ADFG SuHydro / AH
- a draft of the FY85 AH
procedures manual

C. AQUATIC HABITAT AND INSTREAM FLOW PROJECT

Section C of this manual is divided into four sections. The first section, an introduction, presents a background review of the FY82, FY83, and FY84 studies and an introduction to the FY85 study program. The second section describes the work plans to be used to evaluate each study task element of the FY85 study program. The third section presents specific data collection and analysis procedures used to meet specific FY85 study objectives that have not been presented in earlier ADF&G Procedures Manuals (ADF&G 1981a, 1983a, 1984). The fourth and final section presents a listing of literature cited in this section of the procedures manual.

1.0 INTRODUCTION

1.1 Background

The overall objectives of the Aquatic Habitat and Instream Flow Project (AH) of the ADF&G Susitna Hydroelectric Feasibility Aquatic Studies are to: 1) identify the seasonal physical and chemical habitat requirements of selected anadromous and resident fish species within the various aquatic habitat types present within the study area (Figure C-1); and, 2) to determine if and how mainstem Susitna River discharge levels influence the quality and availability of these habitat conditions within the various aquatic habitat types of the study area.

To meet these overall objectives, Phase I AH investigations were

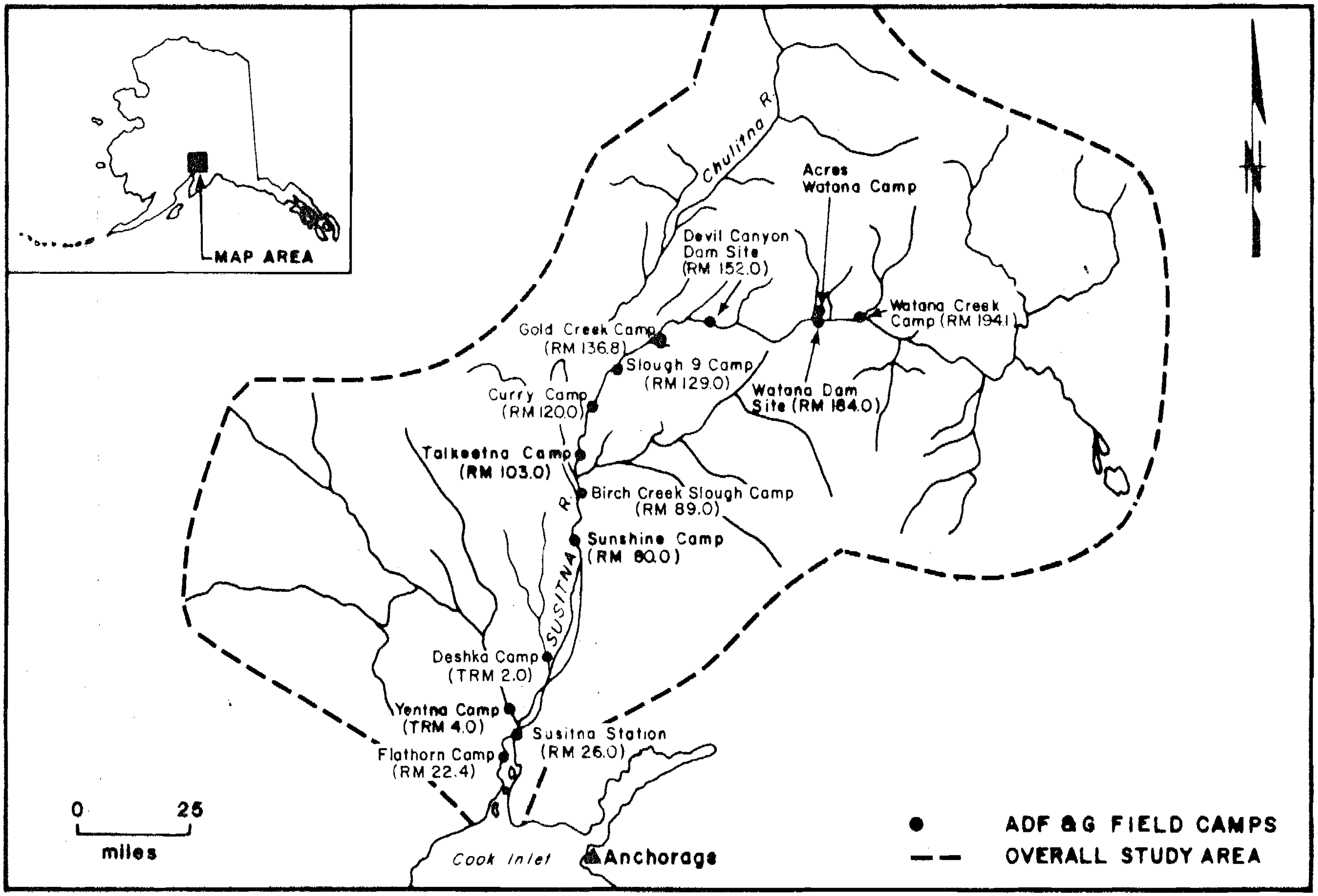


Figure C-1. Susitna Hydroelectric Project study area.

initiated in FY82 (July, 1981 - June, 1982) to begin the process of identifying:

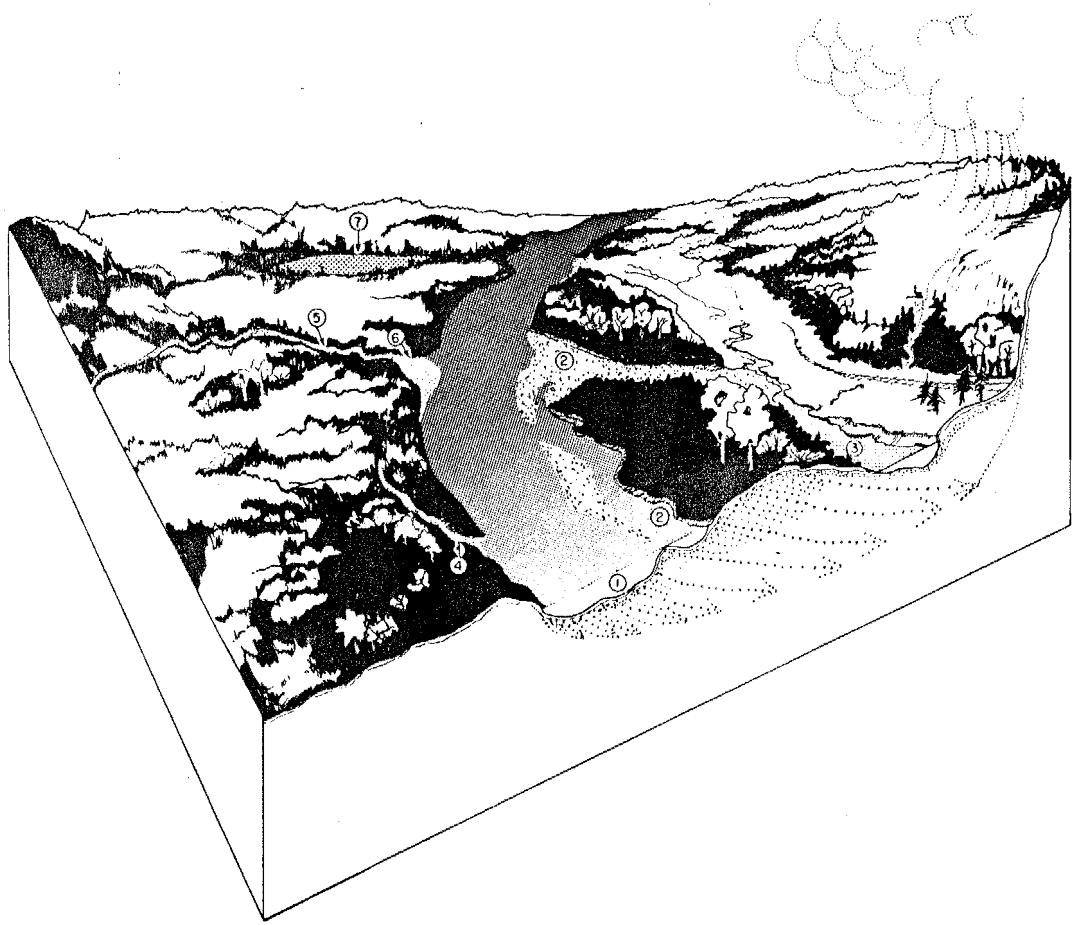
1. aquatic habitat types and their location in the study area;

2. seasonal relationships between mainstem discharge of the Susitna River and the physical and chemical characteristics of these fish habitats; and,

3. seasonal relationships between mainstem discharge of the Susitna River and fish distribution and abundance.

Studies downstream of Devil Canyon during these FY82 Phase I studies were focused on the reach of river between Talkeetna and Devil Canyon (henceforward referred to as the middle river reach). Seven aquatic habitat types were identified in this reach of the river: mainstem, side channel, side and upland slough, tributary, tributary mouth, and lake (Figure C-2). Of these seven aquatic habitat types, slough, tributary, and tributary mouth habitats were identified as principle salmon spawning areas. Of these three, it was determined that slough habitats would be the most directly affected habitats to be influenced by changes in mainstem discharge that may occur with constuction and operation of the proposed hydroelectric facility. For this reason, study emphasis during the remainder of FY82 was placed on slough habitats.

Results of the FY82 studies indicated that mainstem discharge had significant influences on both the immigration of adult salmon into



GENERAL HABITAT CATEGORIES OF THE SUSITNA RIVER

1) Mainstem Habitat consists of those portions of the Susitna River that normally convey streamflow throughout the year. Both single and multiple channel reaches are included in this habitat category. Groundwater and tributary inflow appear to be inconsequential contributors to the overall characteristics of mainstem habitat. Mainstem habitat is typically characterized by high water velocities and well armored streambeds. Substrates generally consist of boulder and cobble size materials with interstitial spaces filled with a grout-like mixture of small gravels and glacial sands. Suspended sediment concentrations and turbidity are high during summer due to the influence of glacial melt-water. Streamflows recede in early fall and the mainstem clears appreciably in October. An ice cover forms on the river in late November or December.

2) Side Channel Habitat consists of those portions of the Susitna River that normally convey streamflow during the open water season but become appreciably dewatered during periods of low flow. Side channel habitat may exist either in well defined overflow channels, or in poorly defined water courses flowing through partially submerged gravel bars and islands along the margins of the mainstem river. Side channel streambed elevations are typically lower than the mean monthly water surface elevations of the mainstem Susitna River observed during June, July and August. Side channel habitats are characterized by shallower depths, lower velocities and smaller streambed materials than the adjacent habitat of the mainstem river.

3) Side Slough Habitat is located in spring fed overflow channels between the edge of the floodplain and the mainstem and side channels of the Susitna River and is usually separated from the mainstem and side channels by well vegetated bars. An exposed alluvial berm often separates the head of the slough from mainstem or side channel flows. The controlling streambed/streambank elevations at the upstream end of the side sloughs are slightly less than the water surface elevations of the mean monthly flows of the mainstem Susitna River observed for June, July, and August. At intermediate and low-flow periods, the side sloughs convey clear water from small tributaries and/or upwelling groundwater (ADF&G 1981c, 1982b). These clear water inflows are essential contributors to the existence of this habitat type. The water surface elevation of the Susitna River generally causes a backwater to extend well up into the slough from its lower end (ADF&G 1981c, 1982b). Even though this substantial backwater exists, the sloughs function hydraulically very much like small stream systems and several hundred feet of the slough channel often conveys water independent of mainstem backwater effects. At high flows the water surface elevation of the mainstem river is sufficient to overtop the upper end of the slough (ADF&G 1981c, 1982b). Surface water temperatures in the side sloughs during summer months are principally a function of air temperature, solar radiation, and the temperature of the local runoff.

4) Upland Slough Habitat differs from the side slough habitat in that the upstream end of the slough is not interconnected with the surface waters of the mainstem Susitna River or its side channels. These sloughs are characterized by the presence of beaver dams and an accumulation of silt covering the substrate resulting from the absence of mainstem scouring flows.

5) Tributary Habitat consists of the full complement of hydraulic and morphologic conditions that occur in the tributaries. Their seasonal streamflow, sediment, and thermal regimes reflect the integration of the hydrology, geology, and climate of the tributary drainage. The physical attributes of tributary habitat are not dependent on mainstem conditions.

6) Tributary Mouth Habitat extends from the uppermost point in the tributary influenced by mainstem Susitna River or slough backwater effects to the downstream extent of the tributary plume which extends into the mainstem Susitna River or slough (ADF&G 1981c, 1982b).

7) Lake Habitat consists of various lentic environments that occur within the Susitna River drainage. These habitats range from small, shallow, isolated lakes perched on the tundra to larger, deeper lakes which connect to the mainstem Susitna River through well defined tributary systems. The lakes receive their water from springs, surface runoff and/or tributaries.

Figure C-2. General habitat catagories of the Susitna River - a conceptual diagram.

slough habitats from the mainstem and the overall availability of spawning habitat within sloughs. High water conditions, insufficient resources, and the start-up nature of the first year studies, however, precluded collecting sufficient data to quantify these findings. Results and findings of these and other studies are summarized in the ADF&G Phase I Final Draft Report, Volume 1, Aquatic Habitat and Instream Flow Project (ADF&G 1981b).

Studies were also initiated in the proposed impoundment areas during the FY82 Phase I studies with the objectives of identifying baseline physical and chemical characteristics of lotic fish habitats which would be inundated by the proposed reservoirs and quantifying the amount of riverine resident fish habitat to be lost. Baseline information of resident fish habitat in major tributaries located within the boundaries of the proposed impoundments was collected and analyzed. A summary of these results are presented in the ADF&G Phase I Final Draft Report, Resident Fish Investigations in the Upper Susitna River (ADF&G 1981c).

Phase II investigations were initiated in FY83 (July, 1982 - June, 1983) to further investigate and determine the relationship of baseline hydrological, hydraulic, and water quality characteristics of mainstem, side channel, slough, and tributary mouth habitats to mainstem discharge to further investigate and quantify the relationship of fish habitats in these aquatic habitats types to mainstem discharge. These investigations were primarily focused on the middle river reach.

These studies provided sufficient data over the range of mainstem discharges evaluated (8,000 to 30,000 cfs) to define the relationship between water surface elevation and mainstem discharge at various mainstem locations between Talkeetna and Devil Canyon. A better understanding of the relationships between mainstem discharge and the backwater characteristics at the mouths of side sloughs were also obtained for the mainstem discharges experienced. This information was used to initiate an evaluation of the accessibility of selected side slough habitats for salmon passage and spawning. Insufficient information, however, was obtained to quantify the relationship between side slough flow and mainstem discharges to the relative availability and utilization of salmon spawning habitat within middle river side slough habitats.

Studies were also initiated during the FY83 in the mainstem river between Cook Inlet and Devil Canyon to evaluate eulachon and Bering cisco spawning habitat. These two species were observed to use the mainstem as their primary spawning habitat. A baseline study of the stage/discharge characteristics at two side channel sites downstream of Talkeetna was also initiated with the objective of developing a data base for identifying whether variations in mainstem discharge would have a significant influences on the hydraulic conditions within these habitats in this reach of the river under project conditions. Results indicate that mainstem discharge influences to varying degrees the hydraulic characteristics of these habitats; however, insufficient data were collected to quantify these relationships.

Complete results and findings of the FY83 Lower River Studies are summarized in the ADF&G Susitna Hydro Aquatic Studies Phase II Basic Data Report, Volume 4: Aquatic Habitat and Instream Flow Studies, Parts I and II (ADF&G 1983b).

Studies in the proposed impoundment areas were expanded during FY83 to include habitat evaluations in a one mile reach upstream of the proposed impoundment boundaries in the seven major tributaries to be inundated, a general habitat evaluation of Sally Lake, and a preliminary evaluation of salmon habitat in two tributaries known to support chinook salmon spawning (Chinook and Cheechako creeks). A study of grayling spawning habitat was also initiated; however, the study was limited by our ability to coordinate sampling with spawning events due to insufficient information available on the timing and locations of grayling spawning activities in impoundment tributaries. Complete results and findings of the FY83 Impoundment Studies are summarized in the ADF&G Susitna Hydro Aquatic Studies Phase II Basic Data Report, Volume 5: Upper Susitna River Impoundment Studies (ADF&G 1983c).

Phase II investigations were continued in FY84 (July, 1983 - June, 1984) to complete the Phase I and Phase II investigations of the baseline hydrological, hydraulic, and water quality characteristics of mainstem, side channel, slough, tributary mouth, and tributary habitats of middle reach of the Susitna River. Additionally, the FY84 investigations had the objective of completing the investigation and quantification of the relationship of fish habitats in slough, side channel, and tributary mouth habitats to changes in site flow and mainstem discharge.

Additional data were collected during the FY84 investigations to describe the relationship of mainstem discharge on the water surface elevation of the mainstem. Based on data from this and prior years studies, this relationship is fairly well defined over the range of discharges from 5,000 to 30,000 cfs (as referenced to the USGS Gold Creek mainstem discharge gaging station). The effect that mainstem discharge has on the hydraulic characteristics of side channels and side slough habitats through the creation of backwater areas and by the overtopping the heads of these habitats was also evaluated in greater detail during FY84. Heads of side sloughs were observed to overtop in the range of mainstem discharges from 16,000 to 42,000 cfs at Gold Creek whereas the heads of side channels were observed to overtop in the range of mainstem discharges from 5,000 to 23,000 cfs at Gold Creek. Prior to mainstem overtopping events, flow within these habitats was found to be generally clear and low, originating from groundwater upwelling and surface water runoff. Subsequent to mainstem overtopping, flow in these habitats was found to increase dramatically and become directly controlled by mainstem discharge. Mainstem discharge was not observed to overtop the heads of upland slough habitats, with the only apparent influence of mainstem discharge on these habitats being backwater effects. The streamflow regimes of the major clearwater tributaries in the middle reach were also evaluated during FY84 to determine the relative contribution of the tributaries to the overall discharge regime of the middle Susitna River watershed.

Additional data were also collected during FY84 to describe the channel characteristics of selected side channel and side sloughs sites.

Thalweg profiles depicting the overall gradient, extent of backwater, and substrate composition were constructed from survey data obtained at four side channels and 13 sloughs in the middle river reach. Additionally, survey data for the development of cross-sectional profiles at selected side channels and slough staff gage stations were collected to describe the cross-sectional channel characteristics at stage and discharge recording stations.

Surface and intragravel water temperature data were also recorded on a continuous basis at selected locations throughout the Susitna River Basin during FY84 to characterize the water temperature regimes of the mainstem Susitna River and its peripheral habitats. During the 1983 open water season (May-October 1983), baseline surface and intragravel water temperature data were recorded in the mainstem Susitna River and its peripheral side channel, side slough, upland slough and tributary habitats. Although data were collected from the estuary (RM 0.0) to above the Oshetna River (RM 235.7), emphasis was concentrated on the reach of the river from the Parks Highway Bridge (RM 83.9) to the Oshetna River (RM 223.4). During the 1983 open water season, surface water temperatures in the mainstem Susitna River generally increased in a downstream direction from RM 235.7 to RM 103.0. Surface water temperatures recorded at RM 83.9 were generally colder than at RM 103.0 reflecting the influences of the Talkeetna and Chulitna Rivers. Intragravel temperatures were also recorded at sites from RM 103.3 to RM 142.3 with the warmest intragravel temperatures being recorded at the most upstream site. The influence of mainstem temperatures on surface water temperatures in side sloughs or side channels resulting from mainstem breaching discharges was observed in Side Channels 10, Upper 11, and 21, and in Side Sloughs 9 and 21. Intragravel temperatures recorded in side channels and side sloughs were found to be influenced by groundwater upwelling or mainstem temperatures. Variability in intragravel temperatures recorded within a side channel or side slough was also observed in Upper Side Channel 11 and Slough 8A.

Baseline water quality data were also collected during FY84 within selected mainstem, side channel, side slough, and tributary mouth habitats located in the middle reach of the Susitna River. These data indicate that water quality in the mainstem Susitna River is relatively similar among sampling locations but that specific water quality conditions at sampling stations change in relation to mainstem discharge. Increased levels of turbidity in the mainstem were found to correlate to mainstem discharge, but are assumed to result from suspended sediment contributed by the Susitna and Maclaren glaciers. Turbidity levels in side channels and side sloughs were found to be independent of mainstem discharge prior to breaching of the heads by the mainstem surface water, however subsequent to breaching those sites were found to resemble the turbidity of the mainstem with the controlling factors being the relative flow contribution of the mainstem to that of the site flow. Tributary water quality was found to be independent of mainstem Susitna River discharge and was determined to influence to varying degrees the water quality conditions of the mainstem depending on the relative size of the tributary.

Sufficient data were also collected during FY84 to complete an evaluation and quantification of the relationship of fish habitat in slough, side channel, and tributary mouth habitats to mainstem discharge.

Three sloughs (8A, 9, and 21) and four side channels (10, Lower 11, Upper 11, and 21) in the middle reach of the Susitna River were evaluated using an Instream Flow Incremental Methodology (IFIM) Physical Habitat Simulation (PHABSIM) modelling approach to evaluate the effects that site flow and mainstem discharge have on chum and sockeye salmon spawning habitat usability. Based on field data collected since 1977, spawning habitat conditions in these sloughs and side channels are thought to represent the range of spawning habitat conditions that are present in slough and side channel habitats of the middle Susitna River which currently support a majority of chum and sockeye salmon spawning in these habitat types.

Ten hydraulic simulation models were calibrated to simulate depths and velocities associated with a range of site-specific flows at these seven modelling study sites. Comparisons between corresponding sets of simulated and measured depths and velocities indicate that the calibrated models provide reliable estimates of depths and velocities with their recommended calibration ranges.

Habitat suitability criteria for chum and sockeye salmon spawning for the habitat variables depth, velocity, substrate, and upwelling were developed for input into a habitat simulation model. The suitability criteria developed for chum salmon spawning were based on an analysis of utilization data as modified using limited preference data, literature information, and the opinion of project biologists familiar with middle Susitna River chum salmon stocks. The spawning suitability criteria constructed for sockeye salmon were developed using the same analytical approach used in the chum salmon analysis with the exception that no analysis of preference could be made.

Using a habitat simulation model (HABTAT), the output of hydraulic simulation models and the spawning habitat suitability criteria were linked to project usable area of chum and sockeye salmon spawning habitat (WUA) as a function of flow for each of the seven modelled study sites. Using these relationships and relationships between site flows and mainstem discharge, the relationships between chum and sockeye salmon spawning habitat as a function of mainstem discharge for the period of controlled site flows were also determined for each modelled study site. These projections of chum and sockeye spawning WUA made at study sites indicate that spawning habitat usability in sloughs and side channels exhibits certain species-specific and site-specific trends. Generally, projections of WUA at study sites peak in the range mainstem discharges from 20,000 to 35,000 cfs, with the controlling factor appearing to be the overtopping of the site by mainstem discharge and the subsequent control of the site flow by mainstem discharge. Assuming that the modelled sloughs and side channels are representative of other non-modelled sloughs and side channels in the middle reach which currently support spawning, the theoretical maximum WUA for slough and side channel habitats in the middle river reach would occur slightly after the mainstem discharge overtops and controls the hydraulics at a maximum number of these habitats. Based on a review of time series plots of WUA overtime of each study site, however, flows at study sites which currently support chum and sockeye salmon spawning are only infrequently controlled by mainstem discharge. For this reason, the WUA at study sites remains relatively low and stable during the period of peak spawning activity (August through September), except during flood events. There appears to be a general positive correlation between projected WUA and habitat used at study sites.

An interim evaluation of passage conditions for adult Pacific salmon into and within twelve slough and side channel sites in the middle reach of the Susitna River was also conducted during FY84 Phase II to determine the effects that mainstem discharge has on passage conditions into these habitat types. These habitats were selected for evaluation as they are important chum and sockeye spawning habitats and are affected by changes in mainstem discharges. The evaluation of salmon passage conditions at each site included the effects of mainstem breaching discharge and backwater staging, and slough flows (local flows) derived from local water sources (e.g., upwelling, tributaries, precipitation). Timing and distribution patterns of salmon were also evaluated as they relate to passage conditions and flow patterns in the Susitna River system.

Daily salmon catch data at three fishwheel sites on the mainstem river were compared to mean daily discharge levels. These discharge data and survey counts of peak numbers of live and dead salmon in sloughs and side channels indicate that the period from 20 August to 20 September is a critical period for providing passage into and within slough and side channel sites from the mainstem Susitna River. All analyses of passage were therefore restricted to this time period.

Reaches within study sites which were restrictive to salmon passage (passage reaches) were identified at each site on the basis of water depth requirements for passage by salmon. Depth requirements for successful passage increase with and increase in the length of a passage. The analyses of breaching and backwater discharges and local flow effects on passage reaches were conducted independently and their relative importance is reported on a site by site basis. In general, breaching discharges affect all passage reaches within a site simultaneously; whereas, backwater staging usually affects only one or two passage reaches in the lower portion of a site. Local flow requirements may affect all passage reaches, but vary among sites and among passage reaches. These variations in local flow requirements are due to spatial variations in sources of local flow.

Data were also collected during FY84 to evaluate chum salmon spawning habitat in tributary mouths of the middle Susitna River. Two tributary mouths (Lane Creek and Fourth of July Creek) located in the middle reach of the Susitna River were evaluated to determine the influence that mainstem discharge has on the quantity and quality of chum salmon spawning habitat. During the 1983 field season, chum salmon were observed spawning in the clearwater plume of Fourth of July Creek, but not within the Lane Creek mouth area. At each study site, the location and surface area of available and usable chum salmon spawning habitat was determined. Available habitat surface area was positively correlated to changes in mainstem discharge at both tributary mouth study sites; whereas, usable chum salmon spawning habitat increased with increasing mainstem discharge only at the Fourth of July Creek mouth area. The surface area of usable chum salmon spawning habitat within the Lane Creek mouth decreased as mainstem discharge increased. This difference in usable surface area responses is likely related to the different type of confluence area of each site. Lane Creek flows directly into the mainstem while Fourth of July Creek empties into a side channel. Spawning activity could not be observed beyond the clearwater plume at the Fourth of July mouth area due to high mainstem turbidities. Because of this, the significance of the clearwater plume in determining the area of usable chum salmon spawning habitat at tributary mouth habitats could not be ascertained. If it is subsequently determined that chum salmon spawning does take place in the clearwater plume area of tributary mouths, the frequency distribution of spawning depths and velocities reported herein is likely biased towards shallower and slower waters.

Utilization data for the habitat variables of depth, velocity, and substrate composition were collected at chinook salmon spawning sites in selected tributaries of the middle reach of the Susitna River during FY84. These data were modified using statistical methods and the professional judgments of project biologists familiar with Susitna River chinook Salmon stocks to develop suitability criteria for chinook salmon spawning in tributaries of the middle Susitna River. Suitability criteria were also developed for coho and pink salmon spawning in tributaries of the middle Susitna River based on literature information as modified using the professional judgments of project biologists familiar with Susitna River coho and pink salmon stocks.

Additional data were also collected to determine naturally occurring hydraulic and temperature relationships to eulachon immigration and spawning. These data indicated that eulachon are probably the most abundant species of fish in the Susitna River. Based on 1982 and 1983 catch data, eulachon begin their upstream spawning runs of eulachon enter the Susitna River with no apparent definite correlation with either mainstem discharge or temperature. Spawning was found to occur over a broad range of hydraulic and substrate conditions along the margins of mainstem habitats from the mouth of the Susitna River (RM 0) upstream to RM 50.3. Based on a representative number of spawning sites selected for further evaluation, it appears that similar physical habitat condition will be present under both decreased and increased mainstem discharge conditions.

A complete summary of the results and findings of the FY84 studies are presented in ADF&G Susitna Hydro Aquatic Studies Report No. 3: Aquatic Habitat and Instream Flow Investigations (May - October, 1983), Chapters 1-10 (Estes and Vincent-Lang 1984).

Studies were also conducted during FY84 to evaluate the incubation life phase of chum salmon in slough and side channel habitats of the middle Susitna River reach. These studies had the objectives of: 1) comparing and evaluating the influences that selected physical, chemical, and biological variables have on the development and overall survival of chum salmon embryos in these aquatic habitat types; and, 2) providing precise field-based data on the development rates of chum salmon embryos in these aquatic habitat types to compare with the development rates derived for Susitna River stocks in laboratory studies (Wangaard and Burger 1983). Results of these investigations are currently being analyzed and will be summarized in a FY85 report.

Studies were also conducted during FY84 to provide information on the aquatic habitat and fish resources within the proposed access and transmission corridors to enable project participants to assess potential impacts on these resources from construction activities. Forty-two proposed stream crossing sites and ten lake habitats were sampled within the ATC study area. Three study reaches of Deadman Creek, which closely parallels the ATC, were also sampled. A total of 13 fish species were found to inhabit the streams and lakes within the ATC study area. Arctic grayling, Dolly Varden and lake trout were the major sport fish species identified within these habitats. General water quality (dissolved oxygen, pH, conductivity and water temperature), discharge, and substrate data were collected at stream crossing study sites. Selected physical and chemical data were collected in Deadman Lake. Population estimates were generated for Arctic grayling within the three study reaches of Deadman Creek. Among the impacts which could result from development of the ATC, the increase in sport fishing pressure, due to the increased access to the area, may have the greatest effect on various sport fish species within the study area. The increase in sport fishing pressure may result in reduced numbers and sized of fish species such as Arctic grayling, Dolly Varden and lake trout. Other impacts which may occur at proposed stream crossing sites include alterations of stream hydraulics, deterioration of water quality, and removal or shifting of substrates. A complete summary of the results and findings of these studies are presented in ADF&G Susitna Hydro Aquatic Studies Report No 4: Access and Transmission Corridor Investigations (July - October 1983) (Schmidt et al 1984).

1.2 FY85 Study Program

The FY85 study program (the third year of the Phase II studies) is specifically designed to expand the evaluation of habitat conditions evaluated in the middle river reach to the reach of river downstream of Talkeetna (henceforward referred to as the lower river reach). Attention is specifically directed towards defining the relationship that baseline hydrological and hydraulic characteristics of mainstem, side channel, and slough habitats of the lower river has to changes in mainstem discharge and to investigate and quantify the relationship that fish habitat in these aquatic habitat types has to changes in mainstem discharge. Additionally, studies will be conducted in association with E. Woody Trihey and Associates (EWT&A) to refine the evaluation of the relationship of salmon spawning and rearing habitat in the middle reach of the Susitna River to changes in mainstem discharge.

The specific study task objectives of the FY85 AH program studies are based on comments received from the Alaska Power Authority and Harza Ebasco Susitna Joint Venture. For a description of the processes used to arrive at these study tasks objectives refer to the Draft Aquatic Plan of Study Fiscal Year 1984 (Harza-Ebasco Susitna Joint Venture 1984).

The FY85 AH study program is divided according to study task (Harza-Ebasco 1984). These study tasks include:

- Basin-wide Instream Physical Data Collection Support (Support to Tasks 14, 16A, 16B, 29, 32, and 36);

-Middle River Habitat Modelling Support (Support to Task 12);

-Food Availability Study (Task 25);

-Preparation of FY84 Winter Incubation Report (Task 26);

-Validation of Passage Criteria (Task 35); and,

-Lower River Habitat Modelling Support (Task 36).

In the following two sections of this manual, work plans and new procedures used to meet FY85 study task objectives are presented. These work plans and procedures are presented according to study task element. Only the specific data collection methods and sampling designs used in the collection of data to meet FY85 objectives that are <u>not</u> outlined in the FY82, FY83, or FY84 Procedures Manual are outlined in this document. Reference is made to the appropriate FY82, FY83, and/or FY84 ADF&G Procedures Manuals (ADF&G 1981a, 1983a, 1984) for all other data collection and analysis procedures.

2.0 WORK PLANS

This section presents a description of the work plans used to evaluate specific FY85 study task elements. Included in each work plan is a discussion of the study approach to be used in the study task element, the rationale used to select study sites for evaluation, and the analytical approach to be used in the reduction and analysis of field data.

2.1 Basin-wide Instream Physical Data Collection Support

Instream physical data collection (stage, discharge, and channel geometry) in support of tasks 14, 16B, 25, 29, 32, and 36 will be conducted by the Physical Description Support Program (PDSP) of the AH project. These activities are discussed below according to study task.

Task 14 Support Program

Study Approach: Stage, site flow, and channel geometry data will be collected at each Task 14 study site to:

1) provide sufficient stage and site flow data to estimate the response of site flow at each Task 14 study site to changes in site stage and mainstem discharge; and,

2) obtain sufficient channel geometry data (cross sectional and thalweg profiles) to describe the channel characteristics of each Task 14 study site.

Stage, site flow, and channel geometry data will be collected using procedures outlined in the FY83 and FY84 Procedures Manuals (ADF&G 1983a, 1984).

Site Selection: The task 14 study sites supported by the PDSP are presented in Table C-1. These study sites were selected by Resident and Juvenile Anadromous project personnel to meet the specific objectives of the Task 14 study task.

Table C-1. Task 14 study sites supported by the Physical Description Support Program.

Study Site	River Mile	Habitat type
Hooligan	35.2	side channel
Eagles Nest	36.2	side channel
Krito Slough Head	36.3	side slough
Rolly Creek	39.0	tributary
Bear Bait	42.9	side channel
Last Chance	44.4	side channel
Rustic Wilderness	59.5	side channel
Caswell Creek	63.0	tributary
Island 1/	63.2	side channel
Goose 2	74.8	side channel
Sucker	84.5	side channel
Beaver Dam	86.3	side channel
Sunrise 1/	87.0	side channel
Birch Creek Slough	88.4	side slough
Trapper Creek 1/	91.6	side channel

1/ These study sites are support Task 36 studies.

Data Analysis: Stage, site flow, and discharge data will be reduced to provide rating curves describing the response of site flow to changes in site water surface elevation and mainstem discharge. Mainstem discharge data will be referenced to the USGS Sunshine gaging station (#15292780) located at the Parks Highway Bridge. Channel geometry data collected at each study site will be reduced to provide cross-sectional and thalweg profiles to describe the relative channel morphology characteristics present at each study site.

Procedures used in the reduction and analysis of field data are summarized in the FY83 and FY84 Procedures Manuals (ADF&G 1982a, 1984). These data will be used by Task 14 personnel to determine the response of habitat for rearing salmon and resident species to changes in mainstem discharge. These data and findings will be summarized as an appendix to the Task 14 report.

Task 16(A & B) Support

Study Approach: Stage, site flow, and channel geometry data will be collected in support of the Task 16 outmigrant studies to:

1) collect sufficient stage and site flow data within each Task 16 study site to evaluate the response of outmigrant juvenile salmon timing to changes in site flow and/or mainstem discharge; and,

2) to provide cross sectional depth and velocity data to describe the cross-sectional channel morphology and velocity characteristics of each Task 16 study site at a variety of site flows and mainstem discharges.

Stage, site flow, and cross-sectional channel geometry data will be collected using procedures outlined in the FY83 and FY84 Procedures Manuals (ADF&G 1983a, 1984).

Site Selection: The Task 16 study sites supported by the PDSP are presented in Table C-2. These study sites were selected by Resident and Juvenile Anadromous project personnel to meet the objectives of the Task 14 study task.

Table C-2. Task 16 study sites supported by the Physical Description Support Program.

Site	River Mile	Habitat type
Deshka River	40.6 (TRM 3.0)	Tributary
Flathorn Station	22.4	Mainstem

Data Analysis: Stage, site flow, and mainstem discharge data will be reduced to provide rating curves describing the response of site flow to changes in site stage and mainstem discharge. Mainstem discharge data will be referenced to the USGS Sunshine gaging station (#15292780) located at the Parks Highway Bridge. Cross-sectional depth and velocity data collected at each study site will be reduced to cross-sectional depth and velocity profiles at each evaluated site flow or mainstem discharge.

Procedures used in the reduction and analysis of field data are summarized in the FY83 and FY84 Procedures Manuals (ADF&G 1983a, 1984). These data will be used by Task 16 personnel to estimate the rate of outmigrant of juvenile salmon in response to changes in mainstem discharge and site flow. These data and finding will be summarized as an appendix to the Task 16 report.

Task 25 Support Program

Study Approach: Intragravel and surface water temperature data will be obtained by the PDSP in support of Task 25 studies. These data will be collected using procedures outlined in the FY84 Procedures Manual (ADF&G 1984).

Site Selection: Temperature data will be obtained at each Task 25 study site. These sites were selected for study by Task 25 study personnel to meet the specific objectives of the Task 25 study.

Data Analysis: Intragravel and surface water temperature data will be reduced to provide daily, weekly, and monthly mean, minimum, and maximum temperatures using procedures described in the FY84 Procedures Manual (ADF&G 1984). These data will be used by Task 25 personnel to evaluate mainstem, side channel, and tributary salmon spawning temperature relationships. The reduced data will be summarized as an appendix to the Task 25 report.

Task 29 Support Program

Study Approach: Intragravel and surface water temperature data will be obtained by the PDSP in support of Task 29 studies. These data will be collected using procedures outlined in the FY84 Procedures Manual (ADF&G 1984).

Site Selection: The Task 29 study sites will be selected by Adult Anadromous project personnel to meet the specific objectives of the Task 29 study.

Data Analysis: Intragravel and surface water temperature data will be reduced to provide daily, weekly, and monthly mean, minimum, and maximum temperatures using procedures described in the FY84 Procedures Manual (ADF&G 1984). These data will be used by Task 29 personnel to evaluate mainstem, side channel, and tributary salmon spawning temperature relationships. The reduced data will be summarized as an appendix to the Task 29 report.

Task 32 Support Program

Study Approach: Surface water temperature data will be obtained by the PDSP in support of Task 32 studies. These data will be obtained using procedures outlined in the FY84 Procedures Manual (ADF&G 1984).

Site Selection: Temperature data will be obtained at the Task 32 study sites summarized in Table C-3. These sites were selected for study

Table C-3. Temperature stations selected for support of Task 32 for FY85.

Site	River Mile	Tributary River Mile	Habitat type	Temperature Type
Mainstem at RM 18.5	18.5		Mainstem	Surface Water
Yentna River	28.0	3.0	Tributary	Surface Water
Mainstem above Yentna River	29.5		Mainstem	Surface Water
Deshka River	40.6	3.0	Tributary	Surface Water
Mainstem above Deshka River	41.1		Mainstem	Surface Water
Kashwitna River	60.9	0.1	Tributary	Surface Water
Mainstem above Kashwitna River	61.2		Mainstem	Surface Water
Talkeetna River	97.2	4.0	Tributary	Surface Water
Chulitna River	98.6	15.0	Tributary	Surface Water
Talkeetna Fishwheel	103.0		Mainstem	Surface Water
LRX9	103.5		Mainstem	Surface/Intragravel Water
Curry Fishwheel	120.7		Mainstem	Surface Water
LRX29	125.9		Mainstem	Intragravel/Surface Water
LRX53	140.1		Mainstem	Surface Water
LRX56	142.1		Mainstem	Intragravel/Surface Water
Portage Creek	148.8	0.1	Tributary	Surface Water
Mainstem above Portage Creek	148.9		Mainstem	Surface Water
Fog Creek	176.8	0.1	Tributary	Surface Water
Mainstem above Fog Creek	176.9		Mainstem	Surface Water
Tsusena Creek	181.8	0.1	Tributary	Surface Water
Watana Dam	184.2		Mainstem	Surface Water

based on discussions with AEIDC personnel (Ken Voos and Paul Meyer) to meet the specific objectives of the Task 32 study.

Data analysis: Surface water temperature will be reduced to provide daily, weekly, and monthly mean, minimum, and maximum temperatures using procedures outlined in the FY84 Procedures Manual (ADF&G 1984). These data will be used by Task 32 personnel to calibrate instream temperature models. These reduced data will be transmitted as a data transmittal report to the Alaska Power Authority.

Task 36 Support Program

Study Approach: Stage, site flow, and channel geometry data will be obtained in support of Task 36 studies to:

1) provide sufficient stage and site flow data to estimate the response of site flow at each Task 36 study site to changes in site stage and mainstem discharge; and,

2) obtain sufficient channel geometry data to describe the channel characteristics of each Task 36 study site.

Stage, site flow, and channel geometry data will be collected using procedures outlined in the FY83 and FY84 Procedures Manual (ADF&G 1983a, 1984).

Site Selection: The Task 36 study sites supported by the PDSP are presented in Table C-4. These sites were selected by Resident and Juvenile Anadromous and Aquatic Habitat and Instream Flow project personnel to meet the specific objectives of the Task 36 study.

Table C-4. Task 36 study sites supported by the Physical Description Support Program.

Site	River Mile	Habitat
Island	63.2	Side Channel
Mainstem Westbank	74.4	Side Channel
Circular	75.3	Side Channel
Sauna	84.5	Side Channel
Sunset	86.9	Side Channel
Trapper	91.6	Side Channel

Data Analysis: Stage and site flow data will be reduced to provide rating curves describing the response of site flow to changes in site stage and mainstem discharge. Mainstem discharge data will be referenced to the USGS Sunshine gaging station (#15292780) located at the Parks Highway Bridge. Channel geometry data collected at each study site will be reduced to provide cross-sectional and thalweg profiles to describe the relative channel morphology characteristics of each study site.

Procedures used in the reduction and analysis of field data are summarized in the FY83 and FY84 Procedures Manuals (ADF&G 1983a, 1984). These rating curves and channel geometry data will be used by Task 36 personnel in the calibration of IFG-2/IFG-4 hydraulic models at each study site. These data will be summarized as an appendix to the Task 36 report.

2.2 Middle River Habitat Modelling Support

ADF&G Su Hydro AH staff will assist E.W. Trihey & Associates (EWT&A) in the middle river Task 12 studies. Specific support tasks to be conducted by ADF&G Su Hydro personnel include assisting with the selection of study sites, design and development of the field data collection plan, and support with data collection, reduction, and analysis. In addition, ADF&G Su Hydro AH personnel will assist in the Task 12 report preparation and review process.

Site selection process: ADF&G Su Hydro AH staff will assist in the systematic review of aerial photographs to select candidate study sites, field visitation of candidate study sites to select actual study sites, and review of the narrative prepared by EWT&A describing the study site selection process.

Field data collection plan development: ADF&G Su Hydro AH staff will recommend the most effective sampling methods and equipment for use in the Task 12 study based on their previous experience. ADF&G Su Hydro AH staff will also provide insights and recommendations to EWT&A regarding inherent biases that may be associated with using various types of sampling gear or schedules, and will recommend a sampling program to accomplish the objectives of the study as best can be done with funded resources. ADF&G Su Hydro AH staff will have the lead responsibility for developing the biologic component of the field data collection study plan, and will review the completed draft version of the overall Task 12 Procedures Manual to be prepared by EWT&A.

Field data collection: The field data collection program will be a joint ADF&G Su Hydro and EWT&A operation under the general direction of EWT&A. ADF&G Su Hydro will have the lead responsibility for implementing the biologic component of the program as defined by EWT&A with EWT&A having the lead responsibility for implementing the hydraulic component of the program. ADF&G Su Hydro will provide six full time equivalents during the period from July 1 to October 31, 1984 to support the field data collection phase of this task. ADF&G Su Hydro will provide camp facilities at Slough 9 for eight people, two river boats, 2 vehicles, and sampling gear necessary to collect the biologic data and portions of the equipment necessary to collect the hydraulic data.

Reduction and analysis of field data: ADF&G Su Hydro staff will have the lead responsibility for reducing, verifying, combining, and analyzing the biologic component of the field data in support of the Task 12 studies in additon to providing support in the reduction, verification, and analysis of the hydrologic component of the field data. ADF&G Su Hydro will provide four full-time equivalents and previously arranged portions of the computer time to support this phase of the task.

Report preparation and review: ADF&G Su Hydro will develop the biologic component of this study into a report for transmittal to EWT&A. The ADF&G Su Hydro deliverable will be solely authored by ADF&G Su Hydro staff and submitted to EWT&A in accord with an outline developed by EWT&A. The principle elements of the biologic component will include:

a) Timing and relative abundance of fish at each (FY85) study site with a comparison to FY83 and FY84 findings.

b) Distribution of fish within each study site and a description of physical habitat conditions present at the time of observation.

c) Refinement of FY84 habitat utilization criteria.

ADF&G Su Hydro staff will provide four full-time equivalents to support this phase of the task.

All ADF&G Su Hydro staff will be directly supervised by ADF&G Su Hydro senior supervisory staff who will follow the study plan developed by EWT&A. Specific levels of involvement in each of the above phases will be established prior to the initiation of each phase. Departures from this plan will be based on available time and resources and the mutual agreement of EWT&A, ADF&G Su Hydro, and the Alaska Power Authority the (APA).

Deliverables: The biologic component of the Task 12 deliverable to EWT&A will be solely authored by ADF&G Su Hydro and submitted to EWT&A in accord to an outline developed by EWT&A. Any departures from this plan will be based on available time and resources and the mutual agreement of EWT&A, ADF&G Su Hydro, and the APA.

2.3 Food Availability Studies

Study Approach: The FY85 food availability study (FAS) has the overall objective of quantifying invertebrate fish food organisms in side channel, slough, and mainstem habitats of the middle Susitna River between River Mile (RM) 120 and RM 146. Two specific sampling tasks will be used to accomplish this overall objective at each study site: 1) an invertebrate drift sampling program and 2) a benthic invertebrate sampling program. In addition, a third sampling task will be used to reaffirm the importance of aquatic invertebrates as a food source for rearing juvenile salmon in mainstem affected habitats.

These three study tasks will provide the data needed to:

1) Compare the number of drifting invertebrates utilized by juvenile chinook salmon present in the mainstem Susitna River to that utilized within mainstem affected side channels and sloughs at various levels of mainstem discharge;

2) Estimate the numerical response of different benthic invertebrate groups utilized as a food source by juvenile chinook salmon in mainstem affected side channels and sloughs to changes in mainstem discharge; and,

3) Reconfirm the importance of aquatic invertebrates as food for rearing juvenile chinook salmon in mainstem affected habitats.

Site Selection: The FY85 FAS program will be conducted at four locations between RM 128 and RM 143. These locations represent side channel and slough habitats which receive varying degrees of mainstem influence at difference mainstem discharges. The selection of sample locations is based on accessibility of the site and ease of sampling under breached conditions and the relative presence of juvenile chinook salmon. Additionally, study sites were selected to utilize previously established transects for hydraulic simulation modelling at each study site. Sites selected based on these criteria include Slough 9, Side Channel 10, Upper Side Channel 11, and Side Channel 21 (at the mouth of Slough 21).

Data Analysis: The distribution and abundance of invertebrates in side channels and sloughs will be determined from information gathered from drift and benthic invertebrate samples. Significant differences in the distribution of drifting invertebrates at the heads and at the hydraulic simulation modelling sites of side channels and sloughs will be determined from analysis of invertebrate count data. The analyses used to make these determinations will include an one-way analysis of variance, Sorensen's similarity quotient, a cluster analysis, and Shanon-Wiener's diversity index (Southwood 1975). Frequency distributions, hydraulic simulation modelling, and Shanon-Wiener's diversity index (Southwood 1975) will be used along with the benthic and drift data to determine the habitat preferences of different invertebrate groups and the weighted area of stream bed usable (WUA) to these groups.

Fish stomach contents will be enumerated and identified in the laboratory. Data will be analyzed to determine if prey types found in stomachs are selected for or against in comparison to those occurring in drift and benthic samples. Pie diagrams and Strauss's electivity index will be used in the analysis of these data. Specific methods and data analysis procedures for the utilized in this study are presented in Section 3.2 of this portion of the procedures manual.

Deliverable: Results and findings of these investigations will be summarized in a technical report to the Alaska Power Authority.

2.4 Preparation of FY84 Winter Incubation Report

Objective: To complete the analysis of incubation related data (intragravel water quality, embryo survival and substrate composition) collected during FY84 (August, 1983 to May, 1984) and to prepare a report synthesizing this information and previous collected data with information available in the literature.

Description: There are three primary sources of data that will be used for report preparation:

1) ADF&G data collected during the FY82 - FY84 field studies;

2) a report by Wangaard and Burger (1983); and,

3) other published literature.

Four types of data will be analyzed: intragravel and surface water quality data, intragravel and surface water temperature data, embryo development and survival data, and substrate composition data. The report will include a discussion of the analyzed data and a comparison of the results of this study to results of similar studies.

Deliverables: A final report summarizing the results and findings of the incubation study for the period August, 1983 to May, 1984.

2.5 Passage Validation Study

Study Approach: The passage criteria developed during FY83 and FY84 were evolutionary steps in the understanding and quantification of conditions needed for salmon passage into and within slough and side channel spawning areas. The products of the FY84 analysis were salmon passage criteria curves and passage/discharge and passage/site flow evaluations which are presented in Estes and Vincent-Lang (1984: Chapter 6). The criteria curves presented in this report were based on a review of limited field data and observations combined with the professional judgement of fishery biologists and a hydraulic engineer. In order to strengthen subsequent analytical steps, additional field observations and data are necessary to verify and refine these passage criteria curves.

During FY85, the Passage Validation Study (PVS) will specifically focus on two objectives:

1) Verify and refine the passage criteria curves describing passage conditions for chum salmon into slough and side channel habitats in the middle reach of the Susitna River developed in the FY84 analysis; and,

2) Refine the estimates of mainstem discharge and local flow required for successful passage for all slough and side channel sites where salmon passage conditions have been previously identified.

Field observations of fish passage activity will be made at each identified passage reach site noting whether successful, successful with difficulty and exposure, or unsuccessful passage occurs. Passage reach dimension data (length, width, depth) will also be collected concurrently with fish passage observations to document channel geometry characteristics at the time of passage. In addition, the predominate substrate type and channel characteristics (ie., uniform straight channel or non-uniform braided channel) will be identified at each passage reach. A combination of the above data will be utilized to validate and/or refine the passage criteria curves. Passage discharge and local flow estimates required for successful passage will be reevaluated based on the refined criteria curves.

Hydraulic data will also be collected to fill several hydraulic data gaps which occurred in the FY84 data base. Hydraulic data to be collected include: 1) survey data for the development of cross section profiles at each passage reach, 2) survey data for the development of thalweg profiles at each study site, 3) stage data, and 4) local site flow data.

Specific data collection techniques and procedures to be used in the collection of these data are presented in Section 3.1 of this portion of this manual.

Site Selection: Slough and side channel spawning locations in the middle river where discharge-related passage problems have been documented will be evaluated as study sites. Table C-5 includes a list of these study sites and the number of passage reaches previously identified at each site that were evaluated during the FY84 analysis. Additional passage reaches will be identified in the field during FY85 as necessary.

Data Analysis: Data analysis will consist of two segments corresponding to each objective. The analysis for Objective 1 will be accomplished by combining fish passage observations with passage reach dimension data and plotting the relationship against the FY84 passage criteria curves. Based on the results, new sets of fish passage criteria curves will be developed that are more representative of natural passage conditions.

To complete Objective 2, the analysis will consist of a reevaluation of passage reaches utilizing the three basic analyses from FY84. This will

Table C-5. Summary of passage validation study sites and corresponding number of passage reaches in the middle reach of the Susitna River.

STUDY SITE	RIVER MILE	PASSAGE REACHES
Whiskers Creek Slough	101.2	3
Mainstem 2 Side Channel	114.4	9
Slough 8A	125.9	9
Slough 9	128.3	5
Slough 9A	133.6	10
Slough 11	135.3	5
Upper Side Channel 11	136.1	3
Slough 19	140.0	Unknown
Slough 20	140.1	6
Side Channel 21	140.6	10
Slough 21	141.8	3
Slough 22	144.2	4

include an analysis of breaching effects, backwater effects, and local flow effects on passage. Modifications may be incorporated into any of these analyses. Based on a more complete data base, the results will provide a more accurate estimates of mainstem discharge and local flow required for successful passage conditions. Specific data analysis procedures to be used in this study are presented in Section 3.1 of this portion of this manual.

Deliverable: Results and finding of these studies will be summarized in a series of technical memorandums and reports, if necessary, to the Alaska Power Authority.

2.6 Lower River Habitat Modelling Support

Objective: To provide calibrated U.S. Fish and Wildlife Service Instream Flow Incremental Methodology (IFIM) Instream Flow Group (IFG) hydraulic simulation models (Milhous et al 1984) at selected lower river juvenile anadroumous and resident fish rearing study sites at which the dominant variables influencing the habitat are water depth and velocity.

Study Approach: The approach of this study will be to apply IFIM IFG hydraulic simulation models (IFG-2 and IFG-4) to sites where water depth and velocity are the dominant hydraulic variables of the habitat. These models will be used to quantify changes in rearing habitat as a function of changes in site flow and mainstem discharge and to determine if this modelling approach is required to evaluate the affects that changes in site flow and mainstem discharge have on other life phases in these habitat types.

Site Selection: A maximum of six sites in side channel areas in the lower reach of the Susitna River will be selected to assess how their associated flows and rearing habitats react to changing site flows and mainstem discharges. Sites, transect locations within the sites, and appropriate hydraulic models will be selected by biologists from the Resident and Juvenile Anadromous project and the Aquatic Habitat and Instream Flow project, and hydraulic engineers from EWT&A. This will ensure that the sites selected for modelling are as representative as possible of the variety of rearing habitats needed to be examined and that the sites can be hydraulically modelled using the IFG hydraulic models. Also taken into account for site selection will be factors concerning logistics such as accessibility and travel time.

Field Data Collection: The data to be collected at each study sites will include water depth, water velocity, substrate, and cover data. The data will be collected along selected representative transects over the full range of site flows and mainstem discharges that occur during the 1984 open water field season. General guidelines from which to make site specific flow measurements will be based on predetermined mainstem discharge ranges. The target ranges will be based on R&M lower river photos of 1983. Because of the unknown nature of how specific flows in the individual side channels will react to associated changes in mainstem discharges and how long target discharge ranges will be available for measurement, it may prove difficult to make all tentatively scheduled measurements. Alternating strategies may have to be made as the season progresses.

The actual on site instream flow measurements will follow the procedures outlined in the following manuals: ADF&G (1984), Bovee and Milhous (1978), and Trihey and Wegner (1981).

Field Data Analysis: The two hydraulic simulation models that will be used in the hydraulic data analysis will be the IFG-2 or IFG-4. The model that will be used at each site will depend on the quantity and quality of hydraulic field data collected at that site (for details see Estes and Vincent-Lang 1984: Chapter 7). The analysis of the field data will follow the procedures outlined in Milhous et al (1984) and Trihey (1980). A hydraulic engineer from EWT&A will supervise the calibration of the models and review the calibrated model for each site to ensure that they are properly calibrated. The calibrated models will in turn be linked to the proper programs in the PHABSIM system (see Milhous et al 1984) to produce the weighted usable area for the rearing phases of the selected target species.

Deliverable: Results and findings of these investigations will be presented as a technical appendix to the Task 14 report.

3.0 TECHNICAL PROCEDURES

This section presents specific data collection and analysis procedures used in meeting FY85 objectives that have not been presented in earlier ADF&G Procedures Manuals or that have been changed from procedures presented in earlier ADF&G Procedures Manuals. Refer to the FY82, FY83, and FY84 ADF&G Procedures Manuals for all other data collection and analysis procedures (ADF&G 1981a, 1983a, 1984).

3.1 Fish Passage

Fish Passage Observation: Field observations of fish passage activity will be made at each site noting whether successful, unsuccessful with difficulty and exposure, or unsuccessful passage occurs. These categories will be defined as follows:

Successful Passage: Fish passage into and/or within the spawning area is uninhibited, and would not affect natural production in the area.

Successful Passage With Difficulty And Exposure: Fish passage into and/or within the spawning area is accomplished, but with stress and exposure to predation with the potential of reducing the level of successful spawning in the area. This condition over a long period of time may result in a decline in natural production in the area. Characteristics of this category are:

1) exposure of the dorsal surface of the fish above water;

2) one or more pauses within a reach due to stranding, changing directions, or resting; or,

3) repeated attempts to navigate a passage reach before succeeding.

Unsuccessful Passage: Fish passage into and/or within the spawning area may be accomplished by a limited number of fish; however, exposure to excessive stress and increased predation (which are associated with these conditions) may eventually eliminate or greatly reduce the natural production in the area. Characteristics of this category are:

1) absence of fish above a passage reach;

2) excessive exposure of the dorsal surface of the fish above water;

3) excessive number of pauses within a passage reach leading to unsuccessful navigation; or,

4) death of a fish while attempting navigation of a passage reach.

Ranking of passage observations into one of three categories of passage is primarily bases on the characteristics stated above. Fish passage observations are focused on chum salmon although observations of the other salmon species are noted if present.

Passage Reach Dimensions: A passage reach will be defined as a portion of the channel at the mouth of or within a study site which is potentially limiting to salmon migration into spawning areas. A transect perpendicular to the flow of water will be chosen to represent each passage reach and provide a consistent point of measurement. Representative transects will be located at the shallowest or most critical part of the passage reach and marked in the field with wood stakes and rebar headpins.

To quantitatively describe a passage reach, the length, width and water depth will be measured. These variables are defined as follows:

Passage Reach Length: The longitudinal distance of a passage reach along the thalweg channel limited by the upstream and downstream points at which water depth is no longer limiting to salmon passage. The length limits are defined as a water depth of 0.5 ft and 0.67 ft based on the passage criteria curves (from Curves I and II respectively; Estes and Vincent-Lang 1984: Chapter 6).

Passage Reach Width: The distance from left water's edge (LWE) to right water's edge (RWE) of a passage reach transect.

Passage Reach Depth: The depth of water at a passage reach which a fish must navigate through in order to proceed upstream. Passage depth is calculated as an average of the mean depth and maximum depth (thalweg depth) at a passage reach transect. Only the maximum depth is measured in the field as an indicator of passage reach depth. The point of maximum depth at a passage reach transect will be marked with a flagged spike in the streambed or a staff gage for a consistent point of measurement. Passage depth will be calculated during data analysis in the office using cross sectional survey data.

Passage reach dimension data will be collected at the same time passage observations are made. Passage reach lengths and widths will be measured with a fiberglass surveyor's tape graduated in one-tenth foot increments. A surveying rod or staff gage will be used to measure passage reach depths.

Substrate Classification: The substrate conditions at each passage reach will be evaluated to characterize channel configuration. Substrate data will be collected by visually classifying the substrate present at a passage reach into the two dominant size groups. This study utilized the same detailed substrate size classification system presented in the FY84 ADF&G Procedures Manual (ADF&G 1984). In addition, the uniformity/non-uniformity of the passage reach channel will be recorded.

Stage and Discharge Measurement: Discharge measurements will be collected at selected passage study sites to quantify local flows during the salmon migrational period. Marsh-McBirney and Pygmy flow meters will be utilized for discharge measurements with total discharge being calculated by the current-meter method using standard USGS techniques (Buchanan and Somers 1973). Refer to the FY84 ADF&G Procedures Manual for details of discharge measurement and calculation procedures (ADF&G 1984).

Staff gages will be established at a minimum of one passage reach within each study site. Stage measurements from staff gages will be collected over a range of flows. These data will be combined with discharge measurements to develop site-specific rating curves. Additional staff gages will be placed at the mouths and heads of study sites to measure backwater and breaching effects, respectively. Refer to the FY84 ADF&G Procedures Manual for details on staff gage and rating curve procedures (ADF&G 1984).

Cross Section Profile: Cross section profiles will be surveyed at all passage reach transects within each study site. Each cross section will include the entire streambed profile between the high water marks on both banks. Refer to FY84 ADF&G Procedures Manual for details on cross section profile study procedures (ADF&G 1984).

Thalwegs: Thalweg profiles have been completed for all the study sites with documented passage problems except Slough 19. Therefore, a complete thalweg of Slough 19 will be surveyed using techniques described in the FY84 ADF&G Procedures Manual (ADF&G 1984).

3.2 Food Availability Studies

Invertebrate Drift Sampling: Invertebrate drift will be sampled at two locations within each of four sampling sites (see Section 2.3 for a list of sampling sites). In general, the location of drift nets will be at the head of each slough or side channel where mainstem water breaches the area and at the hydraulic simulation modelling site within each slough or side channel study site. These locations will be used to evaluate differences in the number of invertebrates from mainstem habitats and mainstem affected (side channel and slough) habitats.

Drifting invertebrates will be sampled using a pair of drift nets (12" x 18" x 39") constructed of 500 micron netting. Each drift net pair will be supported in the water by four one-inch diameter iron stakes. Nets will sample the entire water column for fifteen minutes, two hours before sunset on each of two consecutive days. The time drift nets are left in the water will be adjusted depending on the discharge and amount of floating debris at each sample site. Drifting invertebrates will be sampled three times during the summer of FY 1984. The monthly schedule for sampling invertebrate drift is listed in Table C-6.

The volume of water in cubic feet flowing through nets per minute (ft^3/min) will be used to standardize the number of invertebrates in samples. This volume of water will be calculated from measurements of the current velocity and net area at the net mouth. Current velocity measurements will be taken with a Marsh-McBirney electrical current meter at each net at the start and finish of each sampling period. The

Table C-6. Tentative schedule for sampling benthic invertebrates and invertebrate drift at the four FAS study sites, early June through late August, 1984.

Sites	Date	Type Sampling
Slough 9, Side	6/6/84-6/15/84	Drift
Channel 10, Upper	6/20/84-6/29/84	Benthos
Side Channel 11 and		
Side Channel 21	7/11/84-7/20/84	Drift
	8/8/84-8/17/84	Drift
	8/22/84-8/31/84	Benthos

current velocity used in calculations will be the average of the start and finish measurements. A water sample will also be taken at each drift sample site to measure the turbidity of water during each sampling period. Surface water temperature will be continuously monitored throughout the summer at drift sample sites located in IFG-4 modelling areas. This information will be used to measure the effect that changes in turbidity and water temperature have on the amount of drifting invertebrates in side channels and sloughs.

Benthic Invertebrate Sampling: Benthic invertebrates will be sampled at the same hydraulic simulation modelling sites used in the drift sampling program. Benthic samples will be taken along existing transects to facilitate the use of past hydraulic model data in calculations of weighted usable area.

Benthic samples will be taken with a 25 inch (in) high 4 in^2 cylindrical bottom sampler constructed of aluminum and 500 micron netting. Samples will be taken to a depth of approximately ten centimeters into the substrate. The water depth, current velocity and substrate type will be measured at each sampling point before a sample is taken.

Substrate type will be identified according to a thirteen class ranking system (Table C-7). Mean current velocities will be measured with a Marsh-McBirney electrical current meter. Water depth will be measured to the nearest 0.05 feet. The number of benthic samples taken at each hydraulic simulation modelling site will depend on the number of transects

Table C-7. Thirteen size class IFG-4 ranking system used to identify substrate types, Susitna River, 1984.

Substrate Type	Code	Substrate Size
Silt	1	less than 1.6 mm
Silt-sand	2	
Sand	3	1.6-6.4 mm
Sand-fine gravel	4	
Fine gravel	5	6.4-25.4 mm
Fine gravel-Large gravel	6	
Large Gravel	7	25.4-76.2 mm
Large Gravel-Rubble	8	
Rubble	9	76.2-127.0 mm
Rubble-Cobble	10	
Cobble	11	127.0-254.0 mm
Cobble-Boulders	12	
Boulders	13	greater than 254.0 mm

and the amount of variation in water depth, current velocity, and substrate type found along each transect. Each hydraulic simulation modelling site will be sampled twice during the summer. A list of the side channels and sloughs with hydraulic simulation modelling benthic sampling sites and the sampling dates is shown in Table C-7.

Juvenile Anadromous Fish Sampling: Juvenile chinook salmon will be collected during each invertebrate drift sampling period (Table C-7) using backpack electrofishing techniques. Juvenile fish will collected for stomach analyses from the same hydraulic simulation modelling sites used for drift and benthic invertebrate sampling. Approximately five fish per hydraulic simulation modelling site per sampling period will be collected, for a total of 60 fish per year.

Sample Storage and Handling: All invertebrate samples will be placed in polyethylene plastic bags and preserved with 70% ethyl alcohol (ETOH). Juvenile chinook salmon will be cut open before preserving in 70% ETOH. Invertebrates from benthic and drift samples will be hand sorted from debris and placed in glass vials containing 70% ethyl alcohol for later identification and enumeration. Invertebrates from juvenile salmon stomachs will be stored in similar size glass vials containing 70% ETOH for later analysis.

Data Analysis: All invertebrates will be counted and identified to family. In addition, invertebrates from benthic samples will be identified by trophic status (e.g. predators and shredders).

Invertebrate counts from drift samples will be standardized and reported as the number of individuals passing through a net per cubic feet of water per minute ($N/ft^3/min$). Standardized counts will then be analyzed using one-way analysis of variance to detect significant differences among sampling locations. Sorensen's similarity quotient and cluster analysis (Southwood 1975) will be applied to the qualitative data (i.e. to the number of kinds of invertebrates in samples) to illustrate graphically differences among sampling locations. The Shanon-Wiener diversity index (Southwood 1975) will be used to show differences in invertebrate drift at the community level at sample sites.

The number of organisms per square feet (N/ft^2) will be used to describe the density of benthic invertebrates at hydraulic simulation modelling sample locations. Frequency distributions will be used to illustrate benthic invertebrate preferences for various water depths, current velocities and substrate types. Habitat preference curves will be generated from these bar graphs. Instream Flow Group hydraulic modelling techniques will be used to predict the weighted usable area for each benthic group of invertebrate. Past IFG hydraulic simulation modelling data (eg. current velocities measured along IFG transects in FY 1984) will be used to achieve this objective. The Shanon-Wiener diversity index will be used to measure the stability of benthic invertebrate of the community level.

Invertebrate counts from the stomach of juvenile chinook salmon will be converted to percentages and the proportions illustrated using pie diagrams. Strauss' linear electivity index (Southwood 1975) will be used to show preference of juvenile chinook salmon for certain invertebrate food groups.

4.0 LITERATURE CITED

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