velocity water which result from hydraulic barriers created by mainstem stage. The location and size of these areas at 17 slough and tributary habitat locations was mapped twice monthly between June and September, 1982 to determine their relationship to changing mainstem Susitna River discharges. Graphs plotting the area of backwater mapped at each location as a function of mainstem discharge were constructed. These data showed that the relationships are both predictable and unique for the various habitat locations. In general, the size of the backwater area decrease with decreasing mainstem discharge. At several habitat locations, the backwater area decreased to or approached zero at a lower mainstem discharge. At several of these locations, new backwater areas formed downstream from their previous location, as mainstem stage continued to decrease. These new backwater areas typically appeared in side channels which had depths and substrates which were very different from those present in the backwater areas mapped at higher mainstem discharges.

The backwater area mapped within the boundaries of upper and lower river study locations (below Talkeetna and between Talkeetna and Devil Canyon) was extracted from the data by summing the areas indicated at 2500 and 5000 cfs discharge intervals on the individual graphs. The upper river data summary indicated a marked decrease in the total backwater area present as mainstem discharges (at Gold Creek) decreased below 17,500 cfs. In the lower river data summary, large decreases in backwater area appeared to occur at mainstem discharges (at Sunshine) below 40,000 cfs.

Direct observations at mainstem discharges above and below those observed in this study are necessary to extrapolate the data beyond the limits observed.

The relationship between backwater areas and total wetted surface areas within the study boundaries of the habitat locations studied is presented in the FY83 Fishery Habitat Relationships Report.

4.2.4 Open Channel Studies

Segments of sloughs 8A, 9, and 21, Rabideux Slough and Chum Channel were selected for computer modeling using hydraulic simulation programs developed by the Instream Flow Group (Milhous et. al. 1981). Provided with channel depths, velocities, widths and water surface elevations from transects at known mainstem discharges, these models extrapolate and predict hydraulic variables including depth, velocity, width, wetted perimeter and water surface elevation at unobserved streamflows. Data from actual field observations are used to calibrate the model. The models are considered calibrated when predicted hydraulic parameters at known discharges closely approximate observed parameters and when predicted hydraulic parameters at hypothetical discharges fit a realistic pattern based on past hydrological experience. Data collected during one field season will not necessarily include a sufficient range of conditions to calibrate the model at all potential discharges. Thus, the models are being developed from data collected in 1982 and are reliable only at streamflows within specified limits. The results of modeling will be presented in the FY83 Fishery and Habitat Relationships Report.

4.2.5 Water Temperature Studies

Objectives of the water temperature monitoring program conducted during the 1982 open water field season were to:

1. monitor the seasonal variations in the surface water temperature of the mainstem Susitna River and its associated sloughs and tributaries downstream of Devil Canyon;

2. monitor the seasonal variations in intragravel water temperatures in selected sloughs between Talkeetna and Devil Canyon; and,

3. evaluate the relationship between surface and intragravel water temperature to fish passage and spawning.

Results of the first two objectives are summarized below and in Volume 4 - Part I. Results of the third objective are summarized in Volume 4 - Part II.

The data base includes surface and intragravel water temperatures obtained on an instantaneous and continuous basis. The data is presented by reach of river subdivided into mainstem (including side channel), slough, and tributary sites.

4.2.5.1 Talkeetna to Devil Canyon

4.2.5.1.1 Mainstem Habitats

4.2.5.1.1.1 Instantaneous Surface Water Temperature

Instantaneous measurements of surface water temperatures of the mainstem Susitna River between Talkeetna and Devil Canyon were collected at various locations in the Susitna River from May through October, 1982. Instantaneous surface water temperatures ranged from 5.1°C to 14.4°C, with the lowest temperature occurring at RM 138.9 on September 6 and the highest temperature occurring at RM 120.7 on July 7. In general, instantaneous surface water temperatures of the mainstem Susitna River between Talkeetna and Devil Canyon increased from May to July and decreased from August to October, peaking during July and August.

4.2.5.1.1.2 Continuous Surface Water Temperature

Surface water temperature of the mainstem Susitna River between Talkeetna and Devil Canyon was continuously monitored at six locations from May through October, 1982. Mainstem temperature gaging locations were located at the Talkeetna Fishwheel station (RM 103.0), Lower River Cross Section 18 (RM 113.0), Curry Fishwheel (RM 120.7), LRX 29 (RM 126.1), LRX 35 (RM 130.8), and LRX 53 (RM 140.1). Surface water temperature at these sites ranged from 0.0°C at LRX 18 in October to 15.2°C at LRX 29 in July. Generally, the mainstem surface water temperature increased during the period from May to July and decreased during the period from August to October, peaking during July depending on location.

4.2.5.1.1.3 Intragravel Water Temperature

Intragravel water temperature data in the mainstem between Talkeetna and Devil Canyon was collected on an instantaneous basis only at sites studied in conjunction with the mainstem Adult Anadromous Fish Habitat Investigations between Talkeetna and Devil Canyon from May through October, 1982. These data are summarized in Volume 4 - Part II.

4.2.5.1.2 Slough Habitats

4.2.5.1.2.1 Instantaneous Surface Water Temperature

Instantaneous surface water temperatures of selected sloughs situated between Talkeetna and Devil Canyon were obtained from May through October, 1982. Due to large variability in the data base and the periodic nature of the data, no summary statements concerning the above data can be made at the present time.

4.2.5.1.2.2 Continuous Surface Water Temperature

Surface water temperatures were continuously monitored during FY83 in selected sloughs between Talkeetna and Devil Canyon. Sloughs 8A, 9, 11, 16B, 19, and 21 were monitored during the 1982 open water season while sloughs 9, 9B, 11, 19, and 21 were monitored during the 1982 - 83 ice-covered season.

The surface water temperatures in the sloughs studied during the open water season ranged from 0.2°C at mid-slough in Slough 8A during October to 13.5°C in Slough 9 during August. The greatest variance in maximum surface water temperatures was noted during the first week in September when Slough 9 was 11.0°C and the maximum in Slough 11 was 3.5°C. The greatest variance noted in weekly minimum surface water temperatures was 4.4°C during the last week of August when the minimum temperatures in the mouth of Slough 8A and in Slough 11 were 7.7°C and 3.3°C, respectively. Surface water temperatures in the studied sloughs were notably warmer than surface water temperatures in the mainstem during the months of September and October. Comparing surface water temperatures in mid-Slough 8A (RM 126.1) with surface water temperatures in the mainstem adjacent to the slough (at LRX 29, RM 126.1) shows, for any given week, similar weekly maximum temperatures, but minimum weekly temperatures from 1° to 5.4°C colder in the mainstem than in the slough.

Based on data from the winter season, the overall range of surface water temperatures in the studied sloughs varied from 0.0°C in Whiskers Creek Slough in February to 10.3°C in Slough 9B in May. The greatest variance in maximum surface water temperatures among the studied sloughs occurred during the first week of May when the surface water temperature reached 10.3°C. Generally, winter surface temperatures in the studied sloughs increased gradually or remained stable through February and March and increase notably in April and the first week of May.

4.2.5.1.2.3 Instantaneous Intragravel Water Temperature

Instantaneous measurements of intragravel water temperature were obtained at several sloughs located between Talkeetna and Devil Canyon in conjunction with the Fishery Habitat Utilization slough study. These results are summarized in Volume 4 - Part II.

4.2.5.1.2.4 Continuous Intragravel Water Temperature

During the 1982 open water field season, the intragravel water temperature of five sloughs situated between Talkeetna and Devil Canyon (Sloughs 8A, 11, 16B, 19, and 21) was continuously monitored from late August to October, 1982. During the ice-covered, the intragravel water temperature in four sloughs (Sloughs 9, 9B, 19, and 21) was continuously monitored from February through the first week of May, 1982.

Based on data from the open water season, the intragravel water temperature of the studied sloughs varied overall from 1.5°C at the mouth of Slough 21 during October to 7.5°C in Slough 16B during August. The overall range of intragravel water temperatures in the studied sloughs (1.5°C to 7.5°C) was considerably less than the range of surface water temperatures observed in the studied sloughs (0.2°C to 13.5°C).

In each slough studied, the minimum weekly intragravel water temperature was warmer than the corresponding surface water temperature from mid-September through October. Conversely, minimum intragravel water temperatures in the mouth of Slough 8A, upper Slough 8A, Sloughs 11 and 19, and upper Slough 21 were cooler than corresponding minimum surface water temperatures prior to September. The minimum intragravel temperatures in upper Slough 8A were consistently warmer than those in the other sloughs studied for this period. For August and September, the coolest intragravel temperatures in these sloughs were in Slough 19. The difference between minimum intragravel temperatures in the mouth of Slough 8A and in Slough 19 for September was 3.0°C.

Intragravel water temperatures obtained during the winter season (February to April, 1982) showed considerable variations in intragravel temperatures existed between the sloughs studied. For example, while the intragravel water temperature in the mouth of Slough 21 remained a steady 3.0°C from February through April, it varied from 0.0°C to 5.0°C in Slough 9 over the same time period. In Slough 19, the average intragravel water temperature was warmer than the corresponding surface water temperature from February to April. The same was true in the mouth of Slough 21 for February and March, but by mid-April the average surface water temperature was warmer than the intragravel water temperature. In Sloughs 9 and 9B, the surface water temperature was warmer than the intragravel water temperature from February through April.

4.2.5.1.3 Tributary Habitats

4.2.5.1.3.1 Instantaneous Surface Water Temperatures

Instantaneous measurements of surface water temperatures in tributaries between Talkeetna and Devil Canyon were collected from June through October, 1982. In general, surface water temperature increased from June to August and decreased from September to October, peaking during August. Instantaneous measurements of surface water temperature ranged from 0.9°C in Portage Creek on October 11 to 12.1°C in Fourth of July Creek on August 22.

4.2.5.1.3.2 Continuous Surface Water Temperature

Surface water temperature was continuously monitored from June to October, 1982, in Indian River and Portage Creek. Based on the above data, the surface water temperature of Indian River varied from 0.0°C in late October to 12.5°C in mid-July. The surface water temperature of Portage Creek varied from 0.0°C in mid-October to 13.0°C in mid-August. Temperatures in both Indian River and Portage Creek generally increased from June to August and decreased in September and October, peaking during August.

4.2.5.1.3.3 Intragravel Water Temperature

Intragravel water temperature data was not collected in any tributaries between Talkeetna and Devil Canyon during the 1982 open water field season.

4.2.5.2 Talkeetna to Cook Inlet

4.2.5.2.1 Mainstem Habitats

4.2.5.2.1.1 Instantaneous Surface Water Temperature

Instantaneous measurements of surface water temperature of the mainstem Susitna River downstream of Talkeetna were collected from May through October, 1981. These measurements showed that the surface water temperature in the mainstem below Talkeetna ranged from 0.2°C at RM 77.0 on October 14 to 11.2°C at RM 18.2 on June 1. Because of the limited quantity of data, no further summary statements on the above data can be made at the current time.

4.2.5.2.1.2 Continuous Surface Water Temperature

Surface water temperature of the mainstem Susitna River downstream of Talkeetna was monitored on a continuous basis at three sites from May through October 1982: Susitna Station below the Yentna River confluence

(RM 25.8), west bank above the Yentna River confluence (RM 29.5), and the Parks Highway Bridge (RM 83.4).

The surface water temperature of the mainstem Susitna River downstream of Talkeetna ranged from 0.0°C in October to 13.5°C in June and July. Both temperatures were recorded above the Yentna River confluence at RM 29.3. Generally, the surface water temperature of all mainstem sites downstream of Talkeetna increased during the period from May through August and decreased from September to October, generally peaking from mid-July to mid-August. The peak water temperature appeared to occur somewhat later in the mainstem downstream of Talkeetna (mid-July to mid-August) than in the mainstem above Talkeetna (July).

4.2.5.2.1.3 Intragravel Water Temperature

Intragravel water temperature data was not collected in the mainstem downstream of Talkeetna during 1982.

4.2.5.2.2 Slough Habitats

4.2.5.2.2.1 Instantaneous Surface Water Temperature

Instantaneous measurements of surface water temperature of various sloughs downstream of Talkeetna were collected from June through October, 1982. These temperature measurements ranged from 3.7°C in Lower Goose 2 Slough on October 1 to 16.6°C in Rabideux Creek Slough on June 26. Surface water temperature in the sloughs studied generally rose from June to July, peaked during July and August, and then decreased during September through October.

4.2.5.2.2.2 Continuous Surface Water Temperature

Sloughs located below Talkeetna were not continuously monitored for surface water temperature during 1982.

4.2.5.2.3 Tributary Habitats

4.2.5.2.3.1 Instantaneous Surface Water Temperature

Instantaneous measurements of surface water temperature in selected tributaries downstream of Talkeetna were collected from June through October, 1982. Instantaneous measurements of surface water temperature in these tributaries ranged from 17.4°C in Birch Creek on August 5 to 3.6°C in Sunshine Creek on October 4. Because of the limited quantity of data, no further summary statements on the above data can be made at this time.

4.2.5.2.3.2 Continuous Surface Water Temperature

Surface water temperature was continuously monitored in the three major tributaries downstream of Talkeetna (the Chulitna, Talkeetna, and Yentna Rivers) from May through October, 1982.

The surface water temperature of the Yentna River ranged from 3.5°C in late September (October temperatures not obtained) to 13.0°C in late June. The surface water temperature in the Chulitna River ranged from 0.0°C in October to 8.5°C in September (July and August temperatures not obtained). In the Talkeetna River, the surface water temperature ranged from 0.1°C in October to 11.5°C in August. From July to September, monthly mean mainstem Susitna River surface water temperatures obtained at the Talkeetna fishwheel camp, located approximately five miles upstream from the confluence with the Chulitna and Talkeetna Rivers, were 1-2°C warmer than the monthly mean temperatures obtained in the Chulitna and Talkeetna rivers from July to September. In October, both the Chulitna and Talkeetna rivers and the mainstem Susitna River averaged temperatures between 0.5°C and 1.0°C. Monthly mean surface water temperatures obtained in the mainstem Susitna River above the Yentna River were from 1.0°C to 2.5°C warmer than monthly mean surface water temperatures in the Yentna River.

4.2.6 Other Basic Field Parameters Studies

Objectives of the water quality monitoring program conducted during the 1982 open water field season were to:

1. obtain baseline water quality data to characterize the water chemistry of surface waters at selected mainstem, slough, and tributary sites within the Susitna River;

2. to characterize the influence of discharge on changes in water quality at the above sites; and,

3. to characterize the relationships between water quality and fish passage, spawning, and rearing.

Results of the first two objectives are summarized below and in Volume 4-Part I. Results of the third objective are summarized in Volume 4-Part II.

The basic field parameters measured to assess the water quality of a site were dissolved oxygen, pH, specific conductance, and temperature. In addition, turbidity was also measured at selected locations. The results are summarized according to river reach subdivided into mainstem (including side channel), slough, and tributary habitats.

4.2.6.1 Talkeetna to Devil Canyon

4.2.6.1.1 Mainstem Habitats

The basic field parameters of dissolved oxygen, pH, specific conductance, and temperature were collected at various mainstem and side channel sites between Talkeetna and Devil Canyon primarily in conjunction with the electrofishing program. From RM 114.2 to RM 148.2, the range of dissolved oxygen was 7.1 to 14.0 mg/l over a range of surface water temperatures from 5.8°C to 10.6°C. Measurements of pH and specific conductance were observed to range from 6.9 to 8.7 and

33 to 132 umhos/cm respectively. Turbidity in the mainstem Susitna River from RM 111.5 to RM 148.2 during the 1982 open water field season ranged from 2.4 to 154 Nephlometric Trubidity Units (NTU).

4.2.6.1.2 Slough Habitats

The basic field parameters of dissolved oxygen, pH, specific conductance, temperature, and turbidity were measured at selected upland and side sloughs situated between Talkeetna and Devil Canyon during the 1982 open water field season (refer to the stage/discharge summary section for a definition of upland and side sloughs).

4.2.6.1.2.1 Upland Slough Habitats

Two upland sloughs (Sloughs 6A and 19) were monitored from June to October, 1982 for the basic field parameters primarily in conjunction with the Fish Distribution Study (FDS) program. Overall, dissolved oxygen in the upland sloughs was found to vary from 7.3 to 13.9 mg/l over a range of surface water temperatures from 3.3° to 15.0°C, while measurements of pH and specific conductance varied from 6.0 to 7.8 and 31 to 147 umhos/cm, respectively. Turbidity in upland sloughs was observed to vary from less than 1 NTU to 150 NTUs.

Water quality in the upland sloughs was not influenced to any large extent by changes in mainstem discharge. This is likely the result of upland sloughs not being connected to the mainstem at their heads.

4.2.6.1.2.2 Side Slough Habitats

Twelve side sloughs situated between Talkeetna and Devil Canyon (Whiskers Creek and Lane Creek Sloughs and Sloughs 8A, 9, 9A, 9B, 10, 11, 16, 20, 21, and 22) were monitored for the basic field parameters during the 1982 open water field season. Overall, dissolved oxygen ranged from 5.9 to 14.5 mg/l over a range of surface water temperatures from 2.4° to 16.3°C, while measurements of pH and specific conductance varied from 4.0 to 7.9 and 4 to 238 umhos/cm, respectively. Turbidity was found to vary from less than 1 NTU to 168 NTUs.

Water quality in the side sloughs was found to be influenced by mainstem discharge depending on whether or not the head of the slough was breached. During periods of non-breaching mainstem flows, the water quality of the studied side sloughs had the characteristics of the water sources of the slough, while during periods of breaching mainstem flows the water quality of the studied side sloughs took on the characteristics of the mainstem river. In general, the specific conductance and surface water temperature were higher during periods of non-breaching mainstem flows than during breaching mainstem flows.

In addition to mainstem influences on water quality in the side sloughs, several studied side sloughs exhibited water quality influences due to tributary influx. These were Whiskers Creek Slough and sloughs 9, 20, and 22. In these sloughs, the water quality in the slough under non-breaching mainstem flows was dependent to a large degree on the tributary, while during breaching mainstem flows was dependent to a varying degree on both the mainstem and tributary.

4.2.6.1.3 Tributary Habitats

The basic field parameters were collected at selected tributaries situated between Talkeetna and Devil Canyon during the 1982 open water field season. Overall, dissolved oxygen in the tributaries sampled ranged from 7.9 to 14.5 mg/l over a range of surface water temperatures from 1.7° to 12.2°C. Measurements of pH and specific conductance varied from 5.8 to 7.8 and 14 to 66 umhos/cm, respectively. Turbidity was found to vary from less than 1 NTU to 94 NTUs.

4.2.6.2 Talkeetna to Cook Inlet

4.2.6.2.1 Mainstem Habitats

The basic field parameters were collected from RM 5.0 to RM 85.7 primarily in conjunction with the electrofishing program. at selected mainstem Susitna River and side channel sites below Talkeetna during the 1982 open water field season Overall, the range of dissolved oxygen varied from 6.4 to 15.6 mg/l over a range of surface water temperatures from 0.2° to 13.8°C. Measurements of pH and specific conductance were observed to vary from 5.2 to 7.6 and 46 to 131 umhos/cm respectively. Turbidity was sampled only at Sunshine Creek Side Channel and ranged from 4 to 160 NTUs.

4.2.6.2.2 Slough Habitats

The basic field parameters were collected at selected sloughs below Talkeetna during the 1982 open water field season. Overall, dissolved oxygen ranged from 8.3 to 12.8 mg/l over a range of surface water temperatures from 5.3° to 15.4°C. Measurements of pH and specific conductance were observed to vary from 6.4 to 7.7 and 10 to 204 umhos/cm, respectively. Turbidity ranged from 2 to 120 NTUs.

Water quality in the sloughs studied downstream of Talkeetna was influenced to varying degrees by mainstem discharge depending on whether or not the head of the slough was breached. In addition, since all of the sloughs studied below Talkeetna had tributary influxes, the slough water quality was also influenced to varying degrees by the associated tributaries. In general, during periods non-breaching mainstem flows, the water quality in the slough was dependent on the water quality of the associated tributary while during periods of breaching mainstem flows if was dependent on the water quality of both the mainstem and the tributary.

4.2.6.2.3 Tributary Habitats

The basic field parameters were collected at various tributaries below Talkeetna during the 1982 open water field season. Overall, dissolved oxygen varied from 8.9 to 13.4 mg/l over a range of surface water temperatures from 3.6° to 17.4°C. Measurements of pH and specific conductance were observed to vary from 5.5 to 7.4 and 27 to 204 umhos/cm, respectively. No measurements of turbidity were taken at any tributaries below Talkeetna during 1982.

4.2.7 Dissolved Gas Studies

The objectives of the dissolved gas monitoring program during 1981 and 1982 were to:

1. establish baseline values of supersaturation of dissolved gas in the vicinity of the Devil Canyon rapids of the Susitna River; and,

2. determine the influence that changes in flow of the Susitna River have upon those values.

During the 1981 and 1982 open water seasond, dissolved gas supersaturation levels were measured in the vicinity of Devil Canyon both on a continuous and instantaneous basis. Continuous measurements were obtained from August to October, 1982 at a gaging station immediately below the Canyon. Point measurements were obtained at various times during 1981 and 1982 at several locations in and below the canyon.

Results show that the rapids cause gas entrainment with peak concentrations of 116% saturation measured immediately below the lower Devil Canyon rapids during high water (40,000 cfs). Continuous recordings of disolved gas saturation indicated a direct relationship occurred between level of supersaturation concentrations and discharge through the canyon (i.e., higher discharges increased the levels of dissolved gas). From Devil Canyon to Gold Creek, the elevated dissolved gas concentrations decayed with approximately a 50% decrease in the initial concentrations occurring 20 miles downstream. The rate of decay of dissolved gas appeared to be more rapid below Indian River.

Based on a survey of available literature, concentrations of dissolved gas that occur naturally below Devil Canyon are not sufficient to create an appreciable hazard to the fish presently in the system. The rate of decay of gas in the natural occurring supersaturated water below the canyon is sufficiently slow that elevated gas levels created by a Devil Canyon Dam would not dissipate below a hazardous level until below the Gold Creek area.

4.3 PART II SUMMARY

4.3.1 Mainstem Salmon Spawning Studies

Studies were conducted from August 1 to September 15, 1982 to:

1. determine the extent, timing, and number of chum, pink, sockeye, and coho salmon spawning in the mainstem Susitna River;

2. evaluate the physical and chemical characteristics of mainstem habitats utilized for spawning; and,

3. identify the relationships between changes in mainstem discharge and temperature to the extent, timing, and numbers of salmon present in the mainstem.

Results of the first objective are summarized in Volume 2 of this report. Results of the second and third objectives are summarized below and in Volume 4 - Part II of this report.

Adult anadromous fish distribution data collected during 1981 and 1982 indicate that salmon spawning activity in the mainstem is limited. It is currently unknown whether the limited use of the mainstem for spawning is the result of a lack of suitable spawning habitats or the relatively greater availability of more suitable spawning habitats in other areas (e.g., sloughs). Preliminary data, however, indicate that the substrate in the majority of the mainstem is cemented, making it unsuitable for salmon spawning. Chum salmon appear to be the only salmon species which utilize the mainstem Susitna River for spawning. Coho, pink, and sockeye salmon were not found to spawn in the mainstem during the 1982 open water field season.

Eight chum salmon spawning areas were evaluated for their habitat characteristics during 1982. Based on an evaluation of this data, the majority of the mainstem chum salmon spawning sites surveyed were located in clear backwater habitats situated in side channels which were cut off either entirely or partially from mainstem water influence at their heads. Only one of the surveyed spawning sites was located in the main channel.

Mean water depths and water column velocities measured at mainstem chum salmon spawning sites ranged from 0.1-4.0 feet and 0.0-1.0 feet/second, respectively. Substrate utilized for spawning ranged from silty sand to boulders with gravel, rubble, and cobble substrates being preferred. The substrate was most often loosely embedded with silty sand which was cleared in areas of redds. Intragravel water temperatures, taken at a depth of approximately 1 to 2 feet below the surface, ranged from 3.3-7.0°C.

Each surveyed chum salmon spawning site, except one located at RM 148.2, had clear water zones indicating the surveyed spawning areas were isolated either entirely or partially from mainstem surface water influence. The clear water suggests that these spawning sites receive a significant portion of their surface water flow from subsurface percolation, since very little surface drainage was observed into the study areas. Intragravel water temperatures ranged from 0.2 to 5.3°C cooler than surface water temperatures, suggesting that a subsurface water flow exists in the areas of spawning activity and that it is of a different source than the surface waterflow.

4.3.2 Slough Salmon Spawning Studies

Studies were conducted during the 1982 open water field season in selected sloughs to determine the relative importance and relationship of selected discharge related to variables to spawning activities of salmon. Since chum salmon were the dominant species utilizing the sloughs for spawning during the study period, the majority of the field work and subsequent analyses and discussions dealt with this species. Other salmon species (sockeye, pink, and coho salmon) which utilize the sloughs for spawning in fewer numbers, were dealt with to a lesser degree.

Sloughs were studied at two levels of intensity: specific and general. Specific slough studies consisted of detailed investigations of channel morphology, hydraulic modelling, access and timing of salmon into the sloughs, and availability and utilization of specific habitat conditions related to spawning site selection. Four side sloughs (Chum Channel and Sloughs 8A, 9, and 21) were selected for specific study based on the data from previous studies and their relative importance to the salmon fishery. Nine sloughs (Whiskers and Lane Creek Sloughs and Sloughs 6A, 9A, 10, 16B, 19, 20, and 22) were selected for general slough studies. These sloughs were selected based on their relative lesser importance to the salmon for spawning and overall smaller available data base. General slough studies consisted of a subjective comparison of salmon spawning activity to substrate composition and distribution, water quality, and water sources (i.e., upwelling, springs, tributaries, etc.). Slough 11 was studied at an intermediate level in that all studies pertaining to the specific slough studies were conducted except that no hydraulic modelling was attempted.

4.3.2.1 Specific Slough Studies

Studies pertaining to slough channel morphology and slough to mainstem hydraulic relationships were conducted to ascertain potential access and passage related problems to spawning areas in sloughs. Because access denied into an area eliminates consideration of all other factors, it is of critical concern.

The stage of the mainstem appears to directly influence salmon access into and passage within the study sloughs. During high mainstem stage conditions, when the head of a side slough becomes breached, the hydraulic characteristics of a slough are very similar to those of a side channel of the mainstem. Once overtopped, flows in the sloughs often increased rapidly. During these conditions, sufficient depths were present throughout the sloughs to allow access into and passage within the sloughs to spawning areas. At intermediate mainstem stages when the head of the slough was not breached, a backwater was observed to form at the mouth of the slough. Under these conditions, sufficient depths were maintained in the vicinity of the mouth of the slough (by the mainstem stage) to allow access into the slough, with passage to spawning areas in the upper reaches of the slough becoming a function of slough stage and channel morphology (i.e., depth). During periods of low mainstem discharge, mainstem stage was often not sufficient to allow significant backwater areas to form at the mouths of the sloughs. Under these conditions, access into the sloughs and passage to spawning areas in the upper reaches of the sloughs was found to be a function of slough stage and channel morphology (i.e., depth). It was under these conditions, that the majority of access and passage related problems occurred during 1982.

Cross-section and thalweg survey data were used to determine critical access and passage reaches at various slough flows for each of the study sloughs. Based on visual assessments, 0.3 ft. was assigned as a critical depth for access and passage over a critical reach. These data are summarized in Volume 4 - Part II.

The occurrence and timing of spike discharge events (i.e., increased flows for short duration), was also found to influence access and passage. Spike discharge events during periods when fish are holding, allow access into sloughs and passage to spawning areas which were otherwise inaccessible. This was observed when spike flows during September allowed access into the study sloughs and passage to spawning areas which were previously inaccessible. The presence of spike discharge events however, do not totally alleviate access and passage related problems in sloughs. Timing of the spike discharge events is also found to be important. For example, a spike discharge event on September 15, 1982 occurred during a period when few salmon were holding in pools in Sloughs 8A, 9, and 21. It is believed that if this spike discharge event had occurred earlier in the year, when larger numbers of salmon were holding in pools, more salmon could have gained access to spawning areas in the upper reaches of these sloughs.

The timing of peak numbers of fish and their duration of residence inside sloughs was found to generally follow consistent patterns. In general, pink salmon numbers peaked earlier than chum salmon in all sloughs. With the exception of Slough 11, pink salmon entered sloughs in early to mid-August, peaked in mid-August, and were completely absent by September 1. Chum salmon typically entered sloughs by August 10, peaked between August 20 and September 1, declined rapidly in mid-September, and were completely absent by the end of September. In contrast to the pattern for pink and chum salmon, numbers of sockeye salmon generally lacked definite peaks, were much less abundant than chum salmon and persisted in low numbers in late September. The exception to the above generalizations occurred in Slough 11 where sockeye salmon numbers exhibited a bimodal peak, with peaks occurring at August 30 and September 13, and persisted in the slough until mid-October. In general, these data shown that there was a temporal segregation in usage patterns between species. This was most evident between pink and chum salmon, with numbers of pink salmon consistently peaking before chum salmon. The pattern for sockeye salmon was less distinct, but generally indicated that sockeye salmon spawned in sloughs during the period of, or later than, chum salmon spawning.

Utilization data were collected for various habitat conditions related to spawning site selection at various levels of discharge in Sloughs 8A, 9, 11, and 21. Since chum salmon were the dominant species present in the study sloughs, most utilization data pertain to this species. Enough data is not yet available to set ranges of utilized habitat for the other salmon species present in the sloughs. In general, chum salmon were found to utilize areas of gravel-rubble substrate where depths were over 0.2 ft. (averaging about 1.1 ft.) and mean water column velocities ranged from 0.0 to 1.5 ft./sec. (averaging 0.3 ft./sec.) Areas where significant amounts of silt overlayed rubble and gravel substrates were also utilized for spawning. However, this is likely the results of salmon being forced to use less than optimal areas in 1982 due to low flows causing access problems to more desirable substrates upstream. Areas of ground water upwelling also appeared to be preferably utilized. Ranges of intragravel water temperatures measured in redds showed that the range of utilized temperatures was 3.1 to 11.4°C, with most intragravel water temperatures ranging from 4.0 to 4.9°C. Enough data is not yet available to set the overall ranges of utilized habitat for spawning for all levels of discharge in the sloughs.

Preliminary depth and velocity utilization data collected at chum salmon redds were compared to depth and velocity availability data obtained for five discharge measurements at cross sections in Sloughs 8A, 9 and 21. At low slough flows (3 to 8 cfs), the means of water depths that were available for the five discharge measurements (0.8, 0.8, 0.7, 0.9, 0.9 ft) and that were utilized (1.24, 0.67, 1.02, 0.72, 1.27 ft) for chum salmon redds were approximately the same. However, all chum salmon redds utilized were located in shallower depths, less than 2.6 ft. The means of water velocities that were available (0.10, 0.11, 0.14, 0.17, 0.24 ft/sec) and that were utilized (0.13, 0.03, 0.22, 0.36, 0.16 ft/sec) for chum salmon redds were also approximately the same. These conclusions are preliminary however, since very little data were collected at higher discharge levels (to determine if chum salmon will spawn successfully at greater depths and increased flows).

Computer models of Chum Channel and Sloughs 8A, 9, and 21, which are currently in the process of being calibrated, will be used to predict available water depths and velocities up to sloughflows of 300 cfs. These availability data will be used to compare the above preliminary utilization water depth and velocity data to the computer generated availability data. These analyses will be presented in the Fisheries - Habitat Relationship Report.

4.3.2.2 General Slough Studies

Water quality data and maps of substrate composition, upwelling areas, and ice free areas are presented for each general study slough in Volume 4 - Part II. Subjective comparisons of these data will be discussed in the Fisheries-Habitat Relationships Report.

4.3.3 Eulachon Studies

First year studies were conducted from May 16 (ice-out) to June 16, 1982 to:

1. determine the extent, timing, and numbers of the spawning runs of eulachon in the Susitna River;

2. to evaluate the physical and chemical characteristics of habitats utilized for spawning; and,

3. to identify the relationship between changes in mainstem discharge and temperatures to the extent, timing, and numbers of eulachon present.

Results of the first objective are summarized in Volume 2 of this report. Results of the second and third objectives are summarized below and in Volume 4 - Part II of this report.

Based on 1982 catch data, eulachon began their spawning migration into the Susitna River during early to mid-May. In general, eulachon spawning runs occurred during periods of general inclines in both mainstem discharge and surface water temperature. Eulachon appeared to utilize the majority of the mainstem Susitna River and its associated side channels below RM 49 for passage and spawning. Eulachon appeared to key on water velocity for upstream direction during their spawning runs. Eulachon were never observed to utilize the clear water tributaries upstream of the confluence zones or rarely observed in areas of low water velocity (less than 0.3 ft/sec), backwater, or eddy habitat zones. The majority of the upstream eulachon migration appeared to occur along banks with moderate water velocities (0.3 - 3.0 ft/sec).

Based on these first year studies, the habitat requirements necessary for eulachon spawning appear quite broad, making a significant portion of the lower Susitna River available as spawning habitat. Spawning occurred throughout the mainstem and its associated side channels, with bar and riffle zones having moderate water velocities preferred. Mean water depths and velocities at surveyed spawning sites ranged from 1.1 to 3.1 ft and 0.6 to 1.9 ft/sec, respectively. Substrate used for spawning varied from 100 percent silt to silt and sand intermixed with gravel, rubble, and cobble. The preferred substrate was silt and sand intermixed with gravel. Water temperatures at surveyed spawning sites ranged from 6.2 to 11.2°C.

4.3.4 Bering Cisco Studies

Second year studies were conducted from September 1 to October 15 (freeze-up), 1982 to;

1. determine the extent, timing, and numbers of the spawning runs of Bering cisco in the Susitna River;

2. evaluate the physical and chemical characteristics of habitats utilized for spawning; and,

3. to identify the relationship between changes in mainstem discharge and temperature to the extent, timing, and numbers of Bering cisco present.

Results of the first objective are summarized in Volume 2 of this report. Results of the second and third objective are summarized below and in Volume 4 -Part II of this report.

Based on 1981 and 1982 catch data, Bering cisco began their spawning migration into the Susitna River during early August. Upstream limits of migration during 1981 and 1982 based on electrofishing catch data were RM 100.5 and RM 101.9, respectively. In general, spawning runs occurred during periods of general declines in both mainstem discharge and surface water temperature, with increases in mainstem discharge apparently discouraging upstream movement. Bering cisco appeared to exclusively utilize the mainstem channels for passage, apparently not utilizing the sloughs or tributaries upstream of the confluence zones. Interestingly, Bering cisco were never observed in the east channel of the Susitna River between RM 62 and RM 70 during either 1981 or 1982, although habitats in this reach of the river are similar to those in other reaches utilized by Bering cisco. The reasons for this are currently unclear, however it may possibly be linked to differences in discharge or water quality.

Only one spawning site for Bering cisco was evaluated in terms of spawning habitat found in 1982. This site, which was a documented site in 1981, was located along a mainstem gravel bar opposite Montana Creek (RM 76.8 - 77.6). Habitat characteristics present at this site at the time of spawning generally concur with 1981 findings at this site (ADF&G 1981b), except that surface water temperatures at time of spawning during 1982 ranged from 0.2 - 0.4°C while during 1981 ranged from 3.0 - 3.8°C.

Fewer spawning sites for Bering cisco were located in 1982 than in 1981. One reason for this may be that in 1982, Bering cisco appeared to have begun spawning later. No ripe fish were found in 1982 until October 13, while in 1981 ripe fish were found beginning in early October. Due to an early freeze up, sampling was prevented after October 14, 1982. Because of this, spawning sites could not be located and studied after October 14. It is likely that Bering cisco utilized other areas for spawning after this time.

4.3.5 Juvenile Anadromous Habitat Studies

This section provides an introduction to the analysis of juvenile salmon habitat relationships presented in Volume 4 which will be further developed in the Fisheries and Habitat Relationships Report. The ultimate objective is to examine the effect of habitat quality on juvenile salmon distribution and abundance and to further examine the changes in habitat quality caused by changes in mainstem discharge. Knowledge of these relationships has a direct application in predicting the effects of the proposed hydroelectric project and in developing mitigation procedures.

Three general topics are addressed for the juveniles of four species of salmon (pink salmon are not included because very few were captured). The main emphasis concerns the relative use of the mainstem backwater areas present at the sampling sites. The mainstem backwater area is defined as that area of the sampling site which is backed up as a result of a hydraulic barrier created by mainstem stage at the mouth of the site. This analysis is an attempt to determine the importance of changes in mainstem discharge to habitat quality and availability. The second topic is the distribution of juvenile salmon among the various habitat zones at each site (refer to Volume 4 for the definition of habitat zones). Each habitat zone is characterized by a different set of values for various habitat parameters. The purpose of these studies is to estimate the relative importance of different kinds of habitat and the "preference" of juvenile salmon for certain levels of various habitat parameters. General statements are made concerning specific habitat parameters such as turbidity and water velocity. The third topic concerns the effect of the head of the slough being breached or unbreached.

Chum salmon juveniles had basically outmigrated from the Susitna River above the Chulina River confluence by the end of July so there are less data for this species than for the other three salmon species which were present throughout the entire season. Chum salmon were generally captured in areas of low water velocity. They also seemed to prefer areas with cover provided by mainstem turbidity. These two conditions are characteristic of the habitat present in the mainstem backwater areas which may explain why 59 percent of all chum salmon juveniles captured in early June, 85 percent in late June, and 94 percent in early July were captured in these areas. The lower percentage in early June was a result of chums captured in tributaries during outmigration from tributary spawning grounds. Low mainstem discharges during June and July which lead to the closure of slough heads may have created undesirable habitat conditions for chum salmon juveniles. In some instances this led to stranding of juveniles in isolated pools.

Sockeye salmon juveniles were generally captured only at slough sites. The number of sockeye salmon captured in the mainstem backwater area as a percentage of the total caught in all zones was high (71%) at most sites. Sockeye salmon juveniles captured outside the mainstem backwater area were usually in slack water areas of slough above the backwater area.

Coho salmon juveniles were captured in all major habitat types, including tributaries, sloughs, side channels, and mainstem. The amount and quality of cover, especially aquatic and emergent vegetation, appeared to be a major factor influencing coho abundance and distribution. Coho salmon were generally captured in areas of low to moderate water velocity. Coho salmon were the least likely of the four salmon species to be captured in the backwater area. The largest percentage of coho salmon juveniles captured in that habitat type for all sites during any one sampling period was 32 percent.

Chinook salmon juveniles were also found in all major habitat types. The majority of chinook salmon juveniles captured in June (60-68%) were from the backwater area. This percentage halved in July and remained below 50 percent for the rest of the season. Chinook salmon juveniles were often captured in the mixing areas just below tributary mouths.

4.3.6 Resident Fish Habitat Studies

A literature review of the habitat requirements for the various life phases of important resident species present in the Susitna River is presented in Volume 4 - Part II. Species reviewed include rainbow trout, Arctic grayling, burbot, round whitefish, humpback whitefish, longnose sucker, Dolly Varden, threespine stickleback, slimy sculpin, and Arctic lamprey. Habitat requirements of the following life phases were addressed: adult summer and overwintering rearing life phases, migrational life phases, spawning life phases, and juvenile summer and overwintering life phases. Incorporated into these literature reviews are the known results concerning habitat requirements for the above species in the Susitna River basin. Finding from both FY82 and FY83 are incorporated into the reviews. The data base is largest for rainbow trout, Arctic grayling, burbot, humpback whitefish, round whitefish, and longnose sucker. In general, the data base is stronger for the various adult life phases than it is for the juvenile life phases. This most likely resulted from the ineffectiveness of capture techniques employed in the capture of juvenile species. Data from future studies will be incorporated into these reviews as it becomes available.

A section is also included that describes species associations utilizing similar habitats in the Susitna River. Similar habitat conditions were found to attract different species of resident fish with similar habitat requirements. Species associations are described for the following habitats: tributary - mainstem mixing zones habitats, tributary habitats, and slough habitats. Changes in these species associations over time were described for habitat zones were sufficient data was available.

5.0 VOLUME 5 SUMMARY - UPPER SUSITNA RIVER IMPOUNDMENT STUDIES

5.1 INTRODUCTION

Impoundment study area (Figure 5-1-1) investigations were initiated in 1981 by a joint Aquatic Habitat and Instream Flow (AH) and Resident and Juvenile Anadromous Fish (RJ) study team to provide the basis for attaining the following goals:

1. assess the impacts of transforming the existing lotic environment within the boundaries of the proposed Watana and Devil Canyon reservoirs into one that is lentic, and

2. determine whether alternative fishery habitat is available in the immediate area surrounding the proposed reservoir for replacing fishery habitat lost within the impoundments to sustain the existing level of fish populations.

To achieve the first goal, data were collected with the objectives of determining:

1. which habitats within the impoundment study area were utilized by various fish species on a seasonal basis;

2. the physical and chemical characteristics of these fishery habitats; and,

3. the seasonal distribution and abundance of fish populations within the proposed impoundment areas.

The second goal was not pursued during the 1981 studies because of limited manpower resources.

Investigations were therefore continued in 1982 to:

1. collect additional habitat and fishery data to more accurately characterize the fish populations and their seasonal utilization of habitats within the boundaries of the proposed reservoirs to further meet goal one; and,

2. collect habitat and fishery data to determine whether the reach of tributary immediately upstream of the impoundment boundaries contains similar habitat to that presently found at the mouths of these tributaries and if these upstream reaches presently support fish populations.

5.2 Aquatic Habitat Studies

5.2.1 Introduction

Aquatic habitat studies during 1982 were conducted from May 1 to October 15 and were designed to evaluate the general physical and chemical characteristics of aquatic habitats found within the proposed impoundment study area. The study area was divided into tributary, mainstem, and lake habitat evaluation locations. Studies were conducted on 11 major tributaries and selected portions of the mainstem that would be inundated by the proposed impoundments. Additional surveys were conducted above the proposed impoundment elevation (PIE) on selected tributaries to obtain baseline information on the existing habitat available immediately above the PIE. Additional physical and chemical data were collected (discharge, thermograph and instantaneous water quality) to obtain baseline information for reservoir modeling. Selected morphometric features of Sally Lake, the largest lake within the proposed impoundment boundaries, were also evaluated. The complete results of these investigations are presented in Volume 5 of this report unless otherwise indicated.

5.2.2 Tributary Habitat Studies

Major tributaries within the proposed impoundment study area which were investigated during the 1982 field season included: Cheechako, Chinook, Devil, Fog, Tsusena, Deadman, Watana, Kosina, Jay, and Goose Creeks, and the Oshetna River. The study area of these tributaries included the entire reach of each stream below the PIE and a five mile reach immediately upstream of the PIE. Investigations included collection of water quality and discharge data, evaluation of topographical features, evaluation of spawning habitat, and a general description of each stream.

Instantaneous water quality data collected in tributaries included measurements of dissolved oxygen, ph, specific conductance, water temperature and turbidity. Dissolved oxygen concentrations ranged from 9.6 mg/l in Goose and Watana Creeks, and the Oshetna River to 14.2 mg/l in Deadman Creek. Values of ph ranged from 6.7 in Watana Creek to 8.1 in Jay Creek. Specific conductance ranged from 22 umhos/cm in Cheechako Creek to 212 umhos/cm in Watana Creek. Instantaneous water temperatures ranged from 0.1°C in the Oshetna River to 14.8°C in Goose Creek. Turbidity values ranged from 1 NTU on all tributaries at least one time during the season to 42 NTU's in the Oshetna River.

With the exception of turbidity levels, no major differences were apparent in the ranges of water quality parameters collected during specific sampling periods among tributary sampling sites. Turbidity levels varied frequently in some tributaries due mainly to precipitation and unstable soil conditions. This was especially true in Watana Creek which exhibited relatively high turbidities throughout the open water field season. Turbidities in the tributaries were generally much lower than turbidities in the mainstem Susitna River.

Preliminary water quality data collected above the PIE of four selected tributaries indicated that there is no significant difference in water quality above and below the PIE of these streams.

Continuous surface water temperature data were recorded on five streams: Tsusena, Watana, Kosina, and Goose Creeks and the Oshetna River. These data are being used for reservoir modeling and to further characterize fish habitat on these streams. Preliminary analysis of this data indicates that there are no major differences in overall water temperatures among these tributaries. A tabular listing of thermograph data for these five sites is presented in Volume 4.

Limited discharge data were collected on six streams and were compared with discharge data for the mainstem Susitna River at Vee Canyon and precipitation data for the impoundment study area. These preliminary data indicate that Susitna River discharge data, combined with precipitation data, can be used to determine relative changes in tributary discharge. This type of information may be useful for reservoir modeling purposes in estimating the discharge contribution of individual tributaries to the proposed Devil Canyon and Watana reservoirs. However, due to the limited data collected during 1982, this observation would require considerable more data to validate.

Selected topographical features of major tributaries were evaluated to assist in making general comparisons of these streams and to determine the extent to which they would be affected by the proposed impoundments. Topographical features evaluated included stream gradient, water surface area, length of tributary to be inundated, stream mouth elevation, and drainage basin size. This information, in conjunction with field surveys, was used to evaluate the general habitat characteristics of these streams and changes in the availability of habitat which may occur after inundation of the proposed impoundments.

Two of the more important changes associated with habitat availability are related to fish passage barriers and the extent of the drawdown zone on individual tributaries. Several fish passage barriers have been identified on streams within the proposed impoundment study area. A large waterfall on Deadman Creek is presently the only identified fish passage barrier which would be inundated by either of the proposed impoundments. The inundation of this waterfall would allow fish migration between the Susitna River and the upper Deadman Creek system, including Deadman Lake. This may affect the presently isolated lake trout and grayling populations of Upper Deadman Creek system. All other major barriers which have presently been identified are located above the PIE.

Impoundment pool elevation, stream gradient below the PIE, and tributary mouth elevation will determine the extent to which an individual stream will be inundated by the proposed reservoirs. Since pool levels of the proposed Devil Canyon and Watana impoundments will annually vary 28 and 105 feet, respectively, a drawdown zone of varying size will occur around the perimeter of each reservoir. Grayling eggs spawned within this drawdown zone in early spring when reservoir pool levels are rising, may be adversely affected by the flooding of this habitat. Conversely, whitefish and burbot eggs spawned during the autumn and winter months of the year may be dessicated due to receding reservoir water levels during this period.

5.2.3 Mainstem Habitat Studies

Aquatic habitat investigations during 1982 on the mainstem Susitna River within the proposed impoundment study area (RM 152.0 to 239.0) included the collection of general water quality data at designated sites, mapping the general habitat characteristics at selected habitat evaluation sites, and the identification of mainstem slough habitats. Aerial surveys were conducted on the entire mainstem reach within the study area to generally evaluate the habitat characteristics of this area.

The mainstem was divided into two study sections: The Devil Canyon section extending from RM 152.0 to RM 184.0 and the Watana section extending from RM 184.0 to RM 239.0. The Devil Canyon section, is confined to a more narrow channel, has relatively higher streamflow velocities, and has a steeper gradient (18 ft/mi compared to 13 ft/mi) than the Watana section.

Water quality data collected in the mainstem included dissolved oxygen, ph, water temperature, specific conductance, and turbidity. No major differences were apparent in the range of water quality parameters collected during specific sampling periods among the sampling sites. Turbidity values varied considerably over the course of the sampling season ranging from 14 NTU's above Goose Creek on May 14 to 150 NTU's above Watana Creek on August 16. Fluctuations in mainstem turbidity levels may partially influence the seasonal distribution and abundance of fish species in the mainstem. Arctic grayling were found more often in the clear water tributaries during the summer months when turbidity levels were high in the mainstem.

Four major mainstem slough areas have been identified within the proposed impoundment study area. These four slough areas are referred to as Watana Creek Slough (RM 193.5), Kosina Creek Slough (RM 205.6), Lower Jay Creek Slough (RM 208.1), and Upper Jay Creek Slough (RM 208.7). Water quality data was collected only at Upper and Lower Jay Creek Sloughs. These slough areas appear to be one of the more commonly utilized habitats of resident juvenile fish in the area.

Six additional areas which may classify as mainstem slough habitats were identified from aerial color photos of the proposed impoundment areas. These slough habitats have not been verified by ground surveys at present.

5.2.4 Lake Habitat Studies

Thirty-one lake habitats have been identified within the boundaries of the proposed Devil Canyon and Watana impoundment (Acres 1982). Twenty-seven of these habitats are less than five acres in size. Due to the small size and shallow depths of the majority of these habitats, it is assumed that most are not capable of supporting fish populations. Aerial surveys of many of these habitats during 1982 support this assumption. Therefore, these smaller lakes were not examined more intensively during the 1982 field season.

Lake sampling efforts during 1982 were limited to Sally Lake, the largest lake within the proposed impoundment boundaries. General water quality data were collected monthly during the field season. Morphometric data were collected and from these data a contour map, and depth area and depth volume curves were developed. From these data it was determined that Sally Lake has a surface area of 63 acres, a maximum depth of 27 feet and a total volume of 736 acre-feet.

5.3 Resident Fisheries Studies

5.3.1 Introduction

The following species were captured by the 1982 Resident Fisheries Investigations in the proposed impoundment area:

Arctic grayling
Burbot
Lake trout
Longnose sucker
Dolly Varden
Round whitefish
Humpback whitefish

The investigations were divided into three separate studies: tributary, mainstem, and lake studies.

5.3.2 Tributary studies

The same eight major tributaries studied during the 1981 Impoundment Investigations were sampled on a monthly basis in 1982. All sampling was conducted by hook and line and the target species was Arctic grayling. Arctic grayling population estimates were generated for the eight major tributary streams, and in most cases, were higher than the 1981 estimates. By increasing the amount of effort, using a Petersen single census estimator, and stratifying the population by age and habitat type (pool vs. riffle) during the 1982 study, the major biases encountered during the 1981 study were greatly reduced. The actual population estimates are expressed in numbers per stream, numbers per stream mile, and numbers per acre (density).

Arctic grayling spawning surveys conducted in May showed that grayling did not enter the spawning streams until after ice-out. Surveys were not comprehensive, but spawning Arctic grayling were found in four locations; all of which were below the proposed impoundment elevation (PIE). No Arctic grayling were observed spawning above the PIE in any of the streams surveyed, although spawning must occur here as newly hatched grayling were observed above the PIE in many of the streams.

Arctic grayling migration studies, both intrastream and interstream, were continued in 1982. Arctic grayling entered the tributary streams in late May and early June to spawn. From July through early August, grayling remained in the tributaries to rear and showed relatively little movement. An out-migration of Arctic grayling from the tributaries began in late August and

September, and the fish overwintered in the mainstem Susitna River. Although a significant number of grayling exhibited interstream movement, the pattern of movement appeared to be random.

The proposed impoundment areas are populated by stunted Dolly Varden which were determined to be more widely distributed than the 1981 study indicated. The habitat occupied varied considerably from that occupied by Arctic grayling, with most observations occurring in "plunge pool" type habitats.

The first observation of salmon spawing upstream of the Devil Canyon dam site was recorded in 1982 when chinnok salmon were observed spawning in the extreme lower reaches of Cheechoko (RM 152.4) and Chinook (RM 157.0) Creeks. Spawning also took place in the clear water plume which extended into the Susitna River below the mouth of Cheechako Creek. Additional information on salmon spawning activities in these streams is also presented in Volume 2 of this report.

5.3.3 Mainstem Studies

Seven study sites on the mainstem Susitna River were selected and sampled on a monthly basis. Sampling was conducted by trotlines and gillnets and was targeted towards burbot, longnose sucker, round whitefish, and the humpback whitefish species.

Burbot could be captured at almost any point along the banks of the Susitna River. The major limiting factor appeared to be water velocity, with lower velocities being preferred. Recapture information showed little if any movement occurring during the summer months.

Longnose suckers were captured in the mainstem Susitna River at large pools and the mouths of tributary streams. Adult longnose suckers in spawning condition were observed at the mouths of streams during May and early June. Only two juvenile longnose suckers were captured at mainstem sites and sloughs not affected by the tributaries.

Both round and humpback whitefish species were captured during the fall at or near the mouths of tributary streams. All of the round whitefish captured in early August were in a pre-spawning condition.

Arctic grayling were also captured in the mainstem Susitna River, but only at, or very near, the mouths of tributary streams.

5.3.4 Lake Studies

In 1982, an attempt was made to estimate the lake trout and Arctic grayling populations of Sally Lake, but was not successful. The hoop nets used proved to be too small and hook and line techniques too time consuming. Experimental use of a wide angle vertical sonar proved that fish could be distinguished and counted, but because of the shallow depth of the majority of the lake and the presence of large aquatic plants, this was not a viable method.

Age and length data were recorded for the small number of samples taken. The best estimate for the populations are under 1,000 lake trout and less than 5,000 Arctic grayling.

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