LOWER SUSITNA RIVER PRELIMINARY
CHUM SALMON SPAWNING HABITAT
ASSESSMENT

Draft Technical Memorandum

by

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INTRODUCTION

Background

During the 1984 open water field season, six side channels located in the lower Susitna River between the Kashwitna and Talkeetna rivers were modeled using IFG modeling techniques to evaluate rearing habitat for juvenile salmon. During the course of these investigations, chum salmon were observed spawning, in relatively high numbers, in five of the six side channel modeling sites. Spawning surveys conducted from August 21 to October 17, 1984 of the lower Susitna River as part of the Su Hydro Adult Anadromous Study resulted in a conservative estimate of between 2,600 to 3,900 spawning chum salmon in mainstem and side channel habitats in this reach (Thompson et al. 1985). Because spawning observed in the IFG side channels and at other locations was greater than expected it was necessary to conduct a preliminary baseline evaluation of the newly discovered spawning habitats. These preliminary baseline investigations were therefore conducted in conjunction with the lower river rearing habitat investigations at no additional cost to determine whether additional information may be needed to evaluate whether post-project flows may influence the quality and quantity of the habitats. This technical memorandum reports the findings of these habitat evaluations.

Objective

The objective of this preliminary assessment is to evaluate selected baseline habitat conditions and their relationship to mainstem discharge to determing if further studies may be required to assess the impacts of with-project flows in these habitats. To obtain this objective, the following information was collected:

Habitat Data

1) Continuous surface and intragravel water temperature was monitored at three side channels throughout the ice-covered season (Trapper, Sunset, and Circular) to evaluate conditions in areas of observed spawning activity;

2) Side channel water surface elevations was monitored throughout the ice-covered season in the vicinity of observed chum salmon activity to determine the relationship of side channel stage to mainstem stage; and,

3) Substrate of viable chum salmon redds was sampled and analyzed to determine utilized substrate composition.

Biological Data

4) Surveys were conducted to locate areas of active chum salmon spawning in selected lower river side channel and mainstem habitats;

5) Calibrated IFG-4 hydraulic models developed in support of the lower river rearing habitat investigations were run through the habitat simulation model to project weighted usable area (WUA) of chum salmon spawning habitat at modeling sites at which chum salmon spawning was documented;

6) Eggs were collected to evaluate the overwintering success of selected redds and embryo survival and development; and

7) The occurrence and timing of juvenile salmon outmigration from areas having active chum salmon spawning was evaluated to determine the presence of successful incubation and rearing.

A list of study sites sampled and data collected at each site is presented in Table 1. The six side channels selected for this study were also the subject of the 1984 rearing modelling study. The mainstem site was chosen because it was used by spawning chum salmon and because there is easy access to the site.

Due to time and resource constraints, all sites were not sampled for all data types listed above. The three sites where all data types were collected were selected because of the relatively higher numbers of spawning chum salmon observed of the sites.

Table 1. A summary of data collected at sites selected for biological and habitat assessment.

Site	Chum Salmon Spawning Survey	Chum Salmon Spawning WUA	Egg Survival and Development	Outmigration Occurrence	Intragravel and Surface Temperature	Water Surface Elevations	Substrate
Island Side Channel (RM 63.2)	X						
Mainstem West Bank (RM 74.4)	X	X					
Circular Side Channel (RM 74.3)	X	X	X	X	X	X	X
Sauna Side Channel (RM 79.8)	X						
Sunset Side Channel (RM 86.9)	X	X	X	X	X	X	X
Birch Creek Camp Mainstem (RM 88.6)	X		X				
Trapper Creek Side Channel (RM 91.6)	X	X	X	X	X	X	X

METHODS

Habitat Data

Temperature

Intragravel and surface water temperatures were obtained on a continuous basis from the following three IFG side channel study sites (Table 1): Trapper (RM 92.7), Sunset (RM 86.9), and Circular (RM 75.3). Water temperatures were continuously recorded at each site using Omnidata two channel datapod recorders. The datapod recorders simultaneously recorded both surface and intragravel water temperatures. Field installation and monitoring procedures are outlined in the ADF&G Su Hydro Aquatic Studies (May, 1983 - June, 1984) Procedures Manual (ADF&G 1983).

Within Trapper Side Channel, intragravel and surface water temperatures were obtained from both the lower and upper portions of the chum salmon spawning area. Sunset Side Channel also had two continuous temperature stations located in the lower and upper portion of the spawning area. At Circular Side Channel, continuous temperature recording stations were located in both the mid-portion and lower portion of the spawning site.

All temperature stations were monitored bi-monthly. From the continuous temperature data bases, daily and monthly minimum, mean and maximum water temperatures were calculated and tabulated. From these data, plots of the mean, daily intragravel and surface water temperatures were developed.

Water Surface Elevation

Water surface elevations were obtained in Trapper, Sunset, and Circular side channels and in the mainstem Susitna River adjacent to these side channel sites to evaluate the effect mainstem discharge has on ground water flow in the side channels. Pools located in the side channels within the spawning sites were selected for these water surface elevations. Water surface elevations obtained in the mainstem Susitna River were made adjacent to the side channel.

Water surface elevations were obtained from both the side channel and mainstem sites using the basic survey techniques of differential leveling. At each site a temporary bench mark (TBM) was established and used to reference the water surface elevations. A separate TBM was established for each side channel and mainstem site. Resulting water surface elevations are therefore only relative to the respective TBM. Surveys can therefore only be used to compare trends between mainstem and side channel but not elevations. During periods of ice cover, holes were drilled through the ice to obtain these water surface elevations.

Water surface elevation data were plotted to compare water surface elevations of the side channels and mainstem sites over time.

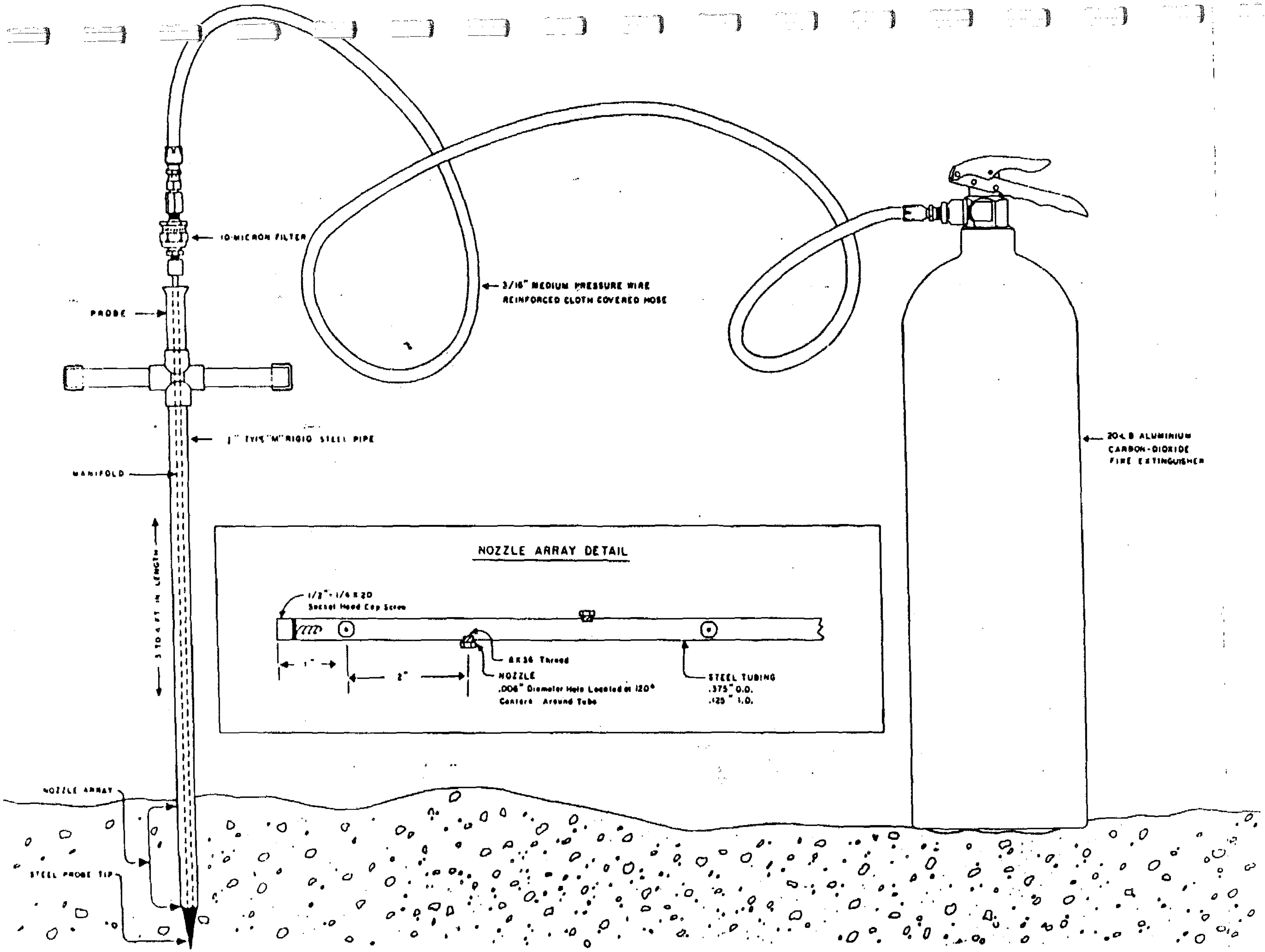


Figure 1. Single probe freeze core sampling system used for sampling substrate and eggs.

Substrate

Substrate samples were obtained at selected redds from each of the three side channel study sites (Trapper, Sunset, and Circular). Substrate samples were obtained using a single freeze core method illustrated in Figure 1 (Walkhotten 1976). Substrate samples were obtained to depths of 12 to 16 inches. These samples were thawed in the field over a series of 4-inch wide substrate boxes producing depth integrated sub-samples. Analysis of these samples were performed by R & M Consultants for substrate composition. The data are plotted by percent per sieve size and depth of sample. Bar graphs describe substrate composition by weight for six substrate size categories. The substrate classification defined substrate sizes ranging from less than .002 inches to greater than 3 inches in diameter.

Biological Data

Chum Salmon Spawning Surveys

Six side channels and one mainstem location were selected for site-specific surveys of chum salmon spawning activity. These sites included Trapper Side Channel, Sauna Side Channel, Mainstem West Bank Side Channel, Sunset Side Channel, Circular Side Channel, Island Side Channel and the mainstem adjacent to the ADF&G Birch Camp referred to as the Birch Camp Mainstem site.

To evaluate the presence of spawning chum salmon, both aerial and foot surveys were conducted. Aerial surveys were made by helicopter to identify areas of chum salmon spawning. Foot surveys were conducted to ground-truth the occurrence of spawning. Once identified, redds were marked using 6 foot, 2x2 wooden stakes to relocate the redds under ice and snow.

Chum Salmon Spawning WUA

The calibrated IFG-4 hydraulic models developed in support of the lower river juvenile anadromous habitat modelling work during FY 85 (ADF&G, 1984b) were run through the USFWS IFG HABTAT model (Bovee 1982) using the middle river suitability criteria for chum salmon (Tables 2-4) developed by Vincent-Lang et al. 1984. The standard calculation method to predict weighted usable area (WUA) as a function of flow was used. Only modelled side channels at which chum salmon have been observed to spawn were evaluated (Table 5).

Cover codes used in running the HABTAT models for juvenile anadromous fish habitat were replaced with joint substrate/upwelling codes to evaluate chum salmon spawning habitat. The first digit of the two digit replacement code represented the substrate classification value from Table 6 and the second digit represented the presence or absence of upwelling.

Upwelling presence was determined by observations of obvious upwelling locations during the summer of 1984, drilling through ice cover during the winter and aerial surveys of open leads during April 1985. IFG

Table 2. Depth suitability criteria for chum salmon spawning.

DEPTH	SUITABILITY INDEX
0.0	0.0
0.2	0.0
0.5	0.2
0.8	1.0
8.0	1.0

Table 3. Velocity suitability criteria for chum salmon spawning.

VELOCITY	SUITABILITY INDEX
0.0	1.0
1.3	1.0
2.8	0.2
4.5	0.0

Table 4. Substrate and upwelling combined suitability criteria for chum salmon spawning.

Substrate	Upwelling[1/]	Code	Suitability Index
Silt	A	1.0	0.00
Silt	P	1.1	0.00
Silt/Sand	A	2.0	0.00
Silt/Sand	P	2.1	0.00
Sand	A	3.0	0.00
Sand	P	3.1	0.025
Sand/Small Gravel	A	4.0	0.00
Sand/Small Gravel	P	4.1	0.05
Small Gravel	A	5.0	0.00
Small Gravel	P	5.1	0.20
Small Gravel/Large Gravel	A	6.0	0.00
Small Gravel/Large Gravel	P	6.1	0.60
Large Gravel	A	7.0	0.00
Large Gravel	P	7.1	1.00
Large Gravel/Rubble	A	8.0	0.00
Large Gravel/Rubble	P	8.1	1.00
Rubble	A	9.0	0.00
Rubble	P	9.1	1.00
Rubble/Cobble	A	10.0	0.00
Rubble/Cobble	P	10.1	0.85
Cobble	A	11.0	0.00
Cobble	P	11.1	0.70
Cobble/Boulder	A	12.0	0.00
Cobble/Boulder	P	12.1	0.25
Boulder	A	13.0	0.00
Boulder	P	13.1	0.00

1/ A = Absent, P = Present

Table 5. Lower River IFG-4 modeling sites representing side channels at which chum salmon have been observed to spawn in 1984.

IFG MODELING SITE	RIVER MILE
Mainstem West Bank Side Channel	74.4
Circular Side Channel	75.3
Sunset Side Channel	86.9
Trapper Creek Side Channel	91.6

Table 6. Substrate size classification system used to evaluate substrate conditions at Lower River study sites.

SUBSTRATE TYPE	SYMBOL	SIZE CLASS
Silt	SI	Very Fines
Sand	SA	Fines
Small Gravel	SG	¼"-1"
Large Gravel	LG	1"-3"
Rubble	RU	3"-5"
Cobble	CO	5"-10"
Boulder	BO	Greater than 10"

model cells were assigned a value of 1 where upwelling was observed and a value of 0 where no open leads or upwelling were considered present.

Sunset Side Channel and Mainstem West Bank Side Channel had observed upwelling and spawning occurring within the study site. At Trapper Creek Side Channel, extensive upwelling and spawning were observed within the side channel but outside of the modelling site. At Circular Side Channel, a few cells in transect 1 had upwelling present. No spawning was observed within this study site, but below the study site where upwelling was also observed, extensive spawning occurred. When the HABTAT model was run for Trapper Creek Side Channel and Circular Side Channel, the resulting WUA's were zero due to a lack of upwelling.

A second run of the HABTAT model was completed after simulated upwelling data was entered in appropriate cells of these models in order to represent the overall side channel with respect to upwelling. This was done since spawning and upwelling were observed in the side channels outside of the modeling sites and it was assumed that the modeling sites are hydraulically representative of the side channels in which they are located.

The process for simulating upwelling was as follows. First, the range of depths and velocities present in cells having upwelling in Mainstem West Bank Side Channel and Sunset Side Channel modelling sites were evaluated. A comparison of mainstem discharge versus site flow indicated that Trapper Creek Side Channel and Circular Side Channel were more closely related hydraulically to Sunset Side Channel than to Mainstem West Bank Side Channel. Cells in Trapper Creek Side Channel within the velocity range of cells in Sunset Side Channel having upwelling were examined. If depth and substrates were within the range of those in Sunset Side Channel upwelling cells, they were assigned an upwelling present code. Mainstem West Bank upwelling cell depth, velocity and substrate ranges were taken into consideration secondarily. Upwelling areas were refined by evaluating areas of upwelling outside the study site and "extending" these down into the site.

The same procedure was used to simulate upwelling in Circular Side Channel except that since upwelling was observed from cross-section points 142-148 of transect 1, this width was extended up through the study site in cells that met the previously described criteria.

Weighted usable area projections generated from the HABTAT model runs were entered into a Lotus computer program for graphing. The following graphs were completed:

1) Mainstem discharge versus WUA.
2) Mainstem discharge versus WUA and gross surface area.
3) Site flow versus WUA.
4) Site flow versus WUA and gross surface area.

In addition, time series plots were developed by interfacing a synthesized record of site flows during the 1984 spawning season with the WUA versus site flow function.

Egg Survival and Development

To evaluate viability of the redds and embryo survival and development, chum salmon embryos were periodically excavated by hand, egg pump or freeze core sampling throughout the winter. Embryonic development was determined by identifying the stage of development methods presented in Vining et al. (1985), (Table 7).

Outmigration Occurrence

To evaluate the presence of successful incubation and rearing, fyke nets were placed in Trapper, Sunset, and Circular side channel study sites downstream of the spawning areas. Nets were installed as soon as ice conditions permitted and remained until breaching conditions made sampling impossible. Nets were monitored daily with species and length recorded.

Table 7. Stages of embryonic development for chum salmon identified for use in this study. Stages correspond to information reported for sockeye salmon by Velsen (1980). Table adapted from Vining et al. 1985.

Development Period	Stage Number	Brief Description	Characteristics of Stage: Start	Characteristics of Stage: End
Cleavage	1	all of cleavage	fertilized egg	blastula
Gastrulation	2	embryo formation	terminal caudal bud present	embryo clearly visible
	3	blastopore formation	1/2 epiboly	3/4 epiboly
	4	blastopore closed	blastopore closed	blastopore closed
Organogenesis (early)	5	caudal bud free	caudal bud free from yolk surface	parts of brain visible
	6	initial yolk vascularization	initial vascularization	2/3 yolk vasculariza-tion
	7	eyed	eye pigment visible through egg membrane	3/4 yolk vasculariza-tion
(late)	8	anal fin formation	anal fin faintly visible	anal fin distinct
	9	dorsal fin formation	dorsal fin faintly visible	dorsal fin distinct
	10	pelvic bud formation	pelvic buds faintly visible	pelvic buds distinct
	11	body pigmented	pigment present on dorsum of head	pigment present on dorsum of head and body
Alevin	12	alevin	just hatched	yolk sac completely absorbed; ventral suture remaining

DATA SUMMARY

Habitat Data

Temperature

Upper Trapper Side Channel

The temperature station in Upper Trapper Side Channel was placed in an area of relative high velocity (1-1.5 fps) and was ice-free throughout the winter. Intragravel and surface water temperatures were obtained from November 5, 1984 to April 3, 1985. These data are presented as daily and monthly minimum, mean, and maximum water temperatures (Table 8). From the mean daily temperatures, a plot of intragravel and surface water was developed (Figure 2).

Intragravel water temperatures obtained at this site were relatively stable and were warmer than surface water. Little variation from the time of installation throughout the period of record was exhibited. Intragravel water temperatures ranged from 3.2°C to 3.9°C for the period of record. Surface water temperatures ranged from 1.4°C to a high of 4.0°C.

Lower Trapper Side Channel

The temperature station in Lower Trapper Side Channel was placed in a pool approximately 2.5 feet deep and was ice covered throughout the winter months. Intragravel and surface water temperatures were obtained at this site beginning on November 6, 1984 for surface water and November 19, 1984 for intragravel continuing to April 24, 1985. Two gaps in this temperature record occurred from January 22-27 and March 8-April 2 because of severed probes and a malfunctioning temperature recorder. The daily and monthly minimum, mean, and maximum water temperatures developed from these data are presented in Table 9. A plot of the mean daily intragravel and surface water temperatures is presented in Figure 3.

Intragravel water temperatures in the lower site were also stable. They were warmer than surface water and exhibited little variation. Intragravel water temperatures for the period of record ranged from a low of 3.1°C to a high of 4.2°C. Surface water temperatures fluctuated substantially and ranged from 0.4°C to 3.7°C.

Upper Sunset Side Channel

The temperature station in Upper Sunset Side Channel was placed in a shallow pool approximately .3-.5 feet deep and was ice covered throughout the winter. Intragravel and surface water temperatures were recorded at this site from November 6, 1984 to April 3, 1985. Gaps in the surface water temperature record occurred from November 27 to January 12 because of a malfunctioning data storage module and from March 16 to April 3 due to an ice-severed surface water probe. These temperature data are presented in Tables 10 and 11, with a plot of mean daily intragravel surface water temperatures presented in Figure 4.

Table 8. Datapod temperature recorder data summary: intragravel and surface water temperatures (C) recorded at Upper Trapper Side Channel, RM 96.0.

November 1984						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
841105	3.9	-----	3.9	2.7	-----	3.0
841106	3.8	3.9	3.9	2.6	2.9	3.2
841107	3.8	3.9	3.9	2.5	2.9	3.2
841108	3.8	3.9	3.9	2.5	2.9	3.3
841109	3.8	3.9	3.9	2.5	2.8	3.1
841110	3.8	3.9	3.9	2.5	2.8	3.1
841111	3.8	3.9	3.9	2.3	2.6	3.0
841112	3.8	3.9	3.9	2.3	2.7	3.0
841113	3.8	3.9	3.9	2.4	2.7	3.0
841114	3.8	3.9	3.9	2.4	2.7	3.2
841115	3.8	3.9	3.9	2.7	3.0	3.2
841116	3.8	3.9	3.9	2.6	3.0	3.2
841117	3.8	3.8	3.9	2.5	2.8	3.3
841118	3.8	3.9	3.9	2.7	2.9	3.3
841119	3.8	3.8	3.9	2.5	2.8	3.1
841120	3.8	3.9	3.9	2.6	3.0	3.3
841121	3.8	3.8	3.9	2.8	3.4	3.5
841122	3.8	3.8	3.9	2.7	3.1	3.4
841123	3.8	3.8	3.9	2.9	3.1	3.3
841124	3.8	3.8	3.9	3.0	3.2	3.3
841125	3.8	3.8	3.9	2.9	3.1	3.3
841126	3.8	3.8	3.9	2.5	3.0	3.3
841127	3.8	3.8	3.9	2.5	2.9	3.2
841128	3.8	3.8	3.9	2.8	3.0	3.3
841129	3.8	3.8	3.9	2.8	3.2	3.4
841130	3.8	3.8	3.8	3.0	3.2	3.4
Monthly Value	3.8	3.8	3.9	2.3	2.9	3.5

----- Data not available.

Table 8. (continued).

Date	Intragravel			Surface Water		
December 1984						
	Min	Mean	Max	Min	Mean	Max
841201	3.8	3.8	3.8	3.1	3.3	3.4
841202	3.8	3.8	3.8	3.0	3.2	3.4
841203	3.8	3.8	3.8	3.2	3.4	3.5
841204	3.8	3.8	3.8	3.2	3.4	3.5
841205	3.8	3.8	3.8	3.1	3.4	3.5
841206	3.8	3.8	3.8	2.9	3.3	3.4
841207	3.8	3.8	3.8	3.0	3.3	3.4
841208	3.8	3.8	3.8	2.6	3.2	3.4
841209	3.7	3.8	3.9	2.5	2.9	3.3
841210	3.7	3.8	3.8	2.4	2.7	3.1
841211	3.7	3.8	3.8	2.5	2.8	3.0
841212	3.7	3.8	3.8	2.3	2.7	3.1
841213	3.7	3.8	3.8	2.4	2.6	2.9
841214	3.7	3.8	3.9	2.4	2.7	2.9
841215	3.7	3.8	3.9	2.5	2.7	3.0
841216	3.8	3.8	3.8	2.7	2.9	3.2
841217	3.7	3.8	3.8	2.8	3.0	3.3
841218	3.7	3.8	3.8	2.5	3.0	3.2
841219	3.7	3.8	3.8	2.4	3.0	3.3
841220	3.7	3.7	3.8	2.4	2.7	2.9
841221	3.7	3.7	3.8	2.4	2.8	3.1
841222	3.7	3.8	3.8	2.5	2.8	3.1
841223	3.7	3.8	3.8	1.8	2.3	2.8
841224	3.7	3.7	3.8	1.8	2.2	2.5
841225	3.7	3.7	3.8	2.0	2.3	2.6
841226	3.7	3.8	3.8	1.9	2.4	2.6
841227	3.7	3.7	3.8	1.8	2.0	2.4
841228	3.7	3.7	3.8	1.6	1.9	2.2
841229	3.7	3.7	3.7	1.5	2.0	2.4
841230	3.7	3.8	3.8	1.5	2.1	2.7
841231	3.7	3.7	3.8	2.2	2.9	3.1
Monthly Value	3.7	3.8	3.9	1.5	2.8	3.5

Table 8. (continued).

January 1985						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
850101	3.7	3.7	3.7	3.0	3.1	3.2
850102	3.7	3.7	3.7	2.8	3.1	3.2
850103	3.7	3.7	3.8	2.3	2.6	3.1
850104	3.7	3.7	3.8	2.0	2.4	2.7
850105	3.7	3.7	3.8	2.1	2.6	3.0
850106	3.6	3.7	3.7	1.9	2.2	2.6
850107	3.6	3.7	3.8	2.2	2.6	3.0
850108	3.6	3.7	3.7	2.6	3.0	3.2
850109	3.6	3.7	3.7	2.3	2.9	3.1
850110	3.6	3.7	3.7	2.4	2.8	3.1
850111	3.7	3.7	3.7	2.6	2.9	3.1
850112	3.7	3.7	3.7	2.4	2.9	3.2
850113	3.6	3.7	3.7	2.1	2.4	2.7
850114	3.6	3.7	3.7	2.1	2.6	2.9
850115	3.7	3.7	3.7	2.6	2.8	3.0
850116	3.7	3.7	3.7	2.6	2.9	3.1
850117	3.7	3.7	3.7	2.7	3.0	3.2
850118	3.6	3.7	3.7	2.7	3.0	3.3
850119	3.6	3.7	3.7	2.5	2.8	3.1
850120	3.6	3.7	3.7	2.5	2.9	3.2
850121	3.6	3.7	3.7	2.4	2.8	3.2
850122	3.6	3.7	3.7	2.5	2.8	3.1
850123	3.6	3.7	3.7	2.7	3.0	3.2
850124	3.6	3.7	3.7	2.7	3.0	3.2
850125	3.6	3.6	3.7	2.5	2.9	3.1
850126	3.6	3.6	3.7	2.7	3.0	3.2
850127	3.6	3.7	3.7	2.7	3.0	3.2
850128	3.6	3.6	3.7	2.9	3.1	3.2
850129	3.6	3.6	3.6	2.5	2.9	3.2
850130	3.6	3.6	3.6	2.5	2.9	3.2
850131	3.6	3.6	3.6	2.5	2.9	3.2
Monthly Value	3.6	3.7	3.8	1.9	2.8	3.3

Table 8. (continued).

February 1985						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
850201	3.6	3.6	3.6	2.6	2.9	3.1
850202	3.6	3.6	3.6	2.7	2.9	3.2
850203	3.6	3.6	3.6	2.4	2.7	3.0
850204	3.6	3.6	3.6	2.4	2.7	3.0
850205	3.6	3.6	3.6	2.1	2.7	3.0
850206	3.5	3.6	3.6	2.0	2.4	2.8
850207	3.6	3.6	3.6	2.0	2.4	2.8
850208	3.6	3.6	3.6	2.2	2.5	2.9
850209	3.6	3.6	3.6	1.9	2.3	2.6
850210	3.5	3.6	3.6	1.7	2.1	2.5
850211	3.5	3.6	3.6	1.5	2.0	2.5
850212	3.5	3.6	3.6	1.5	1.9	2.3
850213	3.5	3.6	3.6	1.6	2.0	2.4
850214	3.5	3.6	3.6	1.6	2.0	2.3
850215	3.5	3.6	3.6	1.7	2.0	2.4
850216	3.5	3.6	3.6	1.6	1.9	2.3
850217	3.5	3.6	3.6	1.6	1.9	2.3
850218	3.5	3.6	3.6	1.7	1.9	2.3
850219	3.5	3.5	3.6	1.7	2.0	2.4
850220	3.5	3.5	3.6	1.9	2.1	2.4
850221	3.5	3.5	3.6	1.8	2.1	2.4
850222	3.5	3.5	3.6	1.7	2.0	2.4
850223	3.5	3.5	3.6	1.8	2.0	2.5
850224	3.5	3.5	3.6	2.1	2.3	2.7
850225	3.5	3.5	3.6	2.0	2.4	2.8
850226	3.5	3.5	3.6	1.9	2.4	2.6
850227	3.5	3.5	3.5	1.8	2.5	3.0
850228	3.4	3.5	3.6	1.9	2.5	3.2
Monthly Value	3.4	3.6	3.6	1.5	2.3	3.2

Table 8. (continued).

March 1985						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
850301	3.4	3.5	3.5	1.9	2.2	2.5
850302	3.4	3.5	3.5	2.0	2.5	3.2
850303	3.4	3.5	3.5	1.7	2.2	2.9
850304	3.4	3.5	3.5	1.8	2.3	2.8
850305	3.4	3.4	3.5	1.9	2.5	3.0
850306	3.4	3.4	3.5	1.6	2.4	3.0
850307	3.4	3.4	3.5	1.8	2.5	3.3
850308	3.4	3.4	3.5	1.9	2.5	3.0
850309	3.3	3.4	3.4	2.5	2.7	3.3
850310	3.4	3.4	3.4	2.3	2.7	3.1
850311	3.4	3.4	3.4	2.0	2.4	2.8
850312	3.4	3.4	3.4	2.3	2.7	3.3
850313	3.3	3.4	3.4	2.0	2.6	3.5
850314	3.4	3.4	3.4	1.9	2.3	3.4
850315	3.4	3.4	3.4	1.8	2.3	3.4
850316	3.4	3.4	3.4	1.9	2.5	3.1
850317	3.4	3.4	3.4	2.2	2.5	3.0
850318	3.3	3.4	3.4	1.9	2.6	3.3
850319	3.3	3.4	3.4	2.0	2.6	3.6
850320	3.3	3.4	3.4	2.1	2.7	4.0
850321	3.3	3.4	3.4	2.0	2.6	3.4
850322	3.3	3.4	3.4	1.9	2.5	4.0
850323	3.3	3.3	3.4	1.7	2.5	3.9
850324	3.3	3.3	3.4	2.0	2.5	3.3
850325	3.3	3.3	3.4	1.9	2.6	3.9
850326	3.3	3.3	3.4	1.6	2.4	4.0
850327	3.3	3.3	3.4	1.5	2.4	3.9
850328	3.2	3.3	3.4	1.5	2.4	3.9
850329	3.2	3.3	3.4	1.8	2.5	3.8
850330	3.2	3.3	3.4	1.6	2.3	3.4
850331	3.2	3.3	3.4	1.7	2.2	3.3
Monthly Value	3.2	3.4	3.5	1.5	2.5	4.0

Table 8. (continued).

April 1985						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
850401	3.2	3.3	3.3	1.5	2.0	2.7
850402	3.2	3.3	3.3	1.4	2.1	3.2
850403	3.2	-----	3.3	1.9	-----	2.5
Monthly Value	3.2	-----	3.3	1.4	-----	3.2

----- Data not available.

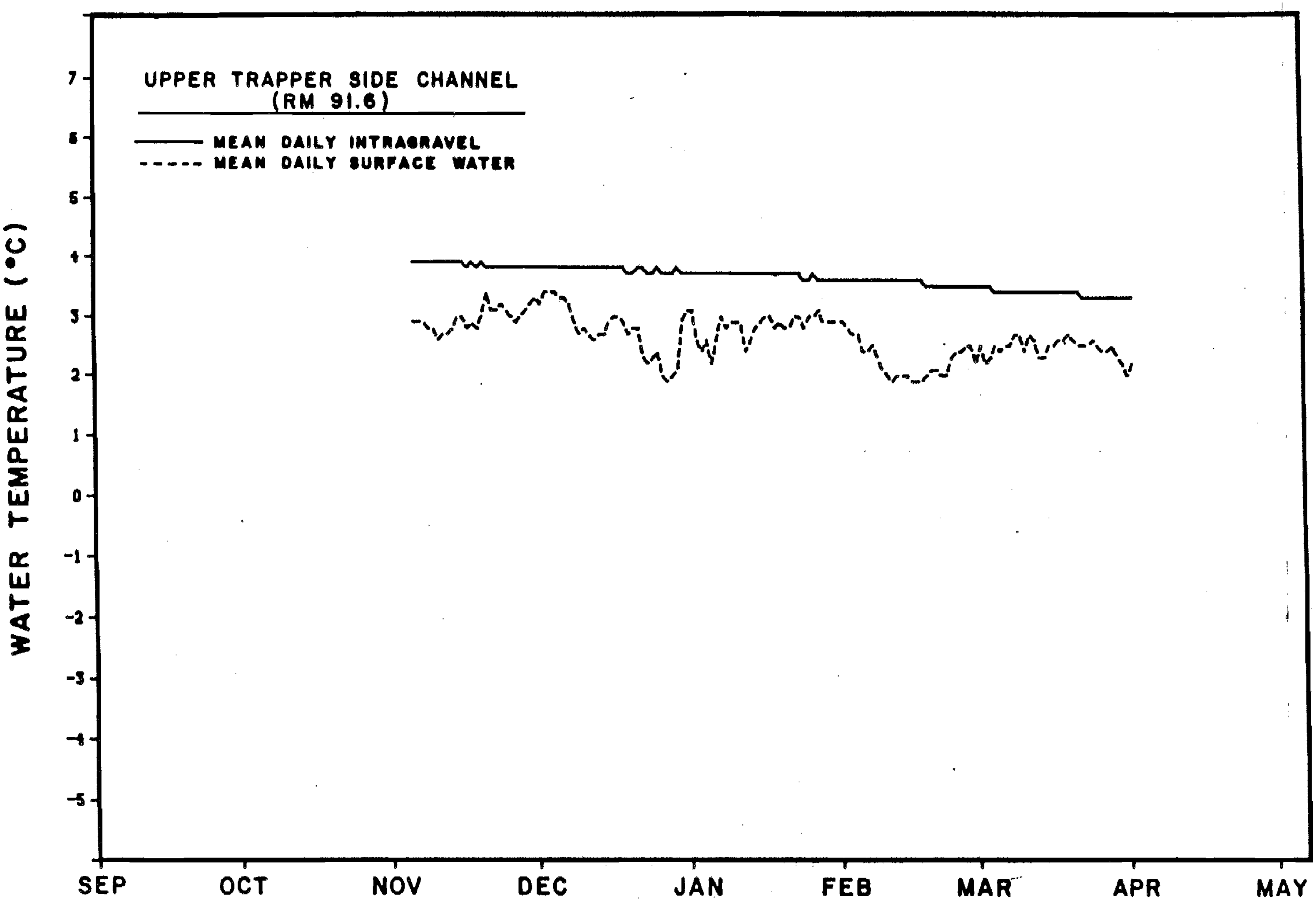


Figure 2. Mean daily intragravel and surface water temperature (°C) recorded at the upper portion of the observed spawning area in Trapper Side Channel.

Table 9. Datapod temperature recorder data summary: intragravel and surface water temperatures (C) recorded at Lower Trapper Side Channel, RM 92.7.

November 1984						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
841106	-----	-----	-----	3.6	-----	3.7
841107	-----	-----	-----	3.6	3.6	3.7
841108	-----	-----	-----	3.5	3.6	3.7
841109	-----	-----	-----	3.6	3.6	3.7
841110	-----	-----	-----	3.6	3.6	3.7
841111	-----	-----	-----	3.6	3.6	3.7
841112	-----	-----	-----	3.6	3.6	3.7
841113	-----	-----	-----	3.6	3.6	3.7
841114	-----	-----	-----	3.6	3.7	3.7
841115	-----	-----	-----	3.6	3.7	3.7
841116	-----	-----	-----	3.6	3.7	3.7
841117	-----	-----	-----	3.6	3.6	3.7
841118	-----	-----	-----	3.6	3.6	3.7
841119	3.5	-----	3.6	2.1	3.5	3.7
841120	3.5	3.6	3.6	1.6	3.3	3.4
841121	3.5	3.6	3.6	1.4	3.2	3.4
841122	3.5	3.6	3.7	1.4	3.0	3.4
841123	3.5	3.5	3.6	1.3	3.1	3.4
841124	3.5	3.6	3.6	1.4	3.0	3.4
841125	3.5	3.6	3.6	1.1	3.0	3.4
841126	3.5	3.6	3.6	1.4	3.1	3.4
841127	3.6	3.6	3.6	1.3	3.1	3.4
841128	3.6	3.6	3.6	1.4	2.8	3.4
841129	3.5	3.6	3.6	1.2	2.9	3.4
841130	3.5	3.6	3.6	1.3	2.8	3.4
Monthly Value	3.5	-----	3.7	1.1	3.4	3.7

----- Data not available.

Table 9. (continued).

December 1984						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
841201	3.6	3.6	3.6	1.3	2.7	3.4
841202	3.6	3.6	3.6	1.2	2.7	3.4
841203	3.6	3.6	3.6	1.4	2.7	3.4
841204	3.6	3.6	3.7	1.3	2.6	3.4
841205	3.6	3.6	3.6	1.1	2.4	3.4
841206	3.6	3.7	3.7	1.1	2.3	3.4
841207	3.6	3.6	3.7	1.2	2.3	3.4
841208	3.6	3.6	3.7	1.1	2.2	3.4
841209	3.6	3.7	3.7	1.3	2.8	3.5
841210	3.6	3.6	3.7	1.2	2.4	3.5
841211	3.6	3.7	3.7	1.3	2.7	3.5
841212	3.6	3.7	3.7	1.7	3.2	3.5
841213	3.7	3.7	3.7	2.0	3.4	3.6
841214	3.7	3.7	3.8	2.3	3.5	3.6
841215	3.7	3.7	3.8	2.4	3.4	3.6
841216	3.7	3.7	3.8	2.1	3.4	3.5
841217	3.7	3.7	3.8	1.1	2.8	3.6
841218	3.7	3.7	3.8	1.3	2.5	3.5
841219	3.7	3.7	3.8	1.1	2.2	3.4
841220	3.7	3.8	3.8	1.2	2.3	3.5
841221	3.7	3.8	3.8	1.1	2.2	3.5
841222	3.7	3.8	3.8	1.1	2.2	3.5
841223	3.7	3.8	3.9	.9	1.8	3.2
841224	3.8	3.9	3.9	.9	1.8	3.5
841225	3.8	3.8	3.9	.7	1.7	3.4
841226	3.8	3.9	3.9	.7	1.5	3.1
841227	3.8	3.9	3.9	.8	1.5	3.2
841228	3.9	3.9	4.0	.8	1.7	3.3
841229	3.9	3.9	4.0	.8	1.6	3.4
841230	3.8	3.9	3.9	.5	1.3	3.0
841231	3.9	3.9	4.0	.5	1.1	2.3
Monthly Value	3.6	3.7	4.0	.5	2.4	3.6

Table 9. (continued).

January 1985						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
850101	3.9	4.0	4.0	.6	0.0	2.3
850102	4.0	4.0	4.0	.5	1.0	2.2
850103	3.9	4.0	4.0	.5	1.0	2.3
850104	4.0	4.0	4.0	.5	1.1	2.7
850105	4.0	4.0	4.1	.5	1.0	2.1
850106	4.0	4.0	4.1	.5	1.1	2.5
850107	4.0	4.0	4.1	.6	1.1	2.5
850108	4.0	4.1	4.1	.5	1.1	2.2
850109	4.0	4.1	4.1	.5	1.1	2.7
850110	4.0	4.1	4.1	.6	1.1	2.3
850111	4.0	4.1	4.1	.5	1.1	2.6
850112	4.0	4.1	4.2	.5	1.1	3.3
850113	4.0	4.1	4.2	.6	1.2	2.7
850114	4.1	4.1	4.1	.5	1.1	2.9
850115	4.1	4.1	4.2	.5	0.0	2.4
850116	4.1	4.1	4.2	.5	.9	2.0
850117	4.1	4.1	4.2	.4	.8	1.8
850118	4.1	4.1	4.2	.4	.8	2.1
850119	4.1	4.1	4.2	.4	.9	2.2
850120	4.1	4.2	4.2	.5	.9	2.1
850121	4.1	-----	4.2	.5	-----	2.6
850128	3.5	-----	3.6	.9	-----	1.5
850129	3.5	3.5	3.6	.9	1.2	1.9
850130	3.5	3.5	3.6	.8	1.3	1.9
850131	3.5	3.5	3.6	.7	1.1	1.7
Monthly Value	3.5	4.0	4.2	.4	1.0	3.3

----- Data not available.

Table 9. (continued).

February 1985						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
850201	3.5	3.5	3.6	.5	1.4	1.9
850202	3.5	3.5	3.6	1.0	1.5	2.0
850203	3.5	3.6	3.6	.5	1.4	2.1
850204	3.5	3.5	3.5	.7	1.2	1.8
850205	3.5	3.5	3.6	.8	1.4	1.9
850206	3.5	3.5	3.7	.7	1.9	3.4
850207	3.5	3.5	3.6	1.4	2.0	2.4
850208	3.5	3.5	3.6	.8	2.1	2.5
850209	3.5	3.5	3.6	1.7	2.4	2.6
850210	3.5	3.6	3.6	1.8	2.5	2.8
850211	3.5	3.5	3.6	1.9	2.7	2.9
850212	3.5	3.6	3.7	2.5	2.7	3.0
850213	3.5	3.6	3.7	2.7	2.9	3.1
850214	3.5	3.6	3.7	2.6	3.0	3.1
850215	3.6	3.7	3.7	2.5	3.1	3.3
850216	3.6	3.7	3.8	2.7	3.0	3.2
850217	3.6	3.7	3.8	2.8	3.1	3.3
850218	3.7	3.7	3.8	2.8	3.2	3.4
850219	3.7	3.8	3.8	3.1	3.4	3.5
850220	3.7	3.8	3.9	3.1	3.5	3.7
850221	3.7	3.8	3.9	3.1	3.5	3.6
850222	3.7	3.8	3.9	2.4	3.4	3.5
850223	3.8	3.8	3.9	2.7	3.4	3.6
850224	3.7	3.8	3.8	2.8	3.4	3.5
850225	3.7	3.8	3.8	3.0	3.3	3.4
850226	3.7	3.8	3.8	2.9	3.2	3.4
850227	3.6	3.7	3.8	2.5	3.0	3.4
850228	3.6	3.7	3.7	2.1	2.9	3.2
Monthly Value	3.5	3.7	3.9	.5	2.7	3.7

Table 9. (continued).

March 1985						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
850301	3.6	3.7	3.7	2.2	2.7	3.0
850302	3.6	3.6	3.7	1.1	2.2	2.8
850303	3.5	3.6	3.7	1.1	2.0	2.6
850304	3.5	3.6	3.7	1.0	1.9	2.6
850305	3.5	3.5	3.6	.9	1.7	2.5
850306	3.5	3.5	3.5	.6	1.5	2.2
850307	3.5	3.5	3.6	.7	1.4	2.3
Monthly Value	3.5	-----	3.7	.6	-----	3.0

----- Data not available.

Table 9. (continued).

April 1985						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
850403	3.2	-----	3.3	1.6	-----	2.5
850404	3.2	3.2	3.2	1.7	2.3	2.5
850405	3.1	3.2	3.3	1.8	2.4	2.8
850406	3.1	3.2	3.3	1.5	2.4	2.8
850407	3.1	3.2	3.2	2.0	2.4	2.7
850408	3.1	3.2	3.2	1.6	2.3	2.6
850409	3.1	3.2	3.2	1.7	2.3	2.7
850410	3.1	3.2	3.3	1.6	2.4	2.8
850411	3.1	3.2	3.3	1.7	2.5	2.9
850412	3.1	3.2	3.3	1.7	2.5	2.9
850413	3.1	3.2	3.2	1.9	2.5	2.7
850414	3.2	3.2	3.3	2.0	2.6	2.9
850415	3.2	3.2	3.3	2.3	2.5	2.8
850416	3.2	3.2	3.3	2.2	2.5	2.7
850417	3.2	3.2	3.3	2.2	2.5	2.7
850418	3.2	3.2	3.3	2.2	2.5	3.0
850419	3.2	3.2	3.3	1.8	2.5	2.7
850420	3.2	3.2	3.3	1.7	2.5	2.8
850421	3.2	3.2	3.3	1.7	2.6	3.0
850422	3.2	3.3	3.3	2.3	2.7	3.4
850423	3.2	3.3	3.3	2.2	2.7	3.4
850424	3.2	-----	3.4	1.8	-----	2.7
Monthly Value	3.1	3.2	3.4	1.5	2.5	3.4

----- Data not available.

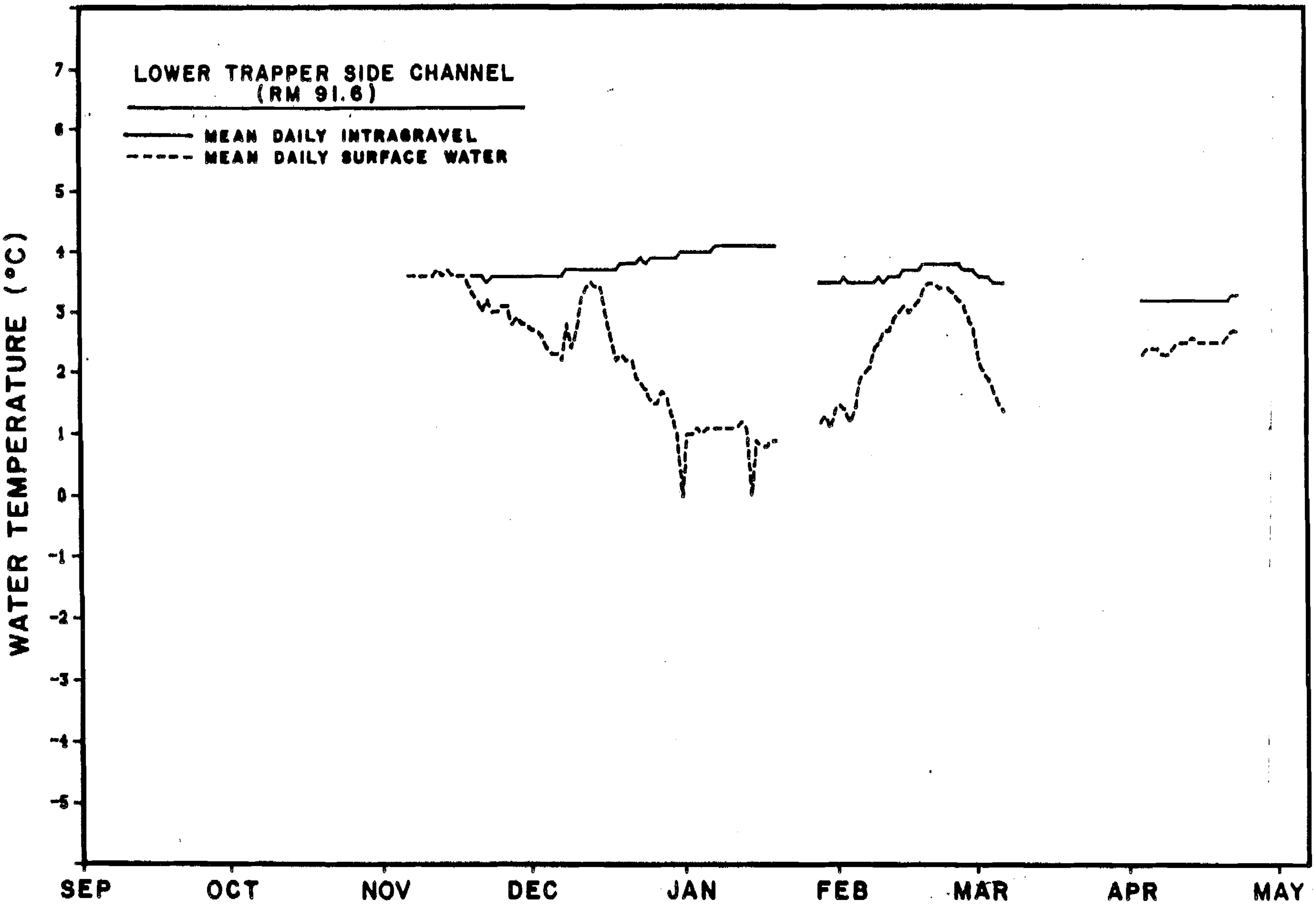


Figure 3. Mean daily intragravel and surface water temperatures (^{0}C) recorded at the lower portion of the observed spawning area in Trapper Side Channel.

Table 10. Datapod temperature recorder data summary: intragravel and surface water temperatures (C) recorded at Upper Sunset Side Channel, RM 86.9.

November 1984						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
841106	3.4	-----	3.5	.1	-----	.3
841107	3.4	3.5	3.5	.1	.2	.2
841108	3.4	3.5	3.5	0.0	.1	.2
841109	3.4	3.5	3.5	0.0	.1	.1
841110	3.4	3.4	3.5	0.0	-----	.1
841111	3.3	3.4	3.5	*****	*****	*****
841112	3.3	3.4	3.4	*****	*****	*****
841113	3.3	3.4	3.4	*****	*****	*****
841114	3.2	3.3	3.4	*****	*****	*****
841115	3.2	3.2	3.3	*****	*****	*****
841116	3.1	3.2	3.3	*****	*****	*****
841117	3.1	3.2	3.2	*****	*****	*****
841118	3.2	3.2	3.3	*****	*****	*****
841119	3.2	3.2	3.3	*****	*****	*****
841120	3.2	3.2	3.3	*****	*****	*****
841121	3.2	3.3	3.3	0.0	.5	1.1
841122	3.2	3.3	3.4	-0.2	-----	1.0
841123	3.3	3.3	3.4	-0.2	-0.2	-0.1
841124	3.3	3.3	3.4	-0.2	-0.1	-0.1
841125	3.3	3.3	3.4	-0.2	-0.1	-0.1
841126	3.3	3.3	3.4	-0.2	-----	-0.1
841127	3.3	3.3	3.4	-----	-----	-----
841128	3.3	3.3	3.4	-----	-----	-----
841129	3.3	3.3	3.4	-----	-----	-----
841130	3.3	3.3	3.4	-----	-----	-----
Monthly Value	3.1	3.3	3.5	-0.2	-----	1.1

----- Data not available.
***** Site frozen, data available in Table 6.

Table 10. (continued).

Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
December 1984						
841201	3.3	3.4	3.4	-----	-----	-----
841202	3.3	3.4	3.4	-----	-----	-----
841203	3.3	3.4	3.4	-----	-----	-----
841204	3.3	3.4	3.4	-----	-----	-----
841205	3.4	3.4	3.4	-----	-----	-----
841206	3.3	3.4	3.4	-----	-----	-----
841207	3.3	3.4	3.4	-----	-----	-----
841208	3.3	3.3	3.4	-----	-----	-----
841209	3.3	3.3	3.4	-----	-----	-----
841210	3.3	3.3	3.4	-----	-----	-----
841211	3.2	3.3	3.4	-----	-----	-----
841212	3.2	3.3	3.4	-----	-----	-----
841213	3.2	3.3	3.3	-----	-----	-----
841214	3.2	3.3	3.3	-----	-----	-----
841215	3.2	3.2	3.3	-----	-----	-----
841216	3.2	3.3	3.3	-----	-----	-----
841217	3.2	3.3	3.3	-----	-----	-----
841218	3.2	3.3	3.3	-----	-----	-----
841219	3.2	3.2	3.3	-----	-----	-----
841220	3.2	3.2	3.3	-----	-----	-----
841221	3.2	3.2	3.3	-----	-----	-----
841222	3.2	3.2	3.3	-----	-----	-----
841223	3.1	3.2	3.2	-----	-----	-----
841224	3.1	3.2	3.2	-----	-----	-----
841225	3.1	3.2	3.2	-----	-----	-----
841226	3.1	3.1	3.2	-----	-----	-----
841227	3.1	3.1	3.2	-----	-----	-----
841228	3.1	3.2	3.2	-----	-----	-----
841229	3.1	3.2	3.2	-----	-----	-----
841230	3.1	3.1	3.2	-----	-----	-----
841231	3.1	3.1	3.2	-----	-----	-----
Monthly Value	3.1	3.3	3.4	-----	-----	-----

----- Data not available.

Table 10 (continued).

January 1985						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
850101	3.1	3.1	3.2	-----	-----	-----
850102	3.1	3.1	3.2	-----	-----	-----
850103	3.1	3.1	3.2	-----	-----	-----
850104	3.1	3.2	3.2	-----	-----	-----
850105	3.1	3.1	3.2	-----	-----	-----
850106	3.1	3.2	3.2	-----	-----	-----
850107	3.1	3.2	3.2	-----	-----	-----
850108	3.1	3.2	3.2	-----	-----	-----
850109	3.1	3.1	3.2	-----	-----	-----
850110	3.1	3.2	3.2	-----	-----	-----
850111	3.1	3.1	3.2	-----	-----	-----
850112	3.0	3.1	3.1	1.9	2.3	2.5
850113	3.0	3.0	3.1	2.1	2.4	2.5
850114	3.0	3.0	3.1	2.3	2.5	2.6
850115	3.0	3.0	3.1	2.3	2.5	2.6
850116	3.0	3.0	3.1	1.2	2.4	2.6
850117	3.0	3.0	3.1	2.1	2.3	2.5
850118	3.0	3.0	3.1	2.4	2.5	2.7
850119	3.0	3.0	3.1	2.5	2.6	2.7
850120	3.0	3.0	3.1	2.3	2.7	2.7
850121	3.0	3.0	3.1	2.2	2.7	2.7
850122	3.0	3.0	3.1	2.4	2.6	2.7
850123	3.0	3.0	3.1	2.6	2.6	2.7
850124	3.0	3.0	3.1	2.6	2.6	2.7
850125	3.0	3.0	3.1	2.5	2.6	2.7
850126	3.0	3.0	3.1	1.9	2.6	2.6
850127	3.0	3.0	3.1	1.8	2.5	2.6
850128	3.0	3.0	3.1	2.4	2.5	2.6
850129	3.0	3.0	3.1	2.3	2.4	2.5
850130	3.0	3.0	3.1	2.2	2.4	2.5
850131	2.9	3.0	3.0	1.6	1.9	2.4
Monthly Value	2.9	3.1	3.2	1.2	2.5	2.7

----- Data not available.

Table 10 (continued).

February 1985						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
850201	2.9	3.0	3.0	1.7	1.7	1.8
850202	2.9	3.0	3.0	1.7	1.8	1.9
850203	3.0	3.0	3.0	1.3	1.6	1.9
850204	2.9	3.0	3.0	1.6	1.9	2.0
850205	2.9	3.0	3.1	2.0	2.0	2.2
850206	2.9	3.0	3.1	1.9	2.2	2.3
850207	2.9	3.0	3.0	2.0	2.2	2.3
850208	2.9	3.0	3.0	2.0	2.1	2.2
850209	2.9	3.0	3.0	1.9	2.1	2.2
850210	2.9	3.0	3.0	1.8	2.0	2.1
850211	2.8	2.9	3.0	1.7	1.7	1.9
850212	2.8	2.9	2.9	1.6	1.7	1.8
850213	2.8	2.9	2.9	1.6	1.7	1.9
850214	2.8	2.9	3.0	1.7	1.9	2.0
850215	2.8	2.9	2.9	1.8	1.9	2.0
850216	2.8	2.9	3.0	1.8	1.9	2.0
850217	2.8	2.9	2.9	1.8	1.9	2.0
850218	2.8	2.8	2.9	1.8	1.9	2.0
850219	2.8	2.8	2.9	1.7	1.8	1.9
850220	2.7	2.8	2.8	1.7	1.7	1.7
850221	2.7	2.8	2.8	1.6	1.7	1.7
850222	2.7	2.7	2.8	1.5	1.6	1.7
850223	2.6	2.7	2.7	1.5	1.6	1.7
850224	2.6	2.6	2.7	1.6	1.6	1.8
850225	2.5	2.6	2.7	1.7	1.8	1.9
850226	2.6	2.6	2.6	1.8	1.9	1.9
850227	2.6	2.6	2.7	1.7	1.7	1.9
850228	2.6	2.6	2.6	1.7	1.7	1.8
Monthly Value	2.5	2.8	3.1	1.3	1.8	2.3

Table 10 (continued).

March 1985						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
850301	2.6	2.7	2.7	1.6	1.7	1.8
850302	2.6	2.7	2.7	1.6	1.7	1.7
850303	2.6	2.7	2.7	1.7	1.7	1.8
850304	2.7	2.7	2.8	1.7	1.8	1.9
850305	2.7	2.8	2.8	1.8	1.9	1.9
850306	2.8	2.8	2.8	1.6	1.8	1.9
850307	2.8	2.8	2.8	1.6	1.8	1.9
850308	2.8	2.8	2.8	1.5	1.7	2.0
850309	2.8	2.8	2.8	1.7	2.0	2.0
850310	2.8	2.8	2.8	2.0	2.0	2.1
850311	2.8	2.8	2.8	1.9	2.1	2.2
850312	2.8	2.8	2.8	2.0	2.2	2.2
850313	2.8	2.8	2.8	1.8	1.9	2.0
850314	2.7	2.8	2.8	1.7	1.7	1.8
850315	2.7	2.7	2.8	.9	1.3	1.8
850316	2.6	2.6	2.7	-----	-----	-----
850317	2.6	2.6	2.6	-----	-----	-----
850318	2.6	2.7	2.7	-----	-----	-----
850319	2.7	2.7	2.7	-----	-----	-----
850320	2.7	2.7	2.8	-----	-----	-----
850321	2.7	2.7	2.8	-----	-----	-----
850322	2.7	2.7	2.8	-----	-----	-----
850323	2.7	2.8	2.8	-----	-----	-----
850324	2.7	2.8	2.8	-----	-----	-----
850325	2.8	2.8	2.8	-----	-----	-----
850326	2.8	2.8	2.8	-----	-----	-----
850327	2.8	2.8	2.9	-----	-----	-----
850328	2.8	2.8	2.8	-----	-----	-----
850329	2.8	2.8	2.9	-----	-----	-----
850330	2.8	2.8	2.8	-----	-----	-----
850331	2.8	2.8	2.9	-----	-----	-----
Monthly Value	2.6	2.8	2.9	.9	-----	2.2

----- Data not available.

Table 10 (continued).

Date	Intragravel			Surface Water		
April 1985						
	Min	Mean	Max	Min	Mean	Max
850401	2.8	2.8	2.8	-----	-----	-----
850402	2.7	2.8	2.8	-----	-----	-----
850403	2.7	-----	2.8	-----	-----	-----
Monthly Value	2.7	-----	2.8	-----	-----	-----

----- Data not available.

Table 11 Datapod temperature recorder data summary: intragravel and surface water temperatures (C) recorded at Upper Sunset Side Channel when the site was frozen, RM 86.9.

November 1984 (Site frozen)						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
841110	+++++	+++++	+++++	-0.7	-0.3	0.0
841111	+++++	+++++	+++++	-1.7	-1.3	-0.7
841112	+++++	+++++	+++++	-2.4	-2.0	-1.6
841113	+++++	+++++	+++++	-2.9	-2.5	-2.0
841114	+++++	+++++	+++++	-3.1	-2.5	-1.7
841115	+++++	+++++	+++++	-1.8	-1.2	-0.8
841116	+++++	+++++	+++++	-0.8	-0.5	-0.3
841117	+++++	+++++	+++++	-0.8	-0.7	-0.5
841118	+++++	+++++	+++++	-0.6	-0.5	-0.4
841119	+++++	+++++	+++++	-0.8	-0.7	-0.5
841120	+++++	+++++	+++++	-0.6	-0.3	0.0
Monthly Value	+++++	+++++	+++++	-3.1	-----	0.0

----- Data not available.
+++++ Data available; site not frozen.

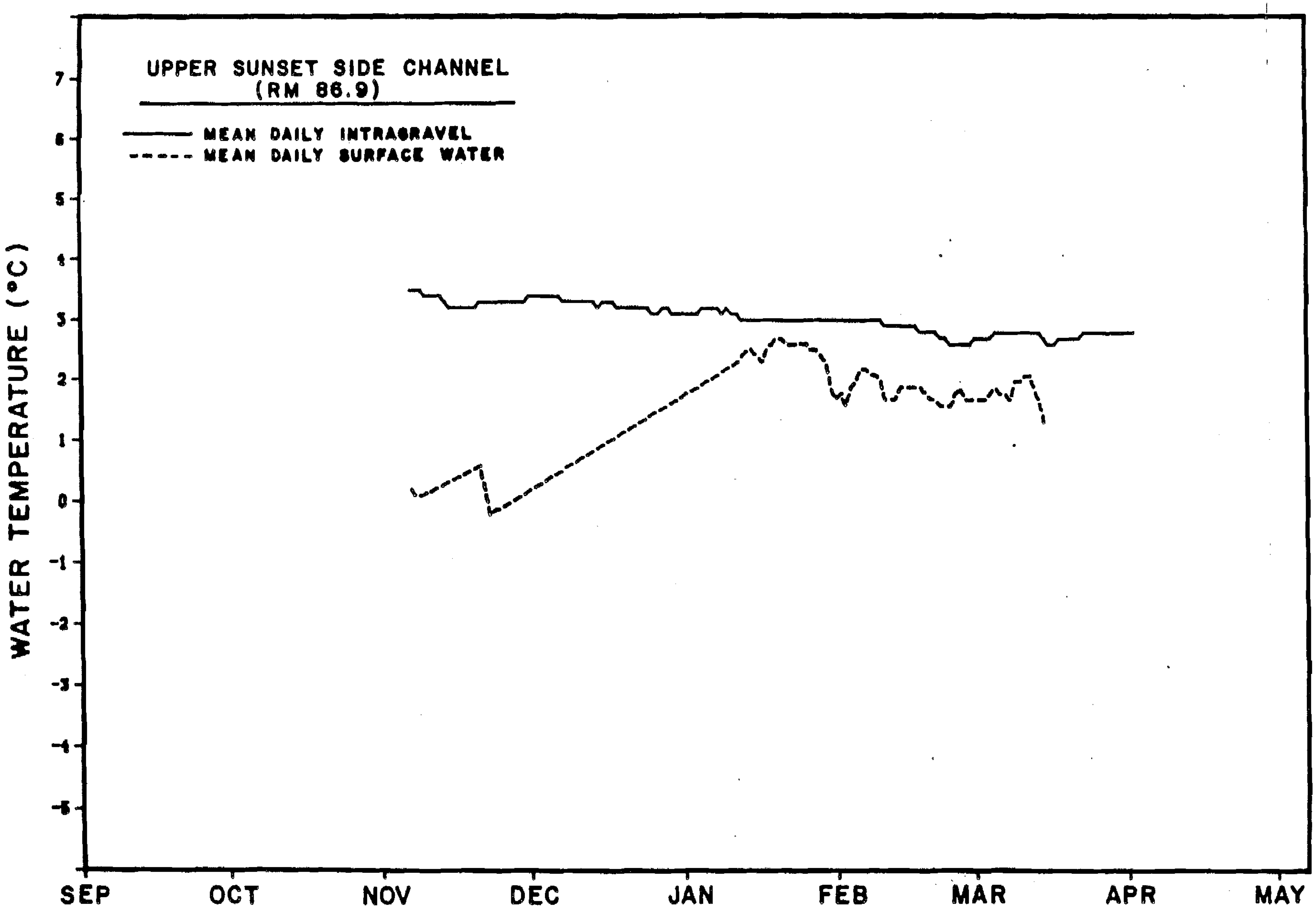


Figure 4. Mean daily intragravel and surface water temperatures (°C) recorded at the upper portion of the observed spawning area in Sunset Side Channel.

Intragravel water temperatures at this site had little variation through the period of record with water temperatures ranging from 2.5°C to 3.5°C. The record for surface water temperatures was most continuous from November 21 to March 15. For this time period, surface water temperatures ranged from 0.9°C to 2.7°C. From November 10 to November 20 temperatures recorded from the surface water probe ranged from -3.1°C to 0.0°C although institial surface water was observed not to be frozen. These low surface water temperatures resulted from the probe becoming embedded in the surface ice. Intragravel water temperatures corresponding to this time ranged from 3.1°C to 3.5°C.

Lower Sunset Side Channel

The temperature station in Lower Sunset Side Channel was placed in a pool approximately 3 feet deep with ice cover. Intragravel and surface water temperatures at this site were obtained from November 6, 1984 to April 3, 1985. Daily and monthly minimum, mean, and maximum water temperatures developed from the sites are presented in Table 12. A plot of mean, daily intragravel and surface water temperatures is presented in Figure 5.

Intragravel water temperatures were found to be similar to those in the upper portion of the side channel and ranged from 2.1°C to 3.3°C for the entire period of record. Intragravel water temperatures were warmer than surface water until mid-March at which time mean daily surface water temperatures slightly exceeded those of intragravel. Surface water temperatures ranged from 0.2°C to 3.1°C for the period of record.

Upper Circular Side Channel

The continuous temperature station in Upper Circular Side Channel was placed in a pool of approximately 1 foot deep with ice cover. Intragravel and surface water temperatures at this site were recorded from November 6, 1984 to April 3, 1985. These data are presented in Table 13 as daily and monthly minimum, mean and maximum water temperatures. Also a plot of the mean, daily intragravel and surface water temperatures was developed and is presented in Figure 6. Intragravel water temperatures were found to be generally warmer than surface water at this site. Intragravel water temperatures ranged from -0.2°C to 4.0°C. Surface water ranged from -0.1°C to 3.8°C.

Lower Circular Side Channel

The temperature station located in Lower Circular Side Channel was placed in a pool of approximately 3 feet deep with ice cover throughout the winter. Intragravel and surface water temperatures at this site were taken from November 6, 1984 to April 24, 1985. Gaps in the data occurred in the intragravel water temperature record from November 10 to November 30, due to shearing of the intragravel probe. For both intragravel and surface water temperatures, a data gap occurred from February 10 to March 6, due to a malfunctioning temperature recorder. Daily and monthly minimum, mean and maximum water temperatures were developed from these data (Table 14). A plot of the mean, daily intragravel and surface water temperatures is presented in Figure 7.

Table 12 Datapod temperature recorder data summary: intragravel and surface water temperatures (C) recorded at Lower Sunset Side Channel, RM 86.9.

November 1984						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
841106	3.2	-----	3.3	1.3	-----	3.0
841107	3.2	3.2	3.3	1.1	1.9	2.7
841108	3.2	3.3	3.3	.8	1.5	2.9
841109	3.2	3.3	3.3	.8	1.3	2.1
841110	3.1	3.2	3.3	.7	1.2	2.1
841111	3.1	3.1	3.2	.4	.8	1.8
841112	2.7	2.9	3.1	.2	.4	.8
841113	2.5	2.6	2.7	.2	.5	.8
841114	2.6	2.7	2.8	.2	.6	1.2
841115	2.7	2.8	3.0	.6	1.1	1.7
841116	2.9	3.1	3.2	1.1	1.7	2.7
841117	3.1	3.2	3.2	1.1	1.5	2.8
841118	3.1	3.1	3.2	1.0	2.1	2.8
841119	3.2	3.2	3.3	1.2	2.1	2.8
841120	3.2	3.2	3.3	1.3	2.5	2.8
841121	3.2	3.2	3.2	1.4	2.4	2.8
841122	3.2	3.2	3.3	1.1	1.8	2.9
841123	3.1	3.1	3.2	.9	1.9	2.7
841124	3.1	3.2	3.3	1.0	2.2	2.9
841125	3.2	3.2	3.3	1.2	2.5	2.9
841126	3.2	3.3	3.3	1.1	2.0	2.9
841127	3.2	3.3	3.3	1.2	2.2	2.9
841128	3.2	3.3	3.3	1.5	2.2	2.9
841129	3.2	3.3	3.3	1.1	2.5	2.9
841130	3.2	3.3	3.3	1.2	2.6	2.9
Monthly Value	2.5	3.1	3.3	.2	1.7	3.0

----- Data not available.

Table 12 (continued).

December 1984						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
841201	3.2	3.3	3.3	1.8	2.4	2.9
841202	3.2	3.2	3.3	1.4	2.6	2.9
841203	3.2	3.2	3.3	1.7	2.9	2.9
841204	3.2	3.2	3.2	2.4	2.8	2.9
841205	3.2	3.2	3.3	1.5	2.8	2.9
841206	3.2	3.2	3.3	1.8	2.8	2.9
841207	3.2	3.2	3.3	2.1	2.8	2.9
841208	3.2	3.2	3.3	1.7	2.4	2.9
841209	3.2	3.3	3.3	1.4	2.5	2.9
841210	3.2	3.2	3.3	1.4	2.7	2.8
841211	3.2	3.2	3.3	1.9	2.7	2.8
841212	3.1	3.2	3.2	1.0	2.5	2.8
841213	3.1	3.2	3.2	1.1	2.0	2.7
841214	3.1	3.2	3.2	1.2	2.4	2.7
841215	3.1	3.1	3.2	1.4	2.5	2.7
841216	3.1	3.1	3.1	1.7	2.5	2.7
841217	3.1	3.1	3.2	1.6	2.5	2.6
841218	3.1	3.1	3.1	1.7	2.5	2.6
841219	3.1	3.1	3.2	2.2	2.6	2.7
841220	3.1	3.2	3.2	2.5	2.6	2.7
841221	3.1	3.1	3.2	.9	2.6	2.7
841222	3.0	3.1	3.1	1.8	2.6	2.6
841223	3.0	3.0	3.1	1.7	2.5	2.6
841224	3.0	3.1	3.1	1.9	2.5	2.6
841225	3.0	3.0	3.1	.6	2.5	2.6
841226	3.0	3.1	3.1	1.8	2.6	2.6
841227	3.0	3.0	3.1	.8	2.5	2.6
841228	2.9	3.0	3.0	.4	2.0	2.5
841229	2.9	2.9	3.0	.7	2.1	2.5
841230	2.9	2.9	3.0	.8	2.3	2.5
841231	2.9	2.9	3.0	1.5	2.4	2.5
Monthly Value	2.9	3.1	3.3	.4	2.5	2.9

Table12. (continued).

January 1985						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
850101	2.9	2.9	3.0	2.1	2.5	2.5
850102	2.9	3.0	3.0	.8	2.5	2.5
850103	3.0	3.0	3.0	2.1	2.5	2.6
850104	3.0	3.0	3.0	2.1	2.5	2.6
850105	3.0	3.0	3.0	2.5	2.5	2.6
850106	3.0	3.0	3.0	2.4	2.5	2.6
850107	2.9	3.0	3.0	2.4	2.5	2.6
850108	2.9	3.0	3.0	2.4	2.5	2.6
850109	3.0	3.0	3.0	1.8	2.5	2.6
850110	2.9	3.0	3.1	2.4	2.5	2.6
850111	2.9	3.0	3.0	2.4	2.5	2.6
850112	2.9	3.0	3.1	2.4	2.5	2.6
850113	2.9	3.0	3.0	1.5	2.5	2.6
850114	2.9	2.9	2.9	1.5	2.4	2.5
850115	2.9	2.9	2.9	1.1	2.4	2.5
850116	2.9	2.9	2.9	1.6	2.4	2.5
850117	2.9	2.9	2.9	2.2	2.5	2.5
850118	2.9	2.9	3.0	2.4	2.5	2.5
850119	2.9	3.0	3.0	1.7	2.5	2.6
850120	2.9	3.0	3.0	1.7	2.5	2.6
850121	2.9	3.0	3.0	2.0	2.5	2.6
850122	2.9	2.9	3.0	2.5	2.5	2.6
850123	2.9	2.9	3.0	2.2	2.5	2.6
850124	2.9	2.9	3.0	2.1	2.5	2.6
850125	2.9	2.9	3.0	2.3	2.5	2.6
850126	2.9	3.0	3.0	2.5	2.5	2.6
850127	2.9	2.9	3.0	.5	2.5	2.6
850128	2.9	2.9	3.0	1.8	2.4	2.5
850129	2.9	2.9	3.0	1.9	2.3	2.5
850130	2.8	2.9	3.0	1.5	2.2	2.4
850131	2.9	2.9	3.0	2.0	2.2	2.4
Monthly Value	2.8	3.0	3.1	.5	2.5	2.6

Table 12. (continued).

February 1985						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
850201	2.9	2.9	3.0	1.8	2.0	2.1
850202	2.9	2.9	3.0	2.0	2.1	2.3
850203	2.8	2.9	3.0	1.9	2.1	2.4
850204	2.9	2.9	3.0	2.0	2.0	2.1
850205	2.8	2.9	3.0	1.9	2.0	2.1
850206	2.8	2.9	3.0	1.8	2.0	2.2
850207	2.8	2.8	2.9	1.7	1.9	2.1
850208	2.8	2.8	2.9	1.8	2.0	2.3
850209	2.7	2.8	2.8	1.7	1.9	2.1
850210	2.7	2.8	2.8	1.7	1.9	2.0
850211	2.7	2.8	2.8	1.8	2.0	2.1
850212	2.7	2.8	2.8	1.8	1.9	2.0
850213	2.7	2.8	2.9	1.8	2.0	2.1
850214	2.7	2.8	2.9	1.9	2.0	2.2
850215	2.7	2.7	2.8	1.8	1.9	2.0
850216	2.6	2.7	2.8	1.8	1.9	1.9
850217	2.6	2.6	2.7	1.7	1.8	1.9
850218	2.5	2.6	2.7	1.5	1.7	1.8
850219	2.4	2.5	2.6	1.3	1.5	1.7
850220	2.3	2.5	2.5	1.1	1.2	1.4
850221	2.3	2.4	2.5	.9	1.1	1.2
850222	2.2	2.4	2.4	.7	.9	1.0
850223	2.2	2.3	2.4	.5	.7	.8
850224	2.1	2.2	2.3	.5	.7	.9
850225	2.1	2.1	2.2	.8	1.2	1.4
850226	2.1	2.2	2.2	1.3	1.5	1.7
850227	2.1	2.2	2.2	1.5	1.6	1.8
850228	2.2	2.2	2.3	1.6	1.8	1.9
Monthly Value	2.1	2.6	3.0	.5	1.7	2.4

Table 12 (continued).

March 1985						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
850301	2.2	2.3	2.3	1.8	2.0	2.1
850302	2.2	2.3	2.4	1.8	2.1	2.2
850303	2.3	2.3	2.4	1.9	2.1	2.2
850304	2.3	2.3	2.4	2.0	2.2	2.3
850305	2.3	2.3	2.4	2.1	2.3	2.3
850306	2.2	2.3	2.4	2.0	2.2	2.4
850307	2.2	2.3	2.4	1.8	2.1	2.3
850308	2.3	2.3	2.4	1.9	2.2	2.4
850309	2.3	2.4	2.5	2.1	2.4	2.5
850310	2.4	2.4	2.5	2.3	2.5	2.6
850311	2.4	2.4	2.5	2.2	2.5	2.6
850312	2.4	2.5	2.5	2.3	2.5	2.6
850313	2.4	2.5	2.5	2.3	2.5	2.6
850314	2.4	2.5	2.6	2.3	2.5	2.7
850315	2.4	2.5	2.6	2.2	2.5	2.7
850316	2.5	2.5	2.6	2.4	2.7	2.8
850317	2.5	2.6	2.6	2.4	2.7	2.8
850318	2.5	2.6	2.6	2.4	2.7	2.7
850319	2.5	2.6	2.7	2.3	2.7	2.8
850320	2.6	2.6	2.7	2.5	2.8	2.9
850321	2.6	2.7	2.7	2.4	2.7	2.9
850322	2.6	2.7	2.7	2.4	2.8	3.0
850323	2.6	2.7	2.7	2.5	2.8	3.0
850324	2.6	2.7	2.7	2.6	2.9	3.0
850325	2.6	2.7	2.8	2.6	2.9	3.1
850326	2.6	2.7	2.7	2.5	2.8	3.0
850327	2.6	2.7	2.7	2.2	2.8	3.0
850328	2.5	2.7	2.7	2.2	2.7	3.0
850329	2.6	2.7	2.7	2.6	2.9	3.0
850330	2.6	2.7	2.8	2.4	2.9	3.1
850331	2.4	2.6	2.7	2.1	2.6	3.0
Monthly Value	2.2	2.5	2.8	1.8	2.5	3.1

Table 12 (continued).

April 1985						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
850401	2.4	2.5	2.6	2.2	2.7	2.9
850402	2.4	2.5	2.5	2.2	2.7	2.7
850403	2.4	-----	2.4	2.3	-----	2.6
Monthly Value	2.4	-----	2.6	2.2	-----	2.9

----- Data not available.

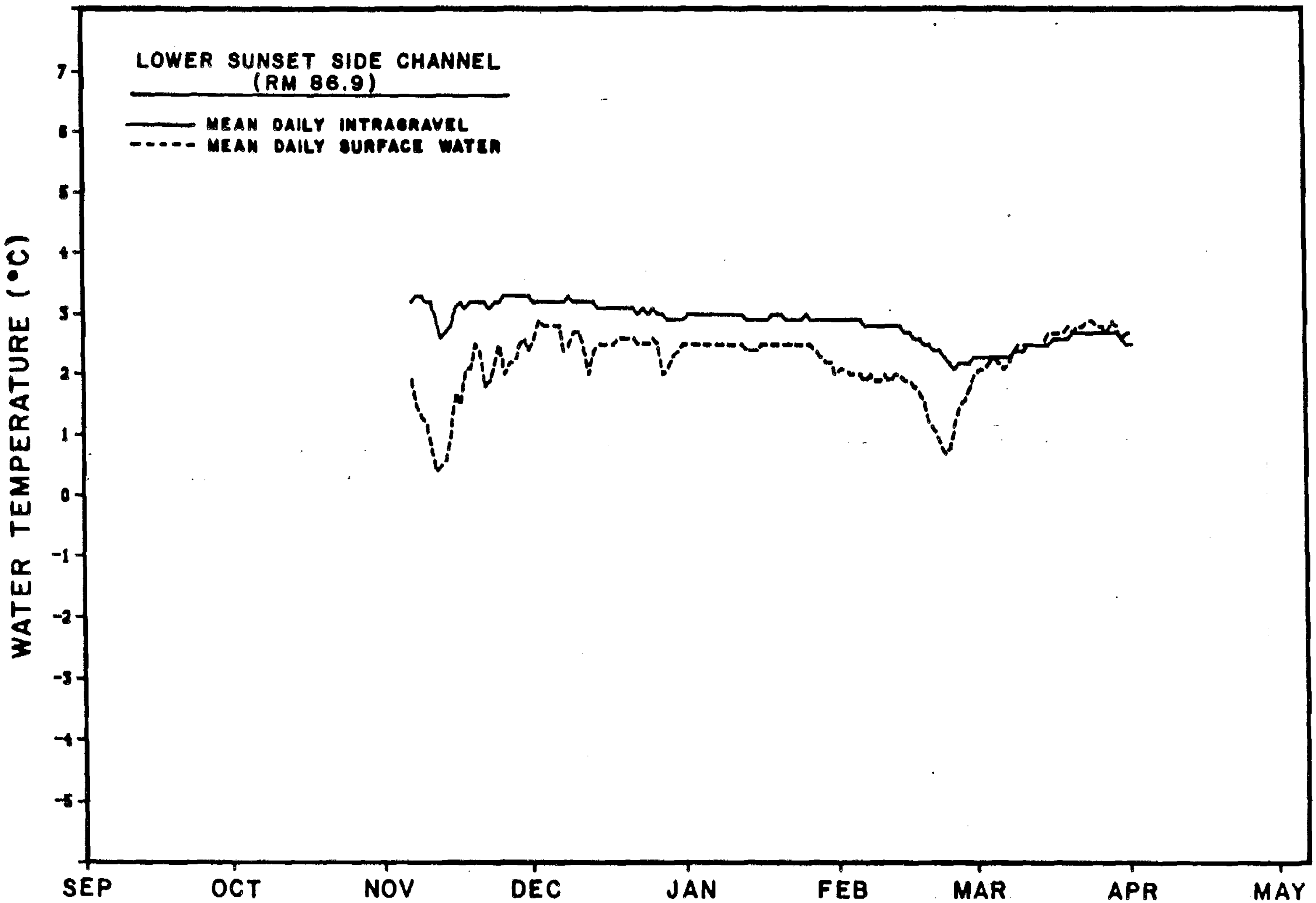


Figure 5. Mean daily intragravel and surface water temperatures (^{O}C) recorded at the lower portion of the observed spawning area in Sunset Side Channel.

Table 13 Datapod temperature recorder data summary: intragravel and surface water temperatures (C) recorded at Upper Circular Side Channel, M 75.3.

Date	Intragravel Min	Intragravel Mean	Intragravel Max	Surface Water Min	Surface Water Mean	Surface Water Max
November 1984						
841106	3.9	4.0	4.0	1.6	1.9	2.4
841107	3.9	4.0	4.0	1.9	2.2	2.4
841108	3.9	3.9	4.0	1.6	2.0	3.3
841109	0.0	2.6	4.0	0.0	1.7	3.8
841110	-0.2	-0.1	0.0	-0.1	0.0	.1
841111	-0.2	0.0	.3	-0.1	0.0	.3
841112	.3	1.0	1.7	.1	.7	1.4
841113	1.6	2.1	2.5	1.0	1.7	2.2
841114	2.5	2.7	2.9	2.0	2.3	2.8
841115	2.9	3.0	3.1	2.1	2.5	2.9
841116	3.0	3.1	3.1	2.3	2.5	2.9
841117	3.1	3.2	3.2	2.2	2.6	2.9
841118	3.1	3.2	3.2	2.2	2.6	3.0
841119	3.0	3.1	3.2	2.4	2.7	2.8
841120	3.0	3.1	3.1	2.7	2.8	2.9
841121	3.0	3.1	3.1	2.8	2.9	3.0
841122	2.9	3.0	3.1	2.2	2.7	3.1
841123	2.8	2.9	3.0	1.9	2.2	2.8
841124	2.9	3.1	3.1	2.4	2.9	2.9
841125	3.0	3.1	3.1	2.2	2.9	3.1
841126	3.0	3.1	3.2	2.3	2.9	3.1
841127	3.0	3.1	3.2	1.4	3.0	3.2
841128	3.0	3.1	3.1	2.8	3.0	3.1
841129	3.0	3.1	3.1	2.8	3.0	3.1
841130	3.0	3.1	3.1	2.6	2.9	3.1
Monthly Value	-0.2	2.8	4.0	-0.1	2.3	3.8

Table 13 (continued).

Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
December 1984						
841201	3.0	3.1	3.1	2.3	2.9	3.1
841202	3.0	3.0	3.1	1.6	1.8	2.3
841203	3.0	3.1	3.2	1.3	1.8	2.1
841204	3.1	3.2	3.2	1.1	1.7	2.1
841205	3.1	3.2	3.3	.1	.9	1.8
841206	3.0	3.1	3.3	0.0	.1	.3
841207	2.9	3.0	3.1	0.0	.2	.3
841208	2.8	2.8	3.0	0.0	.1	.3
841209	2.7	2.7	2.8	0.0	.1	.3
841210	2.7	2.7	2.8	0.0	.2	.4
841211	2.7	2.8	2.9	.1	.8	2.3
841212	2.8	2.9	3.0	1.5	2.2	2.9
841213	2.9	3.0	3.0	2.2	2.5	2.8
841214	2.9	3.0	3.1	2.5	2.7	3.0
841215	3.0	3.1	3.1	2.6	3.0	3.1
841216	3.1	3.1	3.2	2.4	2.9	3.1
841217	3.1	3.1	3.2	2.2	2.7	2.9
841218	3.1	3.2	3.2	2.5	2.7	3.0
841219	3.1	3.2	3.2	2.7	3.0	3.1
841220	3.1	3.1	3.2	2.2	2.7	3.0
841221	3.1	3.2	3.3	2.1	2.5	2.9
841222	3.2	3.3	3.4	2.2	2.5	2.9
841223	3.4	3.5	3.6	2.1	2.3	2.8
841224	3.5	3.6	3.6	2.0	2.2	2.6
841225	3.6	3.6	3.7	2.0	2.2	2.3
841226	3.6	3.6	3.7	2.2	2.6	3.4
841227	3.6	3.6	3.7	2.5	3.2	3.4
841228	3.6	3.6	3.6	2.4	3.0	3.3
841229	3.5	3.6	3.6	1.8	2.5	3.3
841230	3.4	3.5	3.6	2.0	2.4	3.1
841231	3.4	3.4	3.5	1.9	2.2	2.5
Monthly Value	2.7	3.2	3.7	0.0	2.0	3.4

Table 13 (continued).

January 1985						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
850101	3.3	3.4	3.5	1.8	2.2	2.9
850102	3.2	3.3	3.3	1.9	2.1	2.7
850103	3.2	3.3	3.3	1.9	2.1	2.7
850104	3.3	3.4	3.5	2.2	2.8	3.1
850105	3.4	3.5	3.6	1.9	2.6	3.0
850106	3.5	3.6	3.7	1.8	1.9	2.1
850107	3.6	3.7	3.8	1.8	2.0	2.2
850108	3.7	3.8	3.8	1.8	2.1	2.5
850109	3.7	3.8	3.9	1.8	2.2	2.5
850110	3.8	3.8	3.9	2.1	2.5	3.1
850111	3.8	3.9	3.9	2.0	2.2	3.5
850112	3.8	3.8	3.9	1.9	2.9	3.6
850113	3.8	3.8	3.9	1.9	2.5	3.3
850114	3.8	3.8	3.9	2.1	2.7	3.0
850115	3.8	3.8	3.9	1.6	2.6	3.4
850116	3.8	3.8	3.9	2.1	2.5	3.3
850117	3.8	3.9	3.9	2.0	2.2	2.5
850118	3.8	3.9	4.0	2.0	2.2	2.3
850119	3.8	3.9	4.0	1.9	2.1	2.4
850120	3.8	3.9	4.0	1.8	2.0	2.2
850121	3.8	3.9	4.0	1.8	2.1	2.6
850122	3.8	3.9	3.9	2.0	2.2	2.4
850123	3.8	3.9	4.0	2.0	2.2	2.6
850124	3.9	3.9	3.9	2.0	2.2	2.5
850125	3.8	3.9	4.0	1.8	2.2	2.4
850126	3.8	3.9	4.0	2.1	2.2	2.4
850127	3.9	3.9	4.0	2.1	2.2	2.4
850128	3.9	3.9	3.9	2.1	2.3	2.6
850129	3.9	3.9	4.0	2.2	2.3	2.5
850130	3.8	3.9	4.0	2.1	2.4	2.6
850131	3.8	3.9	4.0	2.1	2.2	2.6
Monthly Value	3.2	3.8	4.0	1.6	2.3	3.6

Table 13 (continued).

February 1985						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
850201	3.8	3.9	4.0	2.1	2.4	2.6
850202	3.8	3.9	4.0	2.3	2.4	2.6
850203	3.9	3.9	4.0	2.2	2.4	2.6
850204	3.8	3.9	3.9	2.2	2.3	2.6
850205	3.8	3.9	3.9	2.2	2.4	2.7
850206	3.8	3.9	4.0	2.2	2.4	2.6
850207	3.8	3.9	4.0	2.1	2.3	2.7
850208	3.8	3.9	3.9	1.9	2.2	2.5
850209	3.8	3.9	4.0	2.0	2.2	2.5
850210	3.8	3.8	4.0	1.9	2.2	2.4
850211	3.8	3.8	3.9	1.9	2.2	2.3
850212	3.8	3.8	3.9	1.8	2.0	2.3
850213	3.7	3.8	3.9	1.7	1.9	2.2
850214	3.8	3.8	3.9	1.8	1.9	2.1
850215	3.8	3.9	3.9	1.7	2.0	2.2
850216	3.8	3.9	3.9	1.7	2.0	2.1
850217	3.8	3.9	3.9	1.6	2.0	2.8
850218	3.8	3.9	3.9	1.4	1.9	2.1
850219	3.7	3.8	3.9	1.5	1.8	2.0
850220	3.8	3.8	3.9	1.5	1.8	2.5
850221	3.7	3.8	3.9	1.5	1.8	2.4
850222	3.7	3.8	3.9	1.4	1.8	2.2
850223	3.7	3.8	3.9	1.5	1.8	2.5
850224	3.8	3.8	3.9	1.6	1.9	2.3
850225	3.8	3.8	3.9	1.7	2.0	2.3
850226	3.8	3.9	3.9	1.9	2.2	2.3
850227	3.8	3.8	3.9	2.0	2.2	2.4
850228	3.8	3.8	3.9	1.8	2.1	2.2
Monthly Value	3.7	3.8	4.0	1.4	2.1	2.8

Table 13 (continued).

Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
	March 1985					
850301	3.7	3.8	3.9	1.8	2.0	2.2
850302	3.8	3.8	3.9	1.9	2.1	2.4
850303	3.7	3.8	3.9	2.0	2.1	2.3
850304	3.7	3.8	3.9	1.9	2.1	2.3
850305	3.7	3.8	3.8	1.9	2.2	2.5
850306	3.7	3.7	3.8	1.8	2.2	2.3
850307	3.7	3.7	3.8	2.0	2.4	2.8
850308	3.7	3.8	3.8	2.0	2.5	2.9
850309	3.7	3.8	3.8	2.1	2.4	2.8
850310	3.7	3.8	3.8	2.0	2.6	2.8
850311	3.7	3.8	3.8	1.8	2.3	2.8
850312	3.7	3.8	3.8	1.9	2.2	2.6
850313	3.7	3.8	3.8	2.3	2.6	2.8
850314	3.7	3.7	3.8	2.2	2.6	3.4
850315	3.7	3.7	3.8	2.6	3.1	3.4
850316	3.7	3.7	3.8	2.8	3.1	3.4
850317	3.7	3.7	3.8	2.4	3.0	3.4
850318	3.7	3.7	3.8	2.5	3.0	3.2
850319	3.7	3.7	3.8	2.4	2.8	3.2
850320	3.7	3.7	3.8	2.3	2.7	3.1
850321	3.7	3.7	3.8	2.4	2.7	3.0
850322	3.7	3.7	3.8	2.4	2.7	3.0
850323	3.6	3.7	3.8	2.3	2.6	2.9
850324	3.6	3.7	3.8	2.3	2.6	3.0
850325	3.6	3.7	3.8	2.4	2.7	3.2
850326	3.6	3.7	3.8	2.4	2.8	3.2
850327	3.6	3.7	3.8	2.4	2.8	3.1
850328	3.6	3.7	3.8	2.4	2.8	3.2
850329	3.6	3.7	3.8	2.7	3.0	3.4
850330	3.6	3.7	3.8	2.6	3.0	3.3
850331	3.6	3.7	3.8	2.6	2.9	3.2
Monthly Value	3.6	3.7	3.9	1.8	2.6	3.4

Table 13 (continued).

April 1985						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
850401	3.6	3.6	3.7	2.4	2.8	3.2
850402	3.6	3.6	3.7	2.3	2.7	3.1
850403	3.6	-----	3.7	2.7	-----	3.4
Monthly Value	3.6	-----	3.7	2.3	-----	3.4

----- Data not available.

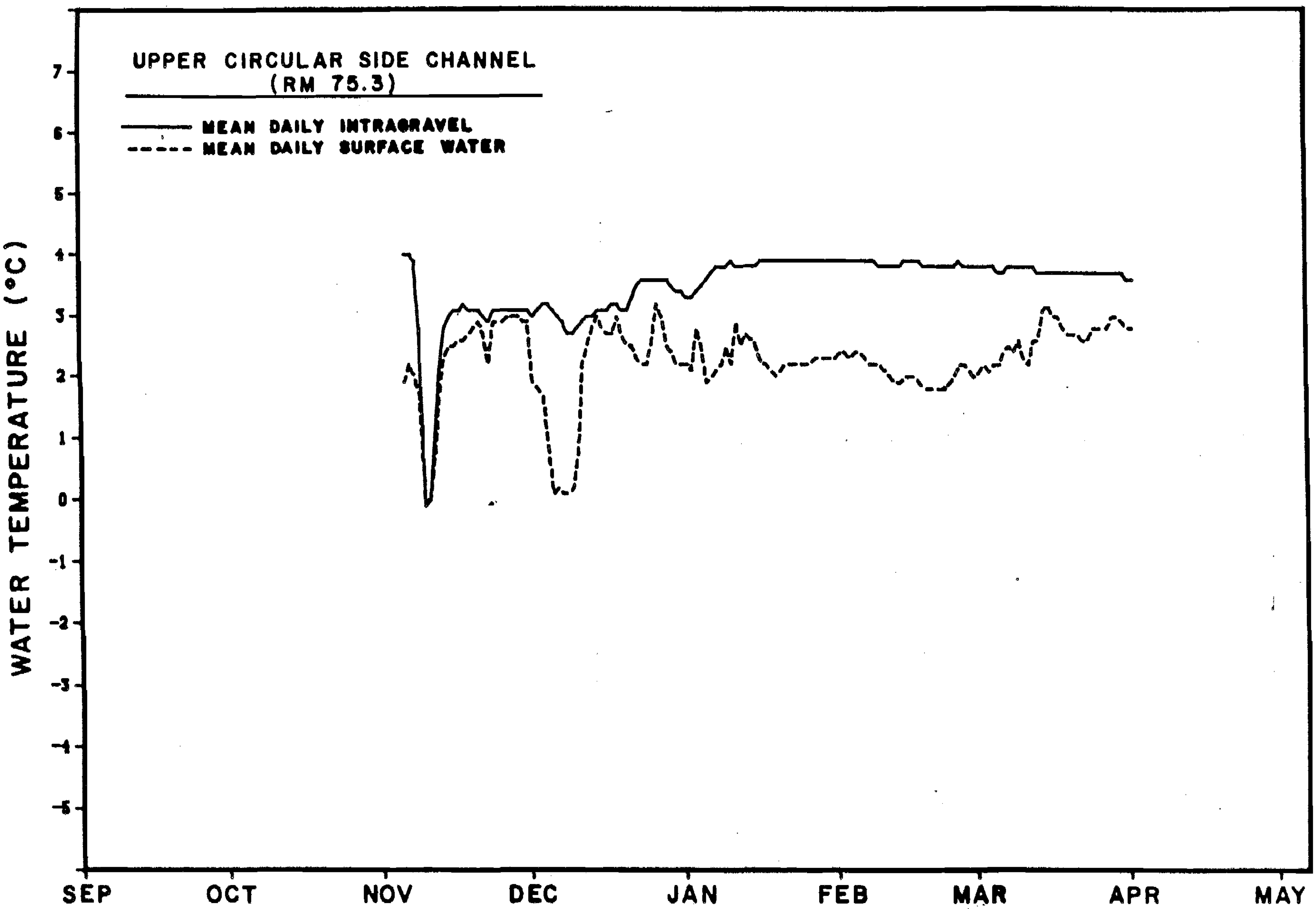


Figure 6. Mean daily intragravel and surface water temperatures (°C) recorded at the upper portion of the spawning area in Circular Side Channel.

Table 14 Datapod temperature recorder data summary: intragravel and surface water temperatures (C) recorded at Lower Circular Side Channel, RM 75.3.

November 1984

Date	Intragravel Min	Intragravel Mean	Intragravel Max	Surface Water Min	Surface Water Mean	Surface Water Max
841106	3.1	3.6	4.3	3.2	3.6	3.7
841107	3.3	3.7	3.7	3.1	3.6	3.7
841108	3.6	3.7	3.8	2.9	3.5	3.7
841109	.8	3.4	3.9	.2	3.0	3.7
841110	-----	-----	-----	-0.2	0.0	.5
841111	-----	-----	-----	-0.2	-0.1	0.0
841112	-----	-----	-----	-0.2	0.0	.1
841113	-----	-----	-----	.1	.2	.5
841114	-----	-----	-----	.4	.7	.9
841115	-----	-----	-----	.7	.8	.9
841116	-----	-----	-----	.3	.5	.7
841117	-----	-----	-----	.2	.3	.4
841118	-----	-----	-----	.4	.5	.7
841119	-----	-----	-----	.6	.8	1.1
841120	-----	-----	-----	1.0	1.4	1.7
841121	-----	-----	-----	1.3	1.7	1.8
841122	-----	-----	-----	0.0	.5	1.3
841123	-----	-----	-----	-0.1	0.0	.1
841124	-----	-----	-----	-0.1	0.0	.1
841125	-----	-----	-----	0.0	0.0	.1
841126	-----	-----	-----	0.0	0.0	.2
841127	-----	-----	-----	.1	.2	.5
841128	-----	-----	-----	.2	.4	.6
841129	-----	-----	-----	.2	.4	.5
841130	-----	-----	-----	.3	.4	.5
Monthly Value	.8	-----	4.3	-.2	.9	3.7

----- Data not available.

Table 14 (continued).

December 1984						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
841201	-----	-----	-----	-0.1	.2	.5
841202	-----	-----	-----	-0.1	0.0	0.0
841203	-----	-----	-----	-0.2	-0.1	0.0
841204	-----	-----	-----	-0.2	-0.1	0.0
841205	-----	-----	-----	-0.1	0.0	.1
841206	-----	-----	-----	-0.1	0.0	0.0
841207	-----	-----	-----	-0.1	0.0	0.0
841208	-----	-----	-----	-0.1	0.0	0.0
841209	-----	-----	-----	-0.1	0.0	.1
841210	-----	-----	-----	-0.1	0.0	.2
841211	-----	-----	-----	0.0	.1	.3
841212	-----	-----	-----	.1	.3	.6
841213	2.8	3.0	3.1	.4	.7	1.2
841214	3.0	3.2	3.2	.6	.7	1.2
841215	3.1	3.2	3.2	.6	1.3	1.8
841216	3.1	3.2	3.2	1.2	1.4	1.7
841217	3.0	3.1	3.1	.9	1.2	1.4
841218	2.9	3.0	3.1	.8	1.0	1.1
841219	2.9	3.0	3.1	.7	.9	1.3
841220	3.0	3.2	3.2	.8	1.2	1.7
841221	3.1	3.2	3.3	1.1	1.6	2.2
841222	3.1	3.2	3.3	1.0	1.9	2.4
841223	3.0	3.1	3.1	.5	1.5	2.0
841224	3.0	3.2	3.4	.3	1.1	1.6
841225	3.2	3.2	3.4	.9	1.2	1.5
841226	3.1	3.2	3.2	1.2	1.6	1.9
841227	3.1	3.3	3.4	1.6	1.8	2.1
841228	3.2	3.4	3.4	1.6	1.8	1.9
841229	3.3	3.3	3.4	1.7	1.9	2.1
841230	3.0	3.1	3.3	1.8	2.0	2.2
841231	2.7	2.9	3.0	1.7	1.9	2.1
Monthly Value	2.7	-----	3.4	-0.2	.9	2.4

----- Data not available.

Table 14 (continued).

January 1985						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
850101	2.7	2.7	2.7	1.6	1.7	2.0
850102	2.7	2.7	2.9	1.2	1.4	1.7
850103	2.7	2.9	3.0	1.1	1.2	1.4
850104	2.9	3.0	3.1	1.2	1.6	2.0
850105	2.8	2.9	3.0	1.3	1.6	2.0
850106	2.8	3.1	3.2	1.0	1.4	1.6
850107	2.9	3.1	3.3	.9	1.2	1.5
850108	2.7	2.8	3.0	1.1	1.3	1.4
850109	2.5	2.8	2.9	1.1	1.3	1.4
850110	2.5	2.9	3.0	1.1	1.3	1.4
850111	2.7	2.9	2.9	1.0	1.2	1.3
850112	2.6	2.7	2.8	.7	.9	1.1
850113	2.6	2.9	3.2	.5	.7	.9
850114	2.9	3.1	3.2	.4	.7	.8
850115	2.8	2.9	3.0	.4	.5	.7
850116	2.7	2.9	3.0	.5	.5	.7
850117	2.6	2.7	2.7	.3	.5	.7
850118	2.4	2.7	2.8	0.0	.1	.4
850119	2.4	2.9	3.0	0.0	.1	.5
850120	2.6	2.9	3.0	0.0	.1	.3
850121	2.4	2.8	3.1	0.0	.1	.3
850122	2.7	2.9	3.0	0.0	.1	.3
850123	2.7	2.8	3.0	0.0	.1	.3
850124	2.6	2.7	2.7	0.0	0.0	.3
850125	2.6	-----	2.6	0.0	-----	.1
850129	-----	-----	-----	.5	.7	.9
850130	3.1	-----	3.2	.7	.8	.9
850131	3.1	3.1	3.2	.5	.7	1.1
Monthly Value	2.4	2.9	3.3	0.0	.8	2.0

----- Data not available.

Table 14 (continued).

Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
February 1985						
850201	3.1	-----	3.2	.6	.8	1.0
850202	3.1	3.1	3.2	.9	1.0	1.2
850203	3.1	3.1	3.1	1.0	1.2	1.7
850204	3.1	3.1	3.2	1.2	1.3	1.6
850205	3.1	3.1	3.2	1.3	1.6	1.8
850206	3.0	3.1	3.2	1.4	1.7	2.0
850207	3.0	3.1	3.2	1.7	1.9	2.0
850208	3.0	3.1	3.2	1.6	1.9	2.1
850209	3.0	-----	3.1	1.8	-----	2.0
Monthly Value	3.0	-----	3.2	.6	-----	2.1

----- Data not available.

Table 14 (continued).

March 1985						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
850307	2.7	-----	2.8	1.8	-----	1.9
850308	2.6	2.7	2.8	1.6	1.7	1.8
850309	2.6	2.7	2.7	1.7	1.7	1.8
850310	2.6	2.7	2.7	1.7	1.7	1.8
850311	2.6	2.7	2.7	1.7	1.7	1.8
850312	2.6	2.6	2.7	1.6	1.7	1.8
850313	2.6	2.6	2.7	1.7	1.7	1.9
850314	2.6	2.7	2.7	1.7	1.7	1.9
850315	2.6	2.7	2.7	1.7	1.7	1.9
850316	2.6	2.7	2.7	1.7	1.8	1.9
850317	2.6	2.7	2.7	1.7	1.8	1.9
850318	2.6	2.6	2.7	1.7	1.8	2.0
850319	2.6	2.7	2.7	1.7	1.8	2.0
850320	2.6	2.7	2.7	1.7	1.9	2.1
850321	2.6	2.7	2.8	1.7	1.9	2.1
850322	2.6	2.7	2.8	1.7	1.9	2.3
850323	2.6	2.7	2.8	1.7	1.9	2.2
850324	2.6	2.7	2.8	1.8	2.0	2.2
850325	2.6	2.7	2.8	1.8	2.0	2.4
850326	2.6	2.7	2.8	1.7	2.0	2.4
850327	2.7	2.7	2.8	1.8	2.0	2.3
850328	2.7	2.7	2.8	1.7	2.0	2.3
850329	2.7	2.7	2.8	1.8	2.0	2.3
850330	2.7	2.7	2.8	1.8	2.0	2.4
850331	2.7	2.7	2.8	1.8	2.0	2.3
Monthly Value	2.6	2.7	2.8	1.6	1.9	2.4

----- Data not available.

Table 14 (continued).

April 1985						
Date	Intragravel			Surface Water		
	Min	Mean	Max	Min	Mean	Max
850401	2.7	2.7	2.8	1.8	2.0	2.1
850402	2.7	2.7	2.8	1.8	2.0	2.1
850403	2.7	2.8	2.8	1.9	2.0	2.2
850404	2.7	2.7	2.8	1.9	2.1	2.3
850405	2.7	2.7	2.8	1.9	2.1	2.4
850406	2.7	2.7	2.8	1.9	2.2	2.4
850407	2.7	2.7	2.8	2.0	2.2	2.3
850408	2.7	2.7	2.8	1.9	2.2	2.3
850409	2.7	2.7	2.8	1.9	2.1	2.4
850410	2.7	2.7	2.8	1.8	2.1	2.4
850411	2.7	2.7	2.8	1.9	2.2	2.3
850412	2.7	2.7	2.8	1.9	2.1	2.3
850413	2.7	2.7	2.8	1.9	2.2	2.3
850414	2.7	2.7	2.8	1.9	2.1	2.3
850415	2.7	2.7	2.8	1.9	2.2	2.6
850416	2.7	2.7	2.8	2.0	2.3	2.6
850417	2.7	2.8	2.8	2.0	2.4	2.8
850418	2.7	2.8	2.9	2.0	2.5	3.1
850419	2.7	2.8	2.9	2.1	2.5	2.8
850420	2.7	2.8	2.9	2.0	2.5	2.9
850421	2.7	2.8	2.9	2.1	2.6	3.4
850422	2.8	2.9	2.9	2.1	2.8	3.6
850423	2.8	2.9	2.9	2.2	2.9	3.8
850424	2.8	-----	3.0	2.2	-----	3.5
Monthly Value	2.7	2.8	3.0	1.8	2.3	3.8

----- Data not available.

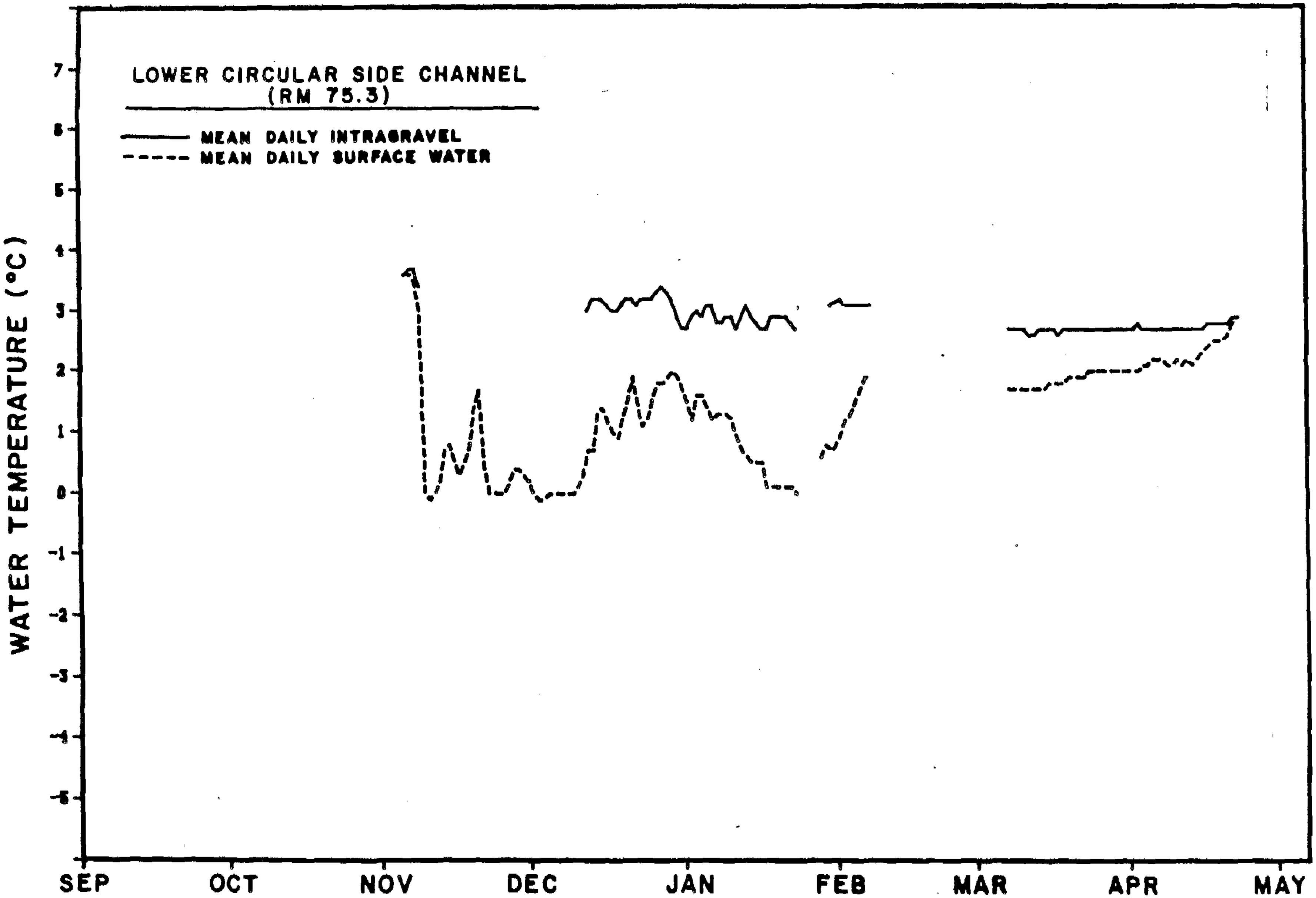


Figure 7. Mean daily intragravel and surface water temperatures (°C) recorded at the lower portion of the observed spawning area in Circular Side Channel.

Intragravel water temperatures at this site ranged from a low of 0.8°C to 4.3°C. Surface water temperatures ranged from -0.2°C to 3.8°C.

Water Surface Elevation

Trapper Side Channel

Water surface elevations were obtained at Trapper Side Channel and in the adjacent mainstem Susitna River on six occasions. Both the side channel and mainstem water surface elevations are relative to separate temporary bench marks; each of which have assigned elevations of 100.00 feet. These water surface elevations are presented in Table 15. A plot of side channel versus mainstem water surface elevations are presented in Figure 8.

Water surface elevations were found to be very stable varying only 0.04 feet from February 20-May 1. Mainstem water surface elevations fluctuated 1.08 feet for the same period. Corresponding mainstem discharges were 3,600-5,000 cfs. The final water surface elevation measurement occurred on May 8 and corresponded to a mainstem discharge of 7,000 cfs. This discharge resulted in an increase of 0.1 feet for the side channel water surface elevation and a mainstem water surface elevation decrease of 0.86 feet. This decrease in mainstem water surface elevation has been speculated to result from an expansion of the wetted area of the mainstem adjacent to this side channel due to ice melt.

Sunset Side Channel

Water surface elevations were also taken in Sunset Side Channel and the mainstem river adjacent to the side channel. These water surface elevations are presented in Table 15. A plot of side channel versus mainstem water surface elevations are presented in Figure 9.

Water surface elevations were stable in this side channel. A maximum variation of 0.15 ft occurred over a mainstem discharge of 3,500-7,000 cfs. A variation of 0.61 ft occurred in the mainstem over the same range of mainstem discharge.

Circular Side Channel

Water surface elevations obtained in Circular Side Channel exhibited slightly more variation (0.55 ft) than Trapper and Sunset Side Channels over a lesser range of mainstem discharges (3,600-4,800 cfs). Mainstem water surface elevations exhibited less variation (0.14 ft) than those obtained from the mainstem sites adjacent to Trapper and Sunset Side Channels. These water surface elevations are presented in Table 15. A plot of side channel versus mainstem water surface elevations are presented in Figure 10.

Table 15. Comparison of water surface elevations obtained at selected side channels in the lower Susitna River to those obtained from adjoining mainstem locations.

Location	Date	WSEL (ft) S/C	WSEL (ft) MS	Mainstem Discharge at Sunshine
Trapper Creek Side Channel	850220	96.39	89.13	3,600
	850321	96.42	89.18	4,100
	850411	96.42	88.54	3,600
	850424	96.41	88.26	4,000
	850501	96.43	88.10	5,000
	850508	96.53	87.24	7,000
Sunset Side Channel	850221	94.02	91.66	3,500
	850321	93.90	92.16	4,100
	850410	93.90	91.70	3,600
	850423	93.87	91.55	3,900
	850430	93.90	91.61	4,800
	850508	93.96	92.06	7,000
Circular Side Channel 1/	850220	82.81	88.31	3,600
	850321	82.77	----- 2/	4,100
	850410	82.39	88.31	3,600
	850424	82.26	88.20	4,000
	850430	82.35	88.34	4,800

1/ Side channel and mainstem water surface elevations are not "tied" to same TBM.
2/ Data not available.

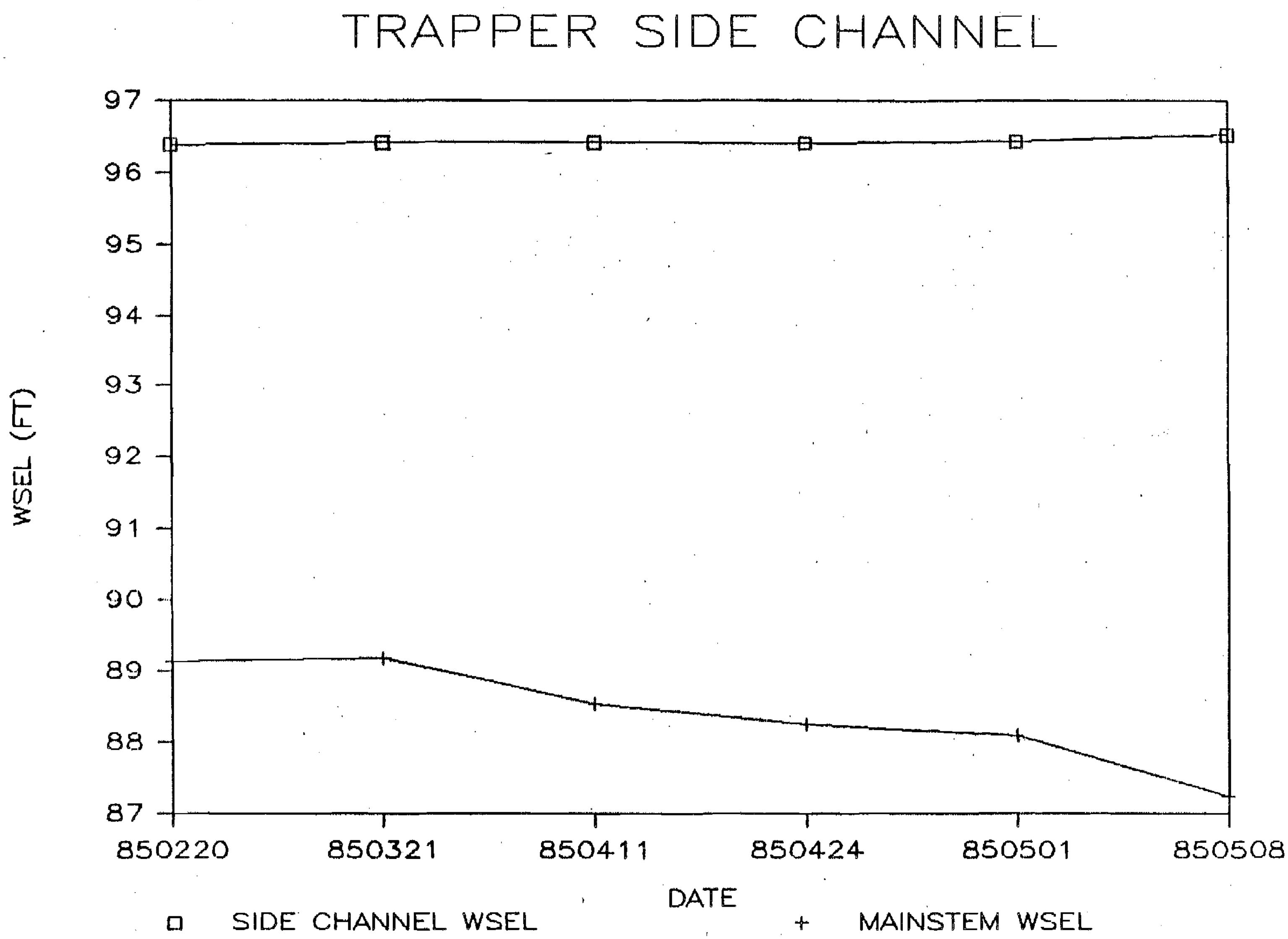


Figure 8. Comparison of mainstem and side channel water surface elevations over time at Trapper Side Channel.

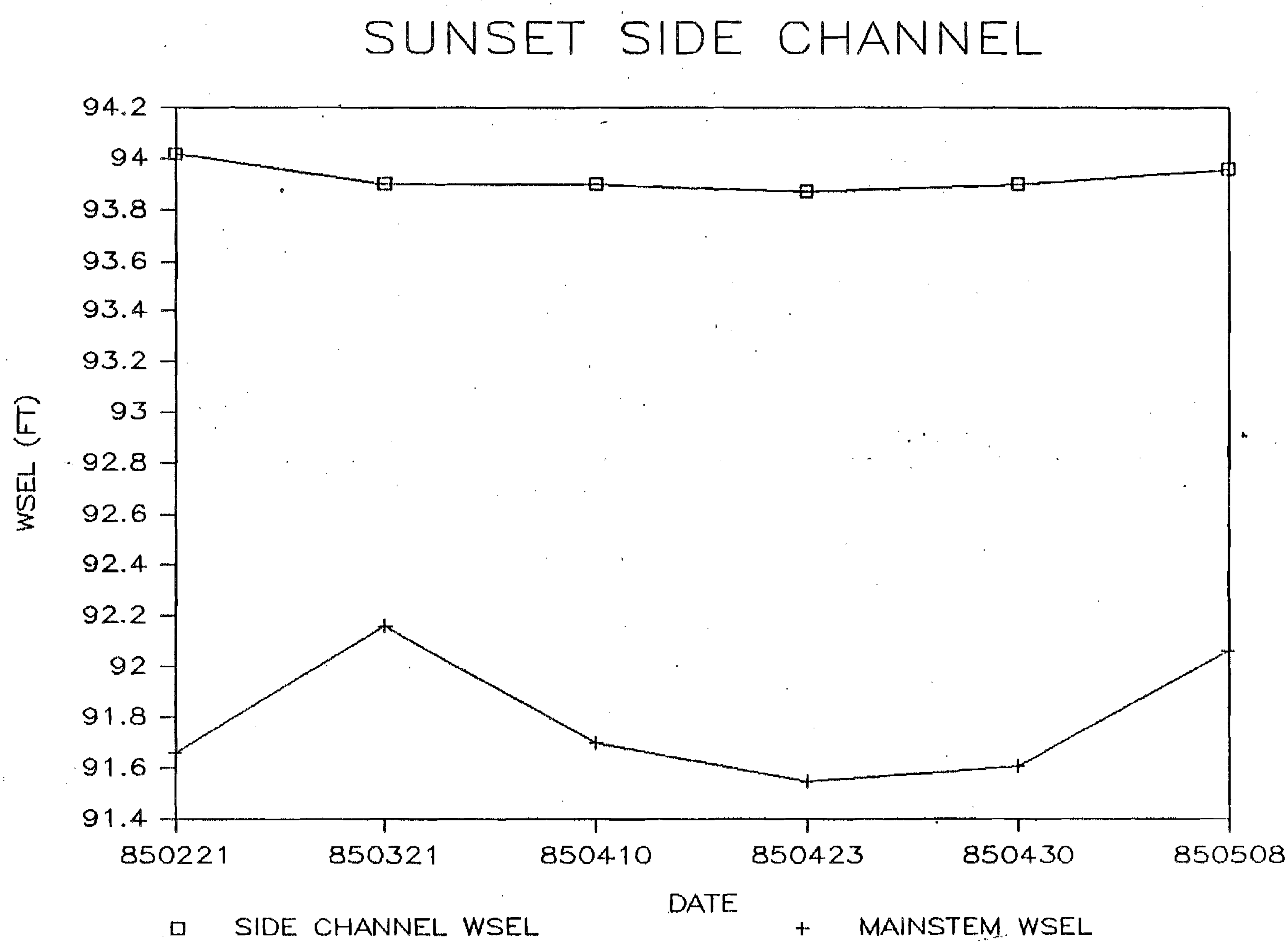


Figure 9. Comparison of mainstem and side channel water surface elevation over time at Sunset Side Channel.

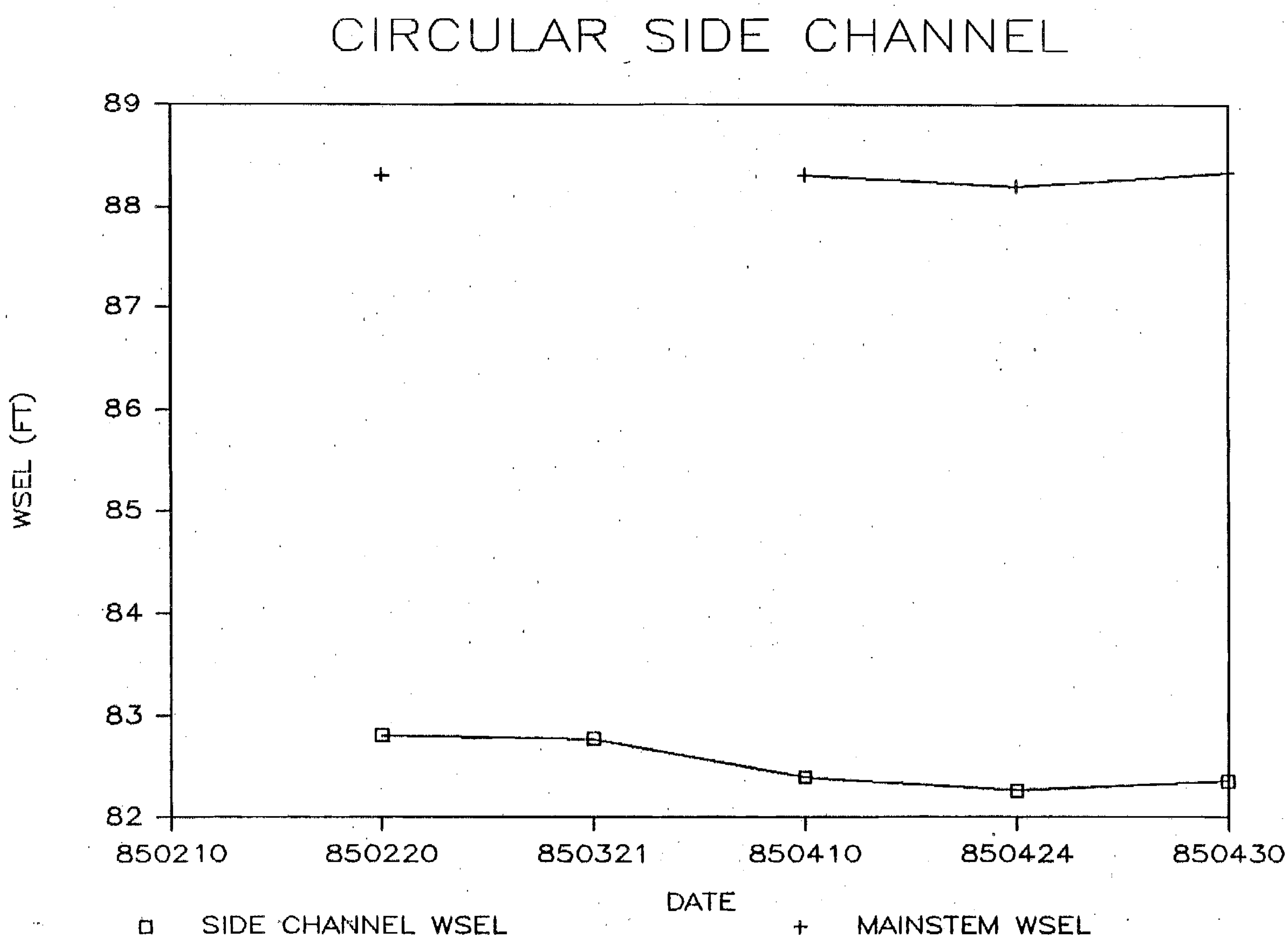


Figure 10. Comparison of mainstem and side channel water surface elevations over time at Circular Side Channel.

Substrate

During January, substrate samples were obtained from Trapper, Sunset, and Circular Side Channels. The results of the analyses of these samples are presented in Tables 16 through 28 and Figure 11 through 36 and are discussed below by site.

Upper Trapper Side Channel

Four substrate samples were collected from the upper portion of the chum salmon spawning area observed in this side channel. Aggregate substrate composition was primarily large gravel (1-3 inch diameter) from the surface to a 4 inch depth. Substrate size from 5 to 16 inch depths were primarily small gravel (.8-1 inch diameter) although large gravel, sand, and silt were present to varying degrees.

Lower Trapper Side Channel

Only one substrate sample was obtained from this site due to ice conditions and water depth. Substrate size from the surface to 4 inches deep was primarily large (76%) and small (23.9%) gravel. Substrate from 5 to 20 inches deep was primarily small gravel although large gravel, sand, and silt were present to varying degrees.

Sunset Side Channel

Five samples were collected from this side channel; three from the upper portion and two from the lower portion. All five samples were relatively similar in substrate size. Large gravel was predominant from the surface to 4 inches deep with small gravel being the predominant substrate size from depths of 5-16 inches. Large gravel, sand, and silt were also present in relatively small quantities from 5 to 16 inches deep.

Circular Side Channel

Three substrate samples were collected at this site. These substrate samples were found to vary from the samples collected at either Trapper or Sunset Side Channels relative to substrate size at various depths. The aggregate size in Circular Side Channel was relatively larger than Trapper and Sunset Side Channels.

Large gravel was predominant from the surface to a 13 inch depth. Redd #R5E contained 69% rubble (3-5 inches in diameter) from a depth of 5-8 inches. Substrate size from a depth of 12-16 inches was primarily small gravel. Some large gravel, sand, and silt was also present.

Biological Data

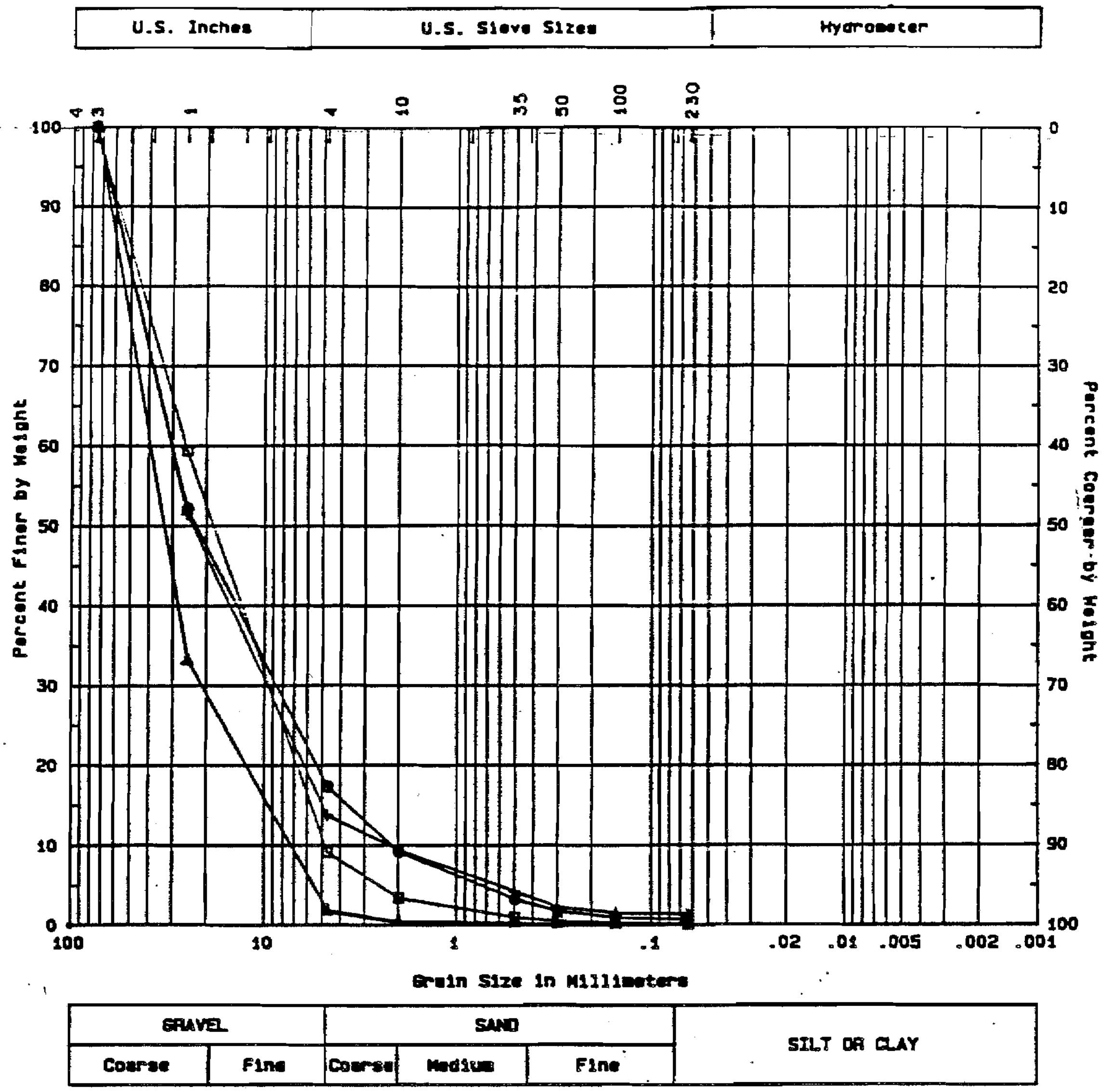
Chum Salmon Spawning Surveys

The locations of observed chum salmon spawning activity noted during the spawning surveys in Circular, Sunset and Lower and Upper Trapper Creek

Table 16. Substrate sieve analysis data for Upper Trapper Side Channel redd number 1 (R-1).

SIDE CHANNEL	SAMPLE NUMBER	SIEVE NUMBER	SIEVE SIZE (IN)	CUM WEIGHT (GMS)	% PASSING	% PER CLASS
UPPER TRAPPER	R-1A	5	5			
UPPER TRAPPER	R-1A	3	3	0	100	67
UPPER TRAPPER	R-1A	1	1	776	33	31.2
UPPER TRAPPER	R-1A	4	0.187	1140	1.8	1.3
UPPER TRAPPER	R-1A	10	0.0787	1155	0.5	0.2
UPPER TRAPPER	R-1A	35	0.0197	1158	0.3	0.1
UPPER TRAPPER	R-1A	50	0.0116	1159	0.2	0.1
UPPER TRAPPER	R-1A	100	0.0059	1160	0.1	0.1
UPPER TRAPPER	R-1A	230	0.0025	1161	0	0
UPPER TRAPPER	R-1A	TOTAL		1161		100
UPPER TRAPPER	R-1B	5	5			
UPPER TRAPPER	R-1B	3	3	0	100	41
UPPER TRAPPER	R-1B	1	1	576	59	49.8
UPPER TRAPPER	R-1B	4	0.187	1289	9.2	5.7
UPPER TRAPPER	R-1B	10	0.0787	1371	3.5	2.5
UPPER TRAPPER	R-1B	35	0.0197	1406	1	0.4
UPPER TRAPPER	R-1B	50	0.0116	1412	0.6	0.2
UPPER TRAPPER	R-1B	100	0.0059	1415	0.4	0.3
UPPER TRAPPER	R-1B	230	0.0025	1419	0.1	0.1
UPPER TRAPPER	R-1B	TOTAL		1420		100
UPPER TRAPPER	R-1C	5	5			
UPPER TRAPPER	R-1C	3	3	0	100	48
UPPER TRAPPER	R-1C	1	1	940	52	35
UPPER TRAPPER	R-1C	4	0.187	1624	17	7.8
UPPER TRAPPER	R-1C	10	0.0787	1784	9.2	5.9
UPPER TRAPPER	R-1C	35	0.0197	1900	3.3	1.5
UPPER TRAPPER	R-1C	50	0.0116	1930	1.8	0.8
UPPER TRAPPER	R-1C	100	0.0059	1946	1	0.3
UPPER TRAPPER	R-1C	230	0.0025	1952	0.7	0.7
UPPER TRAPPER	R-1C	TOTAL		1965		100
UPPER TRAPPER	R-1D	5	5			
UPPER TRAPPER	R-1D	3	3	0	100	49
UPPER TRAPPER	R-1D	1	1	443	51	37
UPPER TRAPPER	R-1D	4	0.187	787	14	4.6
UPPER TRAPPER	R-1D	10	0.0787	827	9.4	5.1
UPPER TRAPPER	R-1D	35	0.0197	874	4.3	2
UPPER TRAPPER	R-1D	50	0.0116	892	2.3	0.8
UPPER TRAPPER	R-1D	100	0.0059	899	1.5	0.2
UPPER TRAPPER	R-1D	230	0.0025	901	1.3	1.3
UPPER TRAPPER	R-1D	TOTAL		913		100

R1-A: Substrate sample obtained from chum redd labeled R1 at a depth of 0-4 inches.
R1-B: 5-8 inches
R1-C: 9-12 inches
R1-D: 13-16 inches



Sample Identification				Classification Data					Unified Class	Remarks
Sym	Hole	Samp	Depth	Cu	Cz	LL	PI	% Org		
▲		R-1A	SURFACE							
□		R1-B	4"							
○		R1-C	8"							
+		R-1D	12"							

DWN CKD DATE 7/11/85 SCALE	R&M CONSULTANTS, INC. ENGINEERS GEOLOGISTS PLANNERS SURVEYORS	ALASKA DEPT OF FISH & GAME SUSITNA HABITAT SUBSTRATE UPPER TRAPPER #1 DATAPOD SITE	FB. GRID PROJ NO 551053 DWG NO

Figure 11. Depth integrated substrate composition, percent by weight passing each sieve size for redd number 1 in Upper Trapper Side Channel.

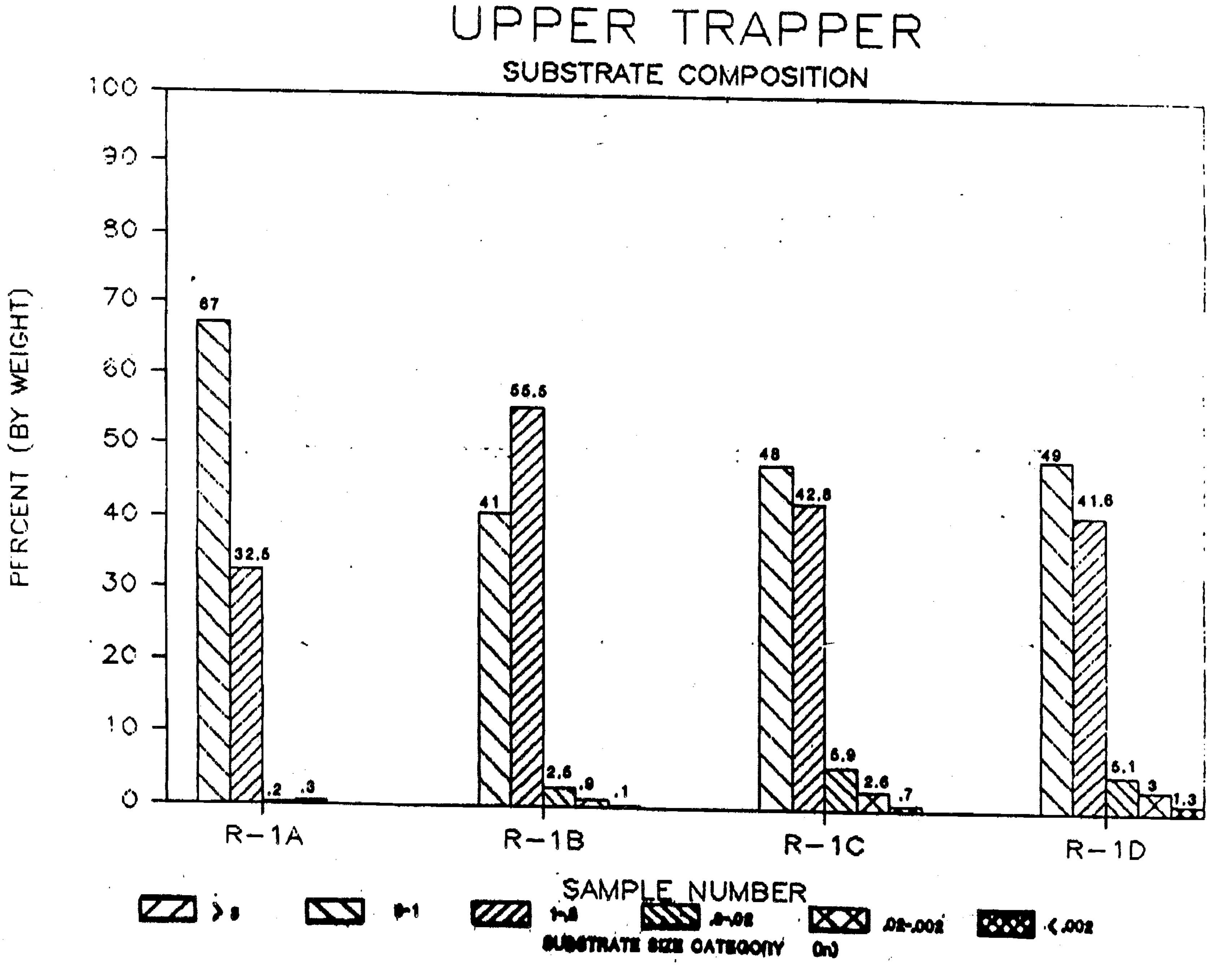
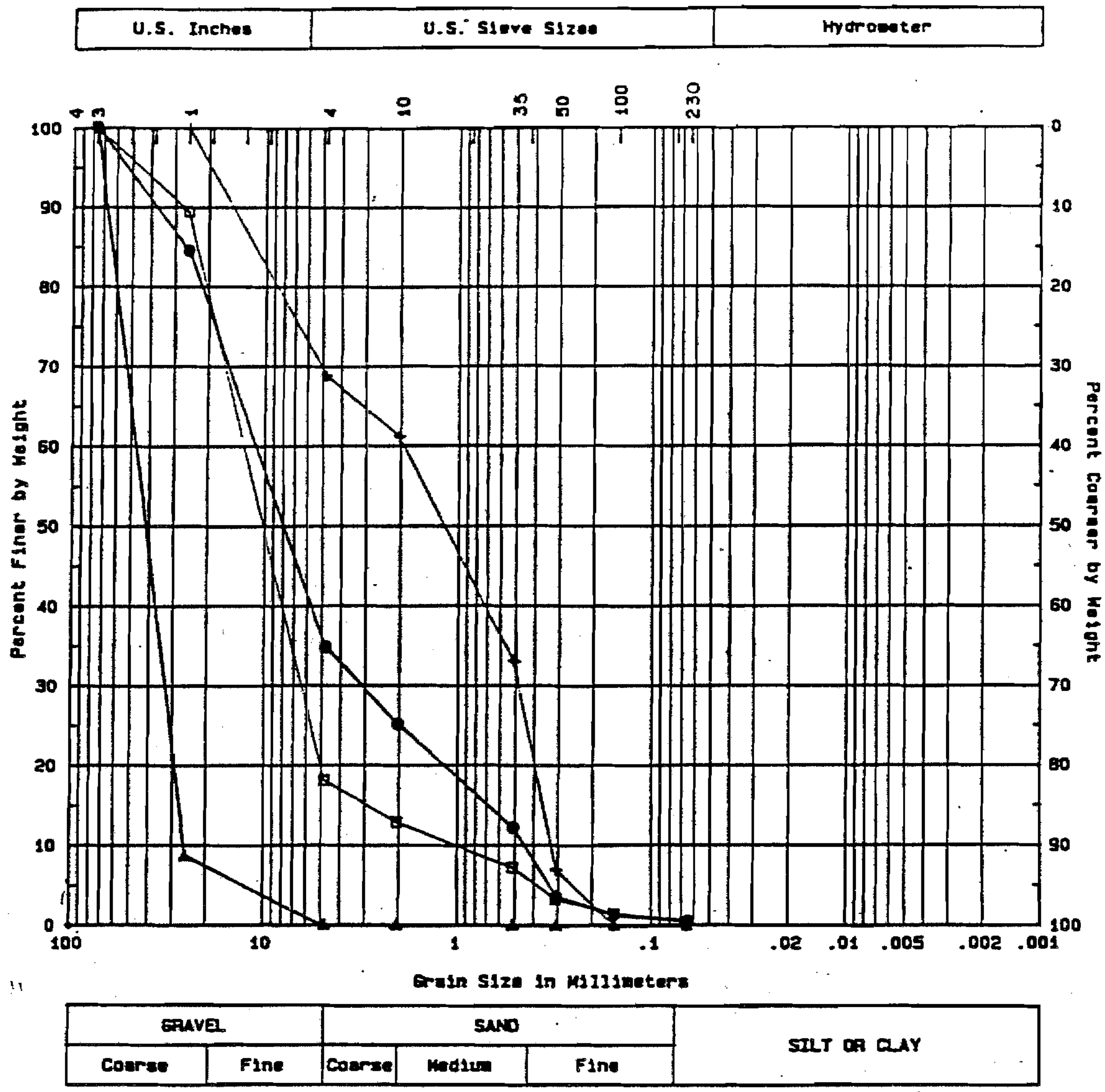


Figure 12. Depth integrated substrate composition by weight from redd number 1 in Upper Trapper Side Channel.

Table 17. Substrate sieve analysis data for Upper Trapper Side Channel redd number 2 (R-2).

SIDE CHANNEL	SAMPLE NUMBER[1]	SIEVE NUMBER	SIEVE SIZE (IN)	CUM WEIGHT (GMS)	% PASSING	% PER CLASS
UPPER TRAPPER	R-2A	5	5			
UPPER TRAPPER	R-2A	3	3	0	100	91.3
UPPER TRAPPER	R-2A	1	1	906	8.7	8.7
UPPER TRAPPER	R-2A	4	0.187	992	0	0
UPPER TRAPPER	R-2A	10	0.0787	992	0	0
UPPER TRAPPER	R-2A	35	0.0197	992	0	0
UPPER TRAPPER	R-2A	50	0.0116	992	0	0
UPPER TRAPPER	R-2A	100	0.0059	992	0	0
UPPER TRAPPER	R-2A	230	0.0025	992	0	0
UPPER TRAPPER	R-2A	TOTAL		992		100
UPPER TRAPPER	R-2B	5	5			
UPPER TRAPPER	R-2B	3	3	0	100	11
UPPER TRAPPER	R-2B	1	1	94	89	71
UPPER TRAPPER	R-2B	4	0.187	727	18	5
UPPER TRAPPER	R-2B	10	0.0787	774	13	5.8
UPPER TRAPPER	R-2B	35	0.0197	824	7.2	3.9
UPPER TRAPPER	R-2B	50	0.0116	859	3.3	1.8
UPPER TRAPPER	R-2B	100	0.0059	875	1.5	1.2
UPPER TRAPPER	R-2B	230	0.0025	885	0.3	0.3
UPPER TRAPPER	R-2B	TOTAL		888		100
UPPER TRAPPER	R-2C	5	5			
UPPER TRAPPER	R-2C	3	3	0	100	15
UPPER TRAPPER	R-2C	1	1	200	85	50
UPPER TRAPPER	R-2C	4	0.187	842	35	10
UPPER TRAPPER	R-2C	10	0.0787	967	25	13
UPPER TRAPPER	R-2C	35	0.0197	1135	12	8.4
UPPER TRAPPER	R-2C	50	0.0116	1246	3.6	2.4
UPPER TRAPPER	R-2C	100	0.0059	1277	1.2	0.6
UPPER TRAPPER	R-2C	230	0.0025	1285	0.6	0.6
UPPER TRAPPER	R-2C	TOTAL		1293		100
UPPER TRAPPER	R-2D	5	5			
UPPER TRAPPER	R-2D	3	3			
UPPER TRAPPER	R-2D	1	1	0	100	31
UPPER TRAPPER	R-2D	4	0.187	44	69	8
UPPER TRAPPER	R-2D	10	0.0787	55	61	28
UPPER TRAPPER	R-2D	35	0.0197	95	33	26
UPPER TRAPPER	R-2D	50	0.0116	132	7	7
UPPER TRAPPER	R-2D	100	0.0059	142	0	0
UPPER TRAPPER	R-2D	230	0.0025	142	0	0
UPPER TRAPPER	R-2D	TOTAL		142		100

[1]R2-A: Substrate sample obtained from chum redd labeled R2 at a depth of 0-4 inches.
R2-B: 5-8 inches
R2-C: 9-12 inches
R2-D: 13-16 inches



Sample Identification				Classification Data					Unified Class	Remarks
Sym	Hole	Samp	Depth	Cu	Cz	LL	PI	% Org		
△		R-2A	SURFACE							
□		R-2B	4"							
○		R-2C	8"							
+		R-2D	12"							

DWN.
CKD.
DATE. 7/11/85
SCALE

R&M CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

ALASKA DEPT OF FISH & GAME
SUSITNA HABITAT SUBSTRATE
TRAPPER REDDCORE #2

FB.
GRID
PROJ.NO 551053
DWG NO

Figure 13. Depth integrated substrate composition, percent by weight passing each sieve size for redd number 2 in Upper Trapper Side Channel.

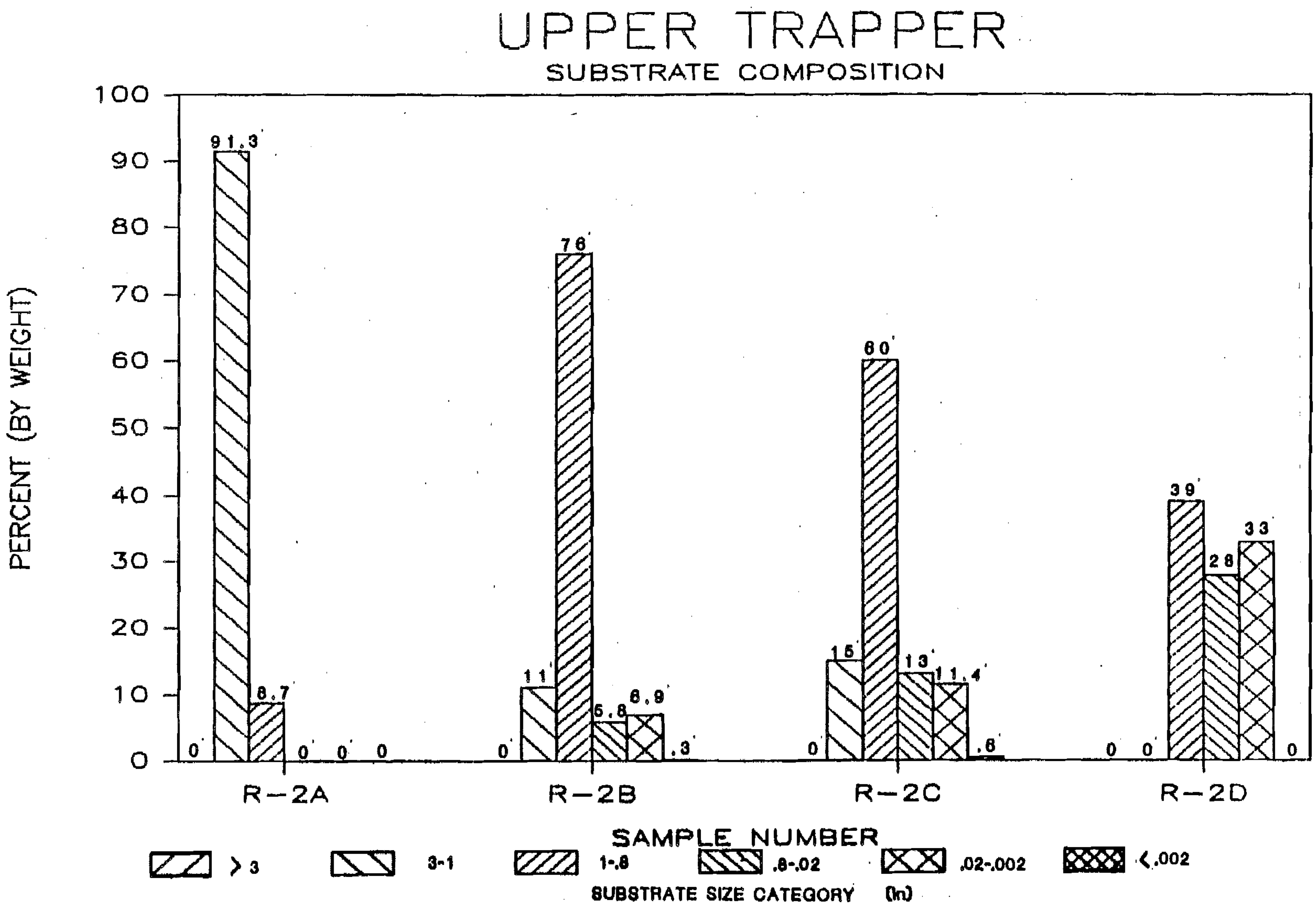
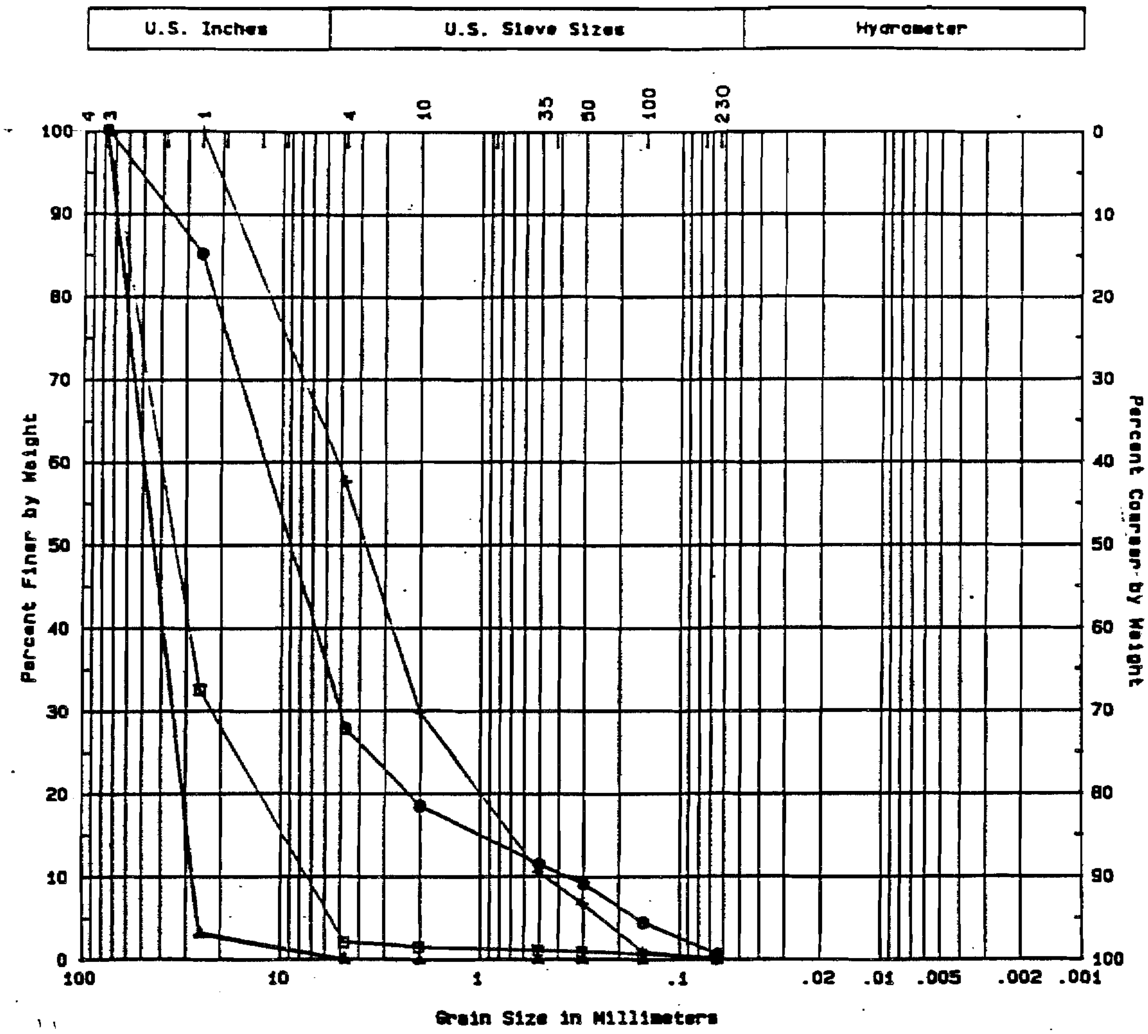


Figure 14. Depth integrated substrate composition by weight from redd number 2 in Upper Trapper Side Channel.

Table 18. Substrate sieve analysis data for Upper Trapper Side Channel redd number 3 (R-3).

SIDE CHANNEL	SAMPLE NUMBER[1]	SIEVE NUMBER	SIEVE SIZE (IN)	CUM WEIGHT (GMS)	% PASSING	% PER CLASS
UPPER TRAPPER	R-3A	5	5			
UPPER TRAPPER	R-3A	3	3	0	100	96.9
UPPER TRAPPER	R-3A	1	1	1378	3.1	3.1
UPPER TRAPPER	R-3A	4	0.187	1422	0	0
UPPER TRAPPER	R-3A	10	0.0787	1422	0	0
UPPER TRAPPER	R-3A	35	0.0197	1422	0	0
UPPER TRAPPER	R-3A	50	0.0116	1422	0	0
UPPER TRAPPER	R-3A	100	0.0059	1422	0	0
UPPER TRAPPER	R-3A	230	0.0025	1422	0	0
UPPER TRAPPER	R-3A	TOTAL		1422	0	100
UPPER TRAPPER	R-3B	5	5			
UPPER TRAPPER	R-3B	3	3	0	100	68
UPPER TRAPPER	R-3B	1	1	475	32	30
UPPER TRAPPER	R-3B	4	0.187	689	2	0.6
UPPER TRAPPER	R-3B	10	0.0787	693	1.4	0.4
UPPER TRAPPER	R-3B	35	0.0197	696	1	0.1
UPPER TRAPPER	R-3B	50	0.0116	697	0.9	0.3
UPPER TRAPPER	R-3B	100	0.0059	699	0.6	0.5
UPPER TRAPPER	R-3B	230	0.0025	702	0.1	0.1
UPPER TRAPPER	R-3B	TOTAL		703		100
UPPER TRAPPER	R-3C	5	5			
UPPER TRAPPER	R-3C	3	3	0	100	15
UPPER TRAPPER	R-3C	1	1	121	85	57
UPPER TRAPPER	R-3C	4	0.187	587	28	10
UPPER TRAPPER	R-3C	10	0.0787	663	18	7
UPPER TRAPPER	R-3C	35	0.0197	720	11	1.9
UPPER TRAPPER	R-3C	50	0.0116	739	9.1	4.7
UPPER TRAPPER	R-3C	100	0.0059	777	4.4	3.8
UPPER TRAPPER	R-3C	230	0.0025	808	0.6	0.6
UPPER TRAPPER	R-3C	TOTAL		813		100
UPPER TRAPPER	R-3D	5	5			
UPPER TRAPPER	R-3D	3	3			
UPPER TRAPPER	R-3D	1	1	0	100	42
UPPER TRAPPER	R-3D	4	0.187	44	58	28
UPPER TRAPPER	R-3D	10	0.0787	73	30	19
UPPER TRAPPER	R-3D	35	0.0197	93	11	4.3
UPPER TRAPPER	R-3D	50	0.0116	97	6.7	5.7
UPPER TRAPPER	R-3D	100	0.0059	103	1	1
UPPER TRAPPER	R-3D	230	0.0025	104	0	0
UPPER TRAPPER	R-3D	TOTAL	-	104		100

[1] R3-A: Substrate sample obtained from chum redd labeled R3 at a depth of 0-4 inches.
R3-B: 5-8 inches
R3-C: 9-12 inches
R3-D: 13-16 inches



GRAVEL		SAND			SILT OR CLAY
Coarse	Fine	Coarse	Medium	Fine	

Sample Identification				Classification Data					Unified Class	Remarks
Sym	Hole	Samp	Depth	Cu	Cz	LL	PI	% Org		
▲		R-3A	SURFACE							
□		R-3B	4"							
o		R-3C	8"							
+		R-3D	12"							

DWN.
CKD.
DATE. 7/11/85
SCALE

R&M CONSULTANTS, INC.

ALASKA DEPT OF FISH & GAME
SUSITNA HABITAT SUBSTRATE
TRAPPER REDDCORE #3

FB.
GRID.
PROJ.NO. 551053
DWG NO.

Figure 15. Depth integrated substrated composition, percent by weight passing each sieve size for redd number 3 in Upper Trapper Side Channel.

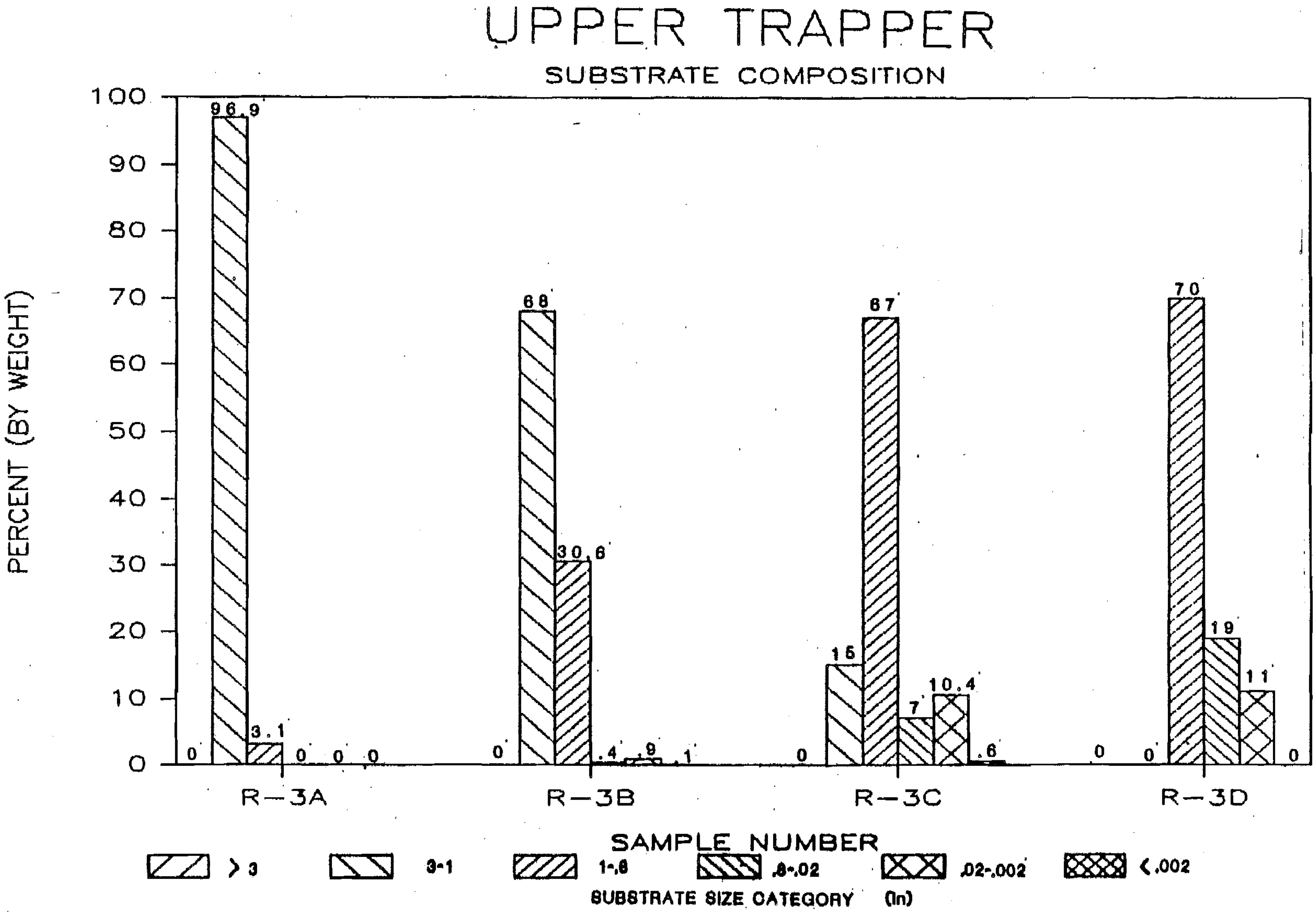
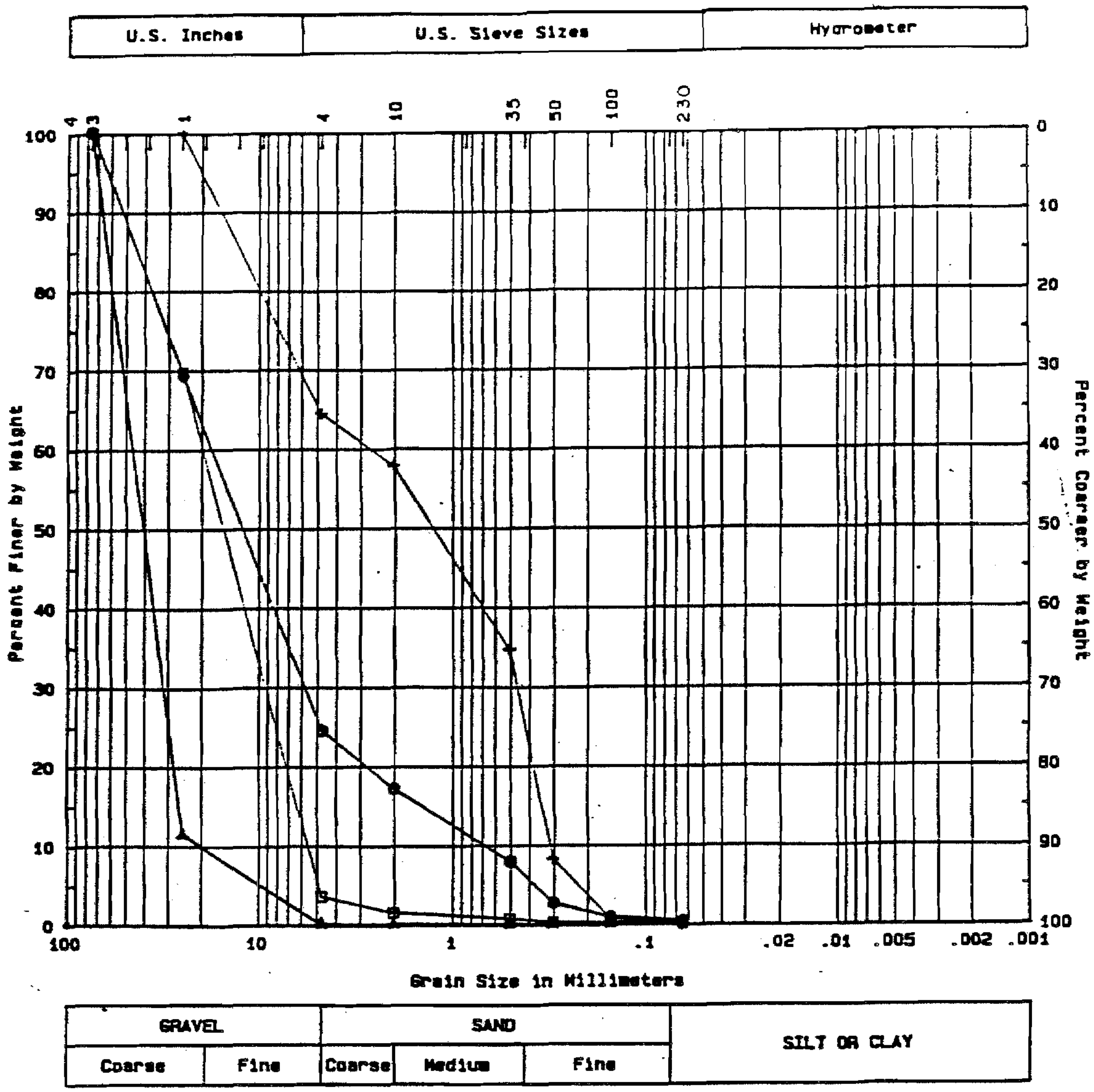


Figure 16. Depth integrated substrate compoisition by weight from redd number 3 in Upper Trapper Side Channel.

Table 19. Substrate sieve analysis data for Upper Trapper Side Channel redd number 4 (R-4).

SIDE CHANNEL	SAMPLE[1] NUMBER	SIEVE NUMBER	SIEVE SIZE (IN)	CUM WEIGHT (GMS)	% PASSING	% PER CLASS
UPPER TRAPPER	R4-A	5	5			
UPPER TRAPPER	R4-A	3	3	0	100	89
UPPER TRAPPER	R4-A	1	1	1135	11	10.9
UPPER TRAPPER	R4-A	4	0.187	1283	0.1	0
UPPER TRAPPER	R4-A	10	0.0787	1283	0.1	0.1
UPPER TRAPPER	R4-A	35	0.0197	1284	0	0
UPPER TRAPPER	R4-A	50	0.0116	1284	0	0
UPPER TRAPPER	R4-A	100	0.0059	1284	0	0
UPPER TRAPPER	R4-A	230	0.0025	1284	0	0
UPPER TRAPPER	R4-A	TOTAL		1284		100
UPPER TRAPPER	R4-B	5	5			
UPPER TRAPPER	R4-B	3	3	0	100	30
UPPER TRAPPER	R4-B	1	1	147	70	66.5
UPPER TRAPPER	R4-B	4	0.187	467	3.5	2.1
UPPER TRAPPER	R4-B	10	0.0787	477	1.4	0.8
UPPER TRAPPER	R4-B	35	0.0197	481	0.6	0.4
UPPER TRAPPER	R4-B	50	0.0116	483	0.2	0
UPPER TRAPPER	R4-B	100	0.0059	483	0.2	0.2
UPPER TRAPPER	R4-B	230	0.0025	484	0	0
UPPER TRAPPER	R4-B	TOTAL		484		100
UPPER TRAPPER	R4-C	5	5			
UPPER TRAPPER	R4-C	3	3	0	100	31
UPPER TRAPPER	R4-C	1	1	247	69	45
UPPER TRAPPER	R4-C	4	0.187	606	24	7
UPPER TRAPPER	R4-C	10	0.0787	665	17	9.1
UPPER TRAPPER	R4-C	35	0.0197	739	7.9	5.3
UPPER TRAPPER	R4-C	50	0.0116	781	2.6	1.7
UPPER TRAPPER	R4-C	100	0.0059	795	0.9	0.5
UPPER TRAPPER	R4-C	230	0.0025	799	0.4	0.4
UPPER TRAPPER	R4-C	TOTAL		802		100
UPPER TRAPPER	R4-D	5	5			
UPPER TRAPPER	R4-D	3	3			
UPPER TRAPPER	R4-D	1	1	0	100	36
UPPER TRAPPER	R4-D	4	0.187	43	64	6
UPPER TRAPPER	R4-D	10	0.0787	51	58	23
UPPER TRAPPER	R4-D	35	0.0197	79	35	26.7
UPPER TRAPPER	R4-D	50	0.0116	111	8.3	7.5
UPPER TRAPPER	R4-D	100	0.0059	120	0.8	0.8
UPPER TRAPPER	R4-D	230	0.0025	121	0	0
UPPER TRAPPER	R4-D	TOTAL		121		100

[1] R4-A: Substrate sample obtained from chum redd labeled R4 at a depth of 0-4 inches.
R4-B: 5-8 inches
R4-C: 9-12 inches
R4-D: 13-16 inches



Sample Identification				Classification Data					Unified Class	Remarks
Sym	Hole	Samp	Depth	Cu	Cz	LL	PI	% Org		
△		R4-A	SURFACE							
□		R4-B	4"							
○		R4-C	8"							
+		R4-D	12"							

DWN CKD DATE 7/11/85 SCALE	R&M CONSULTANTS, INC. ENGINEERS GEOLOGISTS PLANNERS SURVEYORS	ALASKA DEPT OF FISH & GAME SUSITNA HABITAT SUBSTRATE TRAPPER REDDCORE #4	FB GRID PROJ NO 551053 DWG NO

Figure 17. Depth integrated substrate composition, percent by weight passing each sieve size for redd number 4 in Upper Trapper Side Channel.

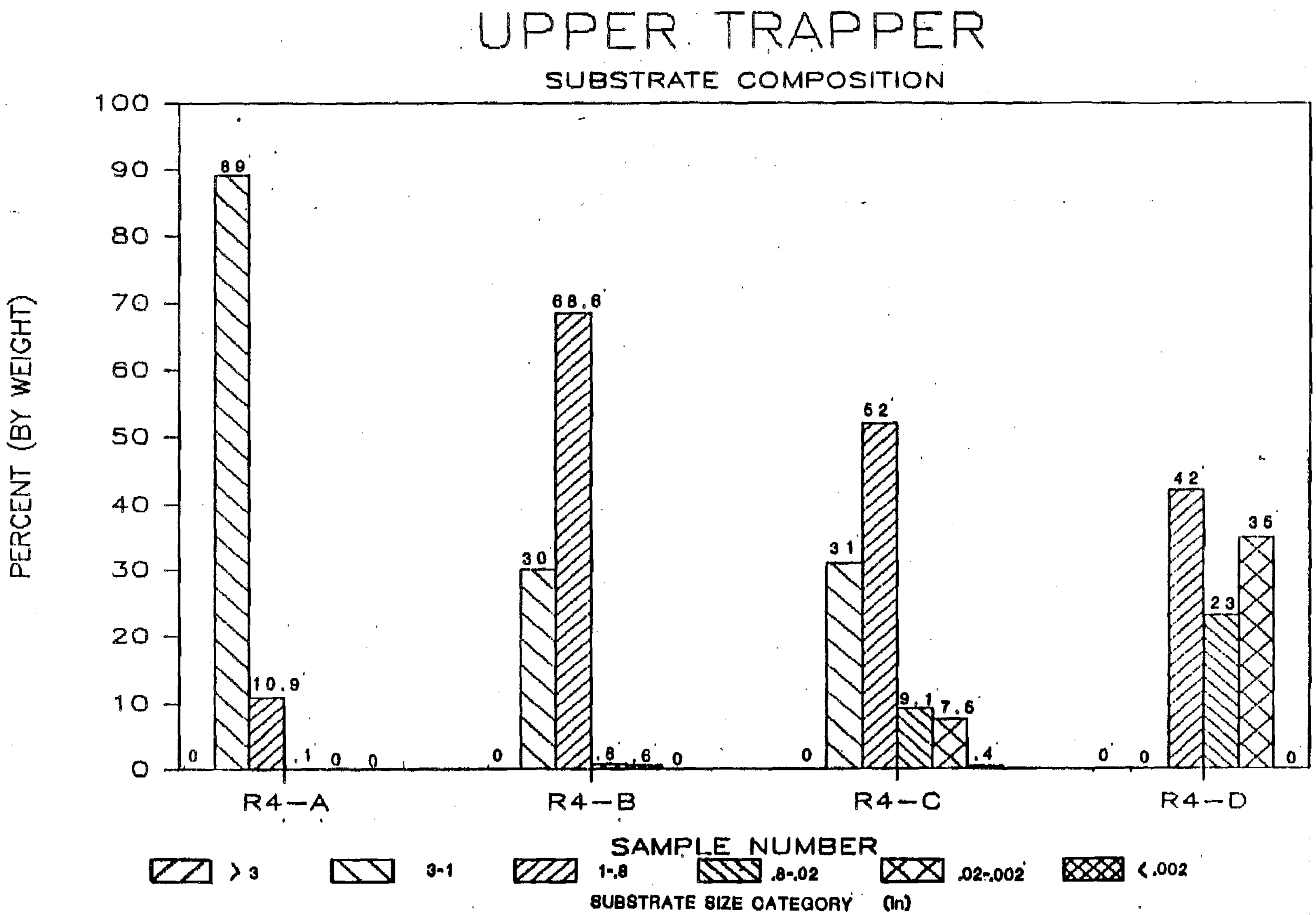
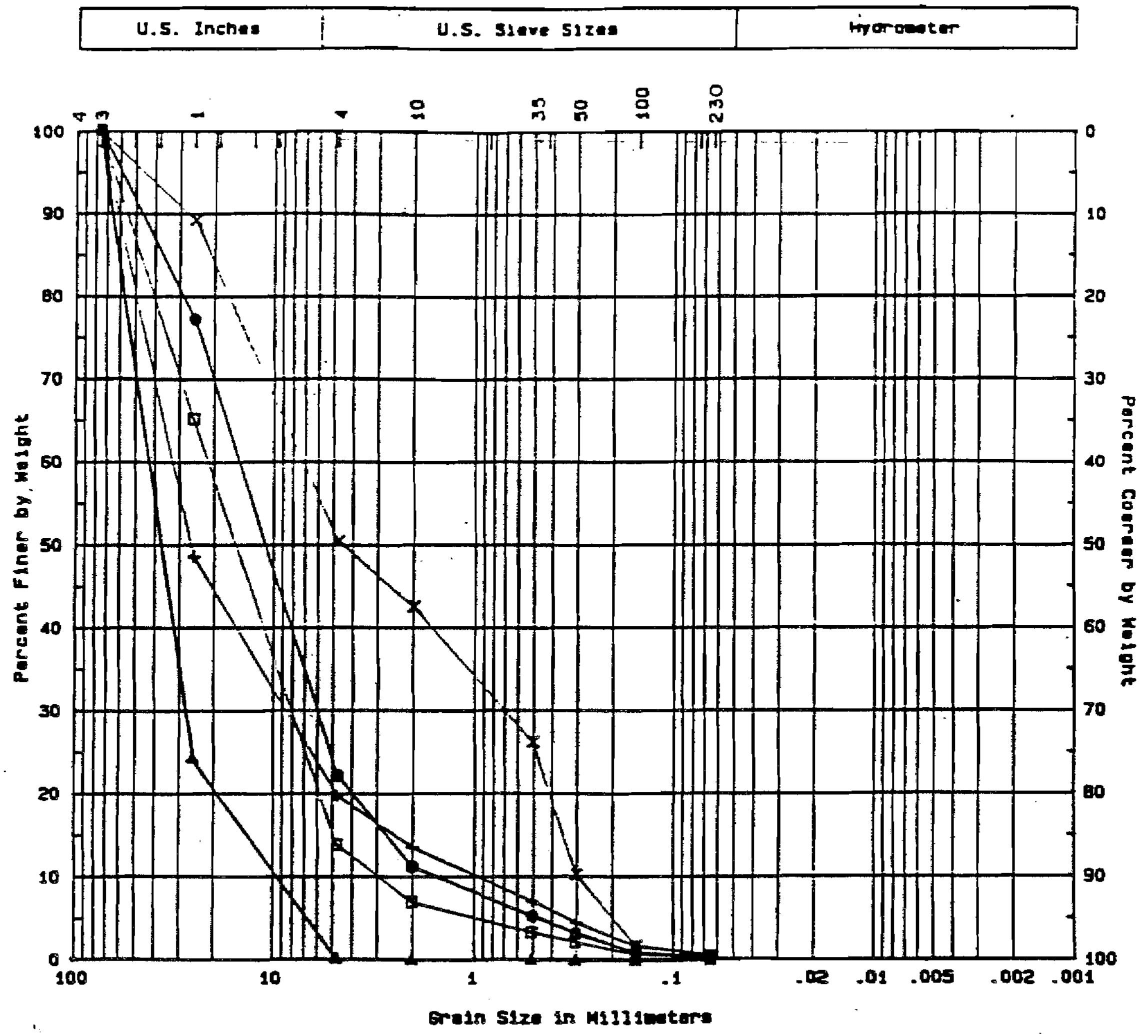


Figure 18. Depth integrated substrate composition by weight from redd number 4 in Upper Trapper Side Channel.

Table 20. Substrate sieve analysis data for Lower Trapper Side Channel redd number 2 (R-2).

SIDE CHANNEL	SAMPLE NUMBER[1]	SIEVE NUMBER	SIEVE SIZE (IN)	CUM WEIGHT (GMS)	% PASSING	% PER CLASS
LOWER TRAPPER	R2-A	5	5			
LOWER TRAPPER	R2-A	3	3	0	100	76
LOWER TRAPPER	R2-A	1	1	1068	24	23.9
LOWER TRAPPER	R2-A	4	0.187	1409	0.1	0
LOWER TRAPPER	R2-A	10	0.0787	1410	0.1	0
LOWER TRAPPER	R2-A	35	0.0197	1410	0.1	0.1
LOWER TRAPPER	R2-A	50	0.0116	1411	0	0
LOWER TRAPPER	R2-A	100	0.0059	1411	0	0
LOWER TRAPPER	R2-A	230	0.0025	1411	0	0
LOWER TRAPPER	R2-A	TOTAL		1411		100
LOWER TRAPPER	R2-B	5	5			
LOWER TRAPPER	R2-B	3	3	0	100	35
LOWER TRAPPER	R2-B	1	1	419	65	51
LOWER TRAPPER	R2-B	4	0.187	1037	14	7.1
LOWER TRAPPER	R2-B	10	0.0787	1120	6.9	3.7
LOWER TRAPPER	R2-B	35	0.0197	1164	3.2	1.1
LOWER TRAPPER	R2-B	50	0.0116	1178	2.1	1.5
LOWER TRAPPER	R2-B	100	0.0059	1196	0.6	0.2
LOWER TRAPPER	R2-B	230	0.0025	1198	0.4	0.4
LOWER TRAPPER	R2-B	TOTAL		1203		100
LOWER TRAPPER	R2-C	5	5			
LOWER TRAPPER	R2-C	3	3	0	100	23
LOWER TRAPPER	R2-C	1	1	363	77	55
LOWER TRAPPER	R2-C	4	0.187	1239	22	11
LOWER TRAPPER	R2-C	10	0.0787	1414	11	5.7
LOWER TRAPPER	R2-C	35	0.0197	1508	5.3	2.1
LOWER TRAPPER	R2-C	50	0.0116	1541	3.2	2.4
LOWER TRAPPER	R2-C	100	0.0059	1579	0.8	0.5
LOWER TRAPPER	R2-C	230	0.0025	1588	0.3	0.3
LOWER TRAPPER	R2-C	TOTAL		1592		100
LOWER TRAPPER	R2-D	5	5			
LOWER TRAPPER	R2-D	3	3	0	100	51
LOWER TRAPPER	R2-D	1	1	1298	49	29
LOWER TRAPPER	R2-D	4	0.187	2023	20	6
LOWER TRAPPER	R2-D	10	0.0787	2181	14	6.9
LOWER TRAPPER	R2-D	35	0.0197	2344	7.1	2.5
LOWER TRAPPER	R2-D	50	0.0116	2409	4.6	2.9
LOWER TRAPPER	R2-D	100	0.0059	2481	1.7	1
LOWER TRAPPER	R2-D	230	0.0025	2506	0.7	0.7
LOWER TRAPPER	R2-D	TOTAL		2524		100
LOWER TRAPPER	R2-E	5	5			
LOWER TRAPPER	R2-E	3	3	0	100	11
LOWER TRAPPER	R2-E	1	1	88	89	38
LOWER TRAPPER	R2-E	4	0.187	406	51	8
LOWER TRAPPER	R2-E	10	0.0787	471	43	17
LOWER TRAPPER	R2-E	35	0.0197	605	26	16
LOWER TRAPPER	R2-E	50	0.0116	736	10	8.2
LOWER TRAPPER	R2-E	100	0.0059	806	1.8	1.2
LOWER TRAPPER	R2-E	230	0.0025	816	0.6	0.6
LOWER TRAPPER	R2-E	TOTAL		821		100

[1] R2-A: Substrate sample obtained from chum redd labeled R2 at a depth of 0-4 inches.
R2-B: 5-8 inches
R2-C: 9-12 inches
R2-D: 13-16 inches
R2-E: 17-20 inches



GRAVEL		SAND			SILT OR CLAY
Coarse	Fine	Coarse	Medium	Fine	

Sample Identification				Classification Data					Unified Class	Remarks
Sym	Hole	Samp	Depth	Cu	Cz	LL	PI	% Org		
▲		R2B-A	SURFACE							
□		R2B-B	4"							
o		R2B-C	8"							
+		R2B-D	12"							
x		R2B-E	16"							

DWN	
CKD	
DATE	7/11/85
SCALE	

R&M CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

ALASKA DEPT OF FISH & GAME
SUSITNA HABITAT SUBSTRATE
LOWER TRAPPER

FB	
GRID	
PROJ NO	551053
DWG NO	

Figure 19. Depth integrated substrate composition, percent by weight passing each sieve size for redd number 2 in Lower Trapper Side Channel.

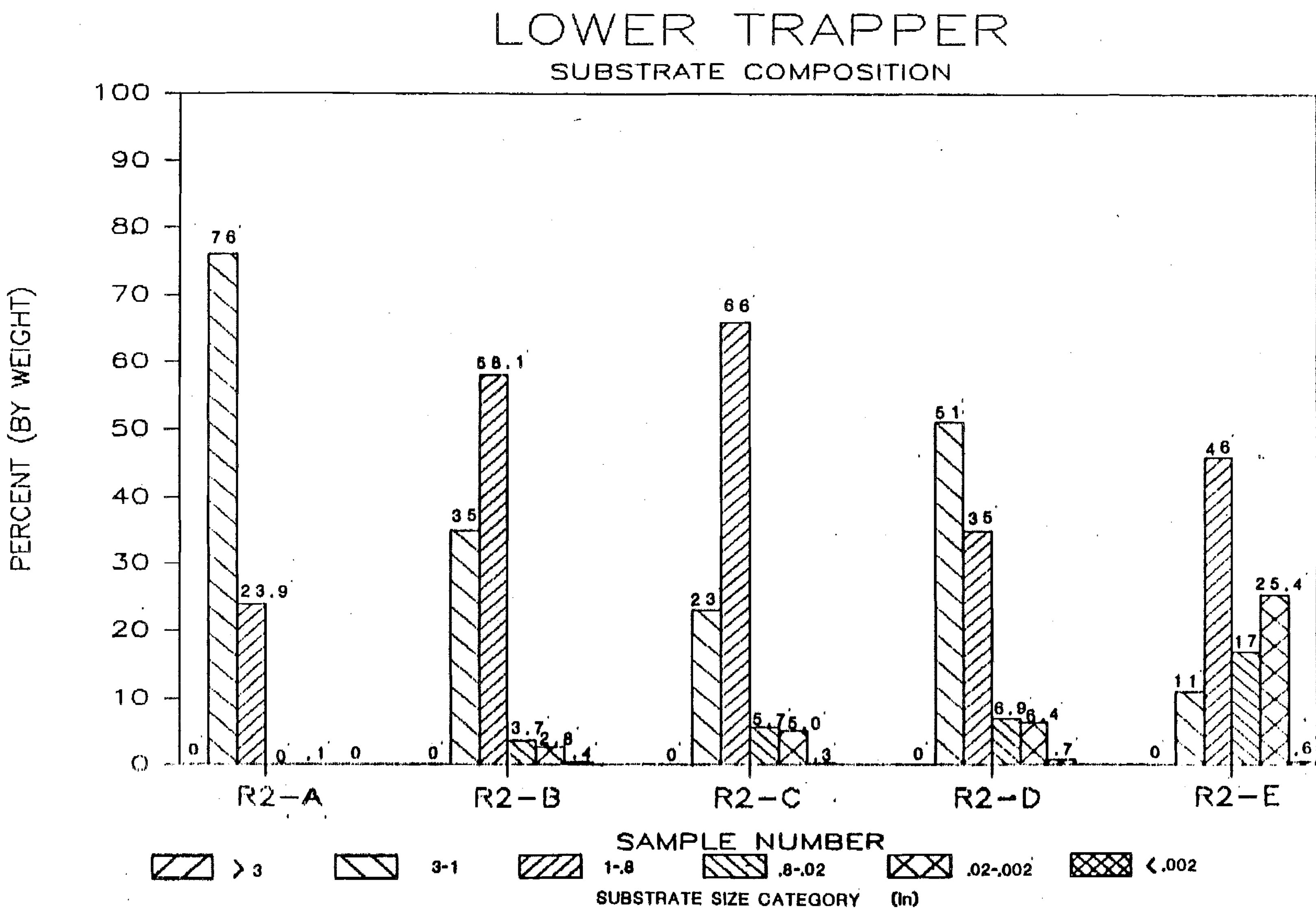
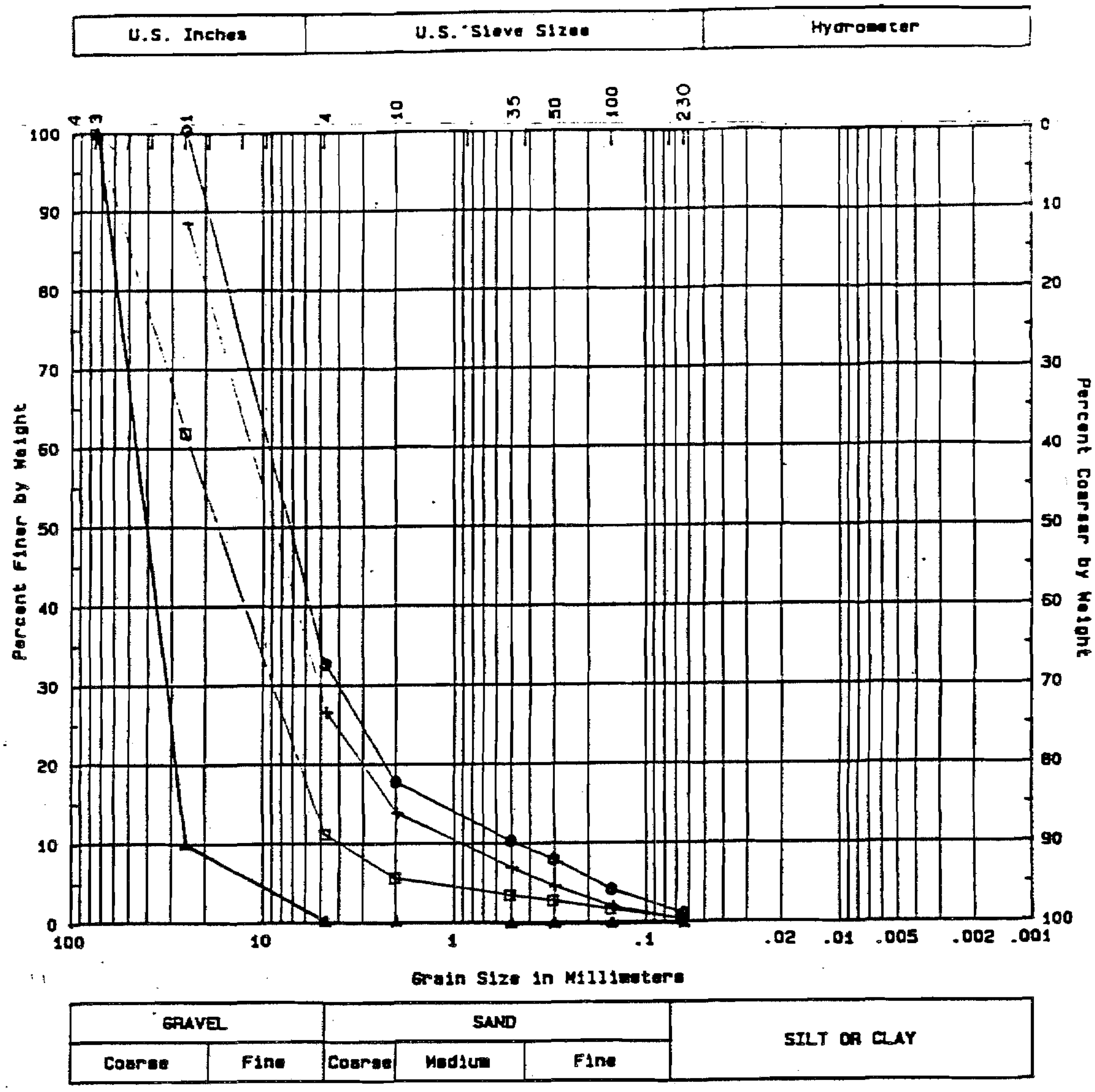


Figure 20. Depth integrated substrate composition by weight from redd number 2 in Lower Trapper Side Channel.

Table 21. Substrate sieve analysis data for Upper Sunset Side Channel redd number 6 (R-6).

SIDE CHANNEL	SAMPLE NUMBER[1]	SIEVE NUMBER	SIEVE SIZE (IN)	CUM WEIGHT (GMS)	% PASSING	% PER CLASS
UPPER SUNSET	R6-6-A	5.00	5			
UPPER SUNSET	R6-6-A	3.00	3	0	100	90
UPPER SUNSET	R6-6-A	1.00	1	378	10	9.8
UPPER SUNSET	R6-6-A	4.00	0.187	419	0.2	0
UPPER SUNSET	R6-6-A	10.00	0.0787	419	0.2	0.2
UPPER SUNSET	R6-6-A	35.00	0.0197	420	0	0
UPPER SUNSET	R6-6-A	50.00	0.0116	420	0	0
UPPER SUNSET	R6-6-A	100.00	0.0059	420	0	0
UPPER SUNSET	R6-6-A	230.00	0.0025	420	0	0
UPPER SUNSET	R6-6-A	TOTAL		420		100
UPPER SUNSET	R6-6-B	5.00	5			
UPPER SUNSET	R6-6-B	3.00	3	0	100	38
UPPER SUNSET	R6-6-B	1.00	1	269	62	51
UPPER SUNSET	R6-6-B	4.00	0.187	628	11	5.2
UPPER SUNSET	R6-6-B	10.00	0.0787	667	5.8	2.1
UPPER SUNSET	R6-6-B	35.00	0.0197	682	3.7	0.7
UPPER SUNSET	R6-6-B	50.00	0.0116	687	3	1.2
UPPER SUNSET	R6-6-B	100.00	0.0059	695	1.8	1.2
UPPER SUNSET	R6-6-B	230.00	0.0025	704	0.6	0.6
UPPER SUNSET	R6-6-B	TOTAL		708		100
UPPER SUNSET	R6-6-C	5.00	5			
UPPER SUNSET	R6-6-C	3.00	3			
UPPER SUNSET	R6-6-C	1.00	1	0	100	68
UPPER SUNSET	R6-6-C	4.00	0.187	521	32	15
UPPER SUNSET	R6-6-C	10.00	0.0787	636	17	7
UPPER SUNSET	R6-6-C	35.00	0.0197	693	10	2.3
UPPER SUNSET	R6-6-C	50.00	0.0116	711	7.7	3.8
UPPER SUNSET	R6-6-C	100.00	0.0059	740	3.9	3.1
UPPER SUNSET	R6-6-C	230.00	0.0025	764	0.8	0.8
UPPER SUNSET	R6-6-C	TOTAL		770		100
UPPER SUNSET	R6-6-D	5.00	5			
UPPER SUNSET	R6-6-D	3.00	3	0	100	12
UPPER SUNSET	R6-6-D	1.00	1	49	88	61
UPPER SUNSET	R6-6-D	4.00	0.187	312	27	13
UPPER SUNSET	R6-6-D	10.00	0.0787	366	14	6.9
UPPER SUNSET	R6-6-D	35.00	0.0197	395	7.1	2.4
UPPER SUNSET	R6-6-D	50.00	0.0116	405	4.7	2.6
UPPER SUNSET	R6-6-D	100.00	0.0059	416	2.1	1.6
UPPER SUNSET	R6-6-D	230.00	0.0025	423	0.5	0.5
UPPER SUNSET	R6-6-D	TOTAL		425		100

[1] R6-6-A: Substrate sample obtained from chum redd labeled R6-6 at a depth of 0-4 inches.
R6-6-B: 5-8 inches
R6-6-C: 9-12 inches
R6-6-D: 13-16 inches



Sample Identification				Classification Data					Unified Class	Remarks
Sym	Hole	Samp	Depth	Cu	Cz	LL	PI	% Org		
△	SS	RG-6-A	SURFACE							
□	SS	RG-6-B	4"							
○	SS	RG-6-C	8"							
+	SS	RG-6-D	12"							

DWN CKD DATE 7/11/85 SCALE	R&M CONSULTANTS, INC. ENGINEERS GEOLOGISTS PLANNERS SURVEYORS	ALASKA DEPT OF FISH & GAME SUSITNA HABITAT SUBSTRATE SS RG-6	FB GRID PROJ NO 551053 DWG NO

Figure 21. Depth integrated substrate composition, percent by weight passing each sieve size for redd number G-6 in Upper Sunset Side Channel.

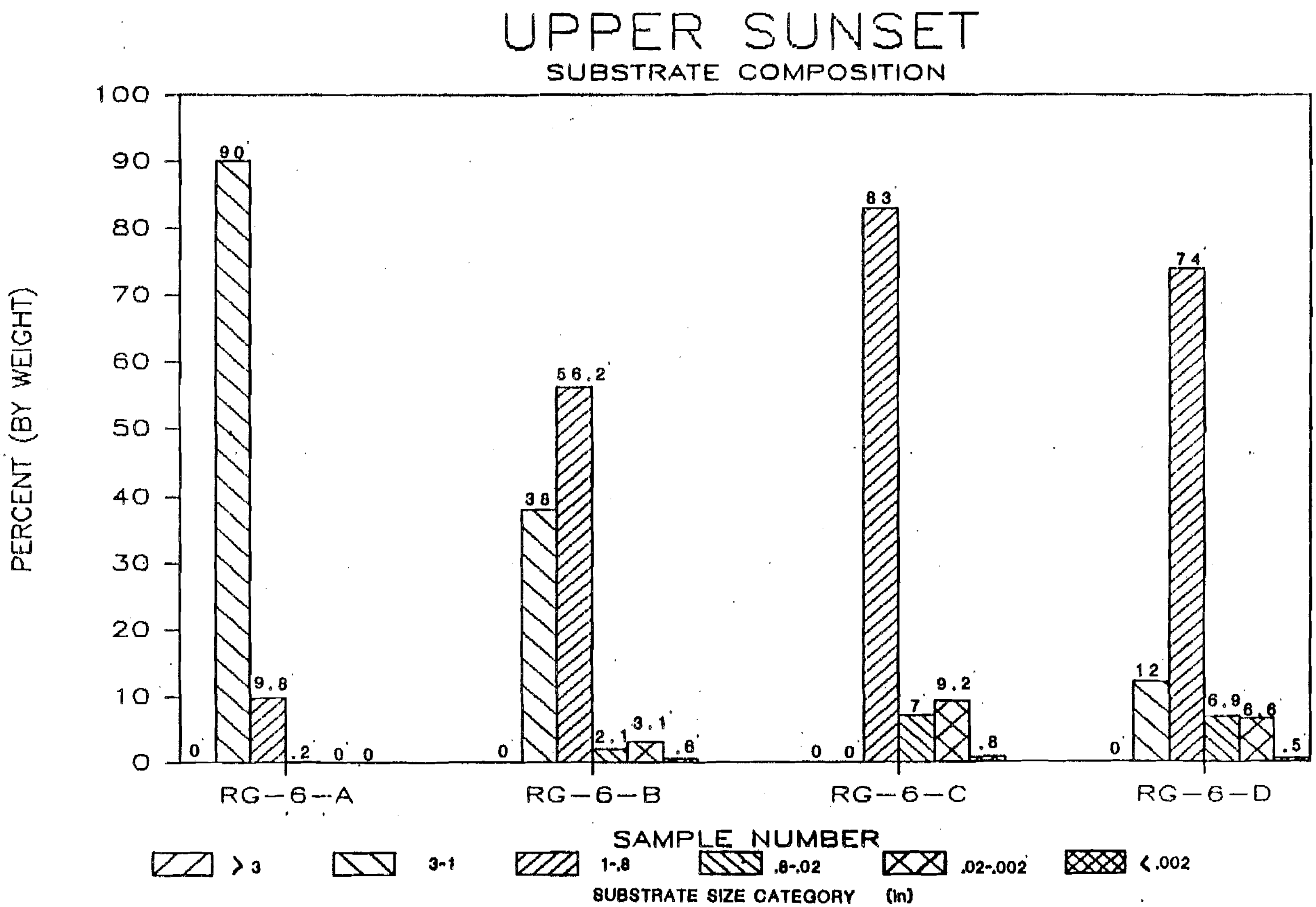
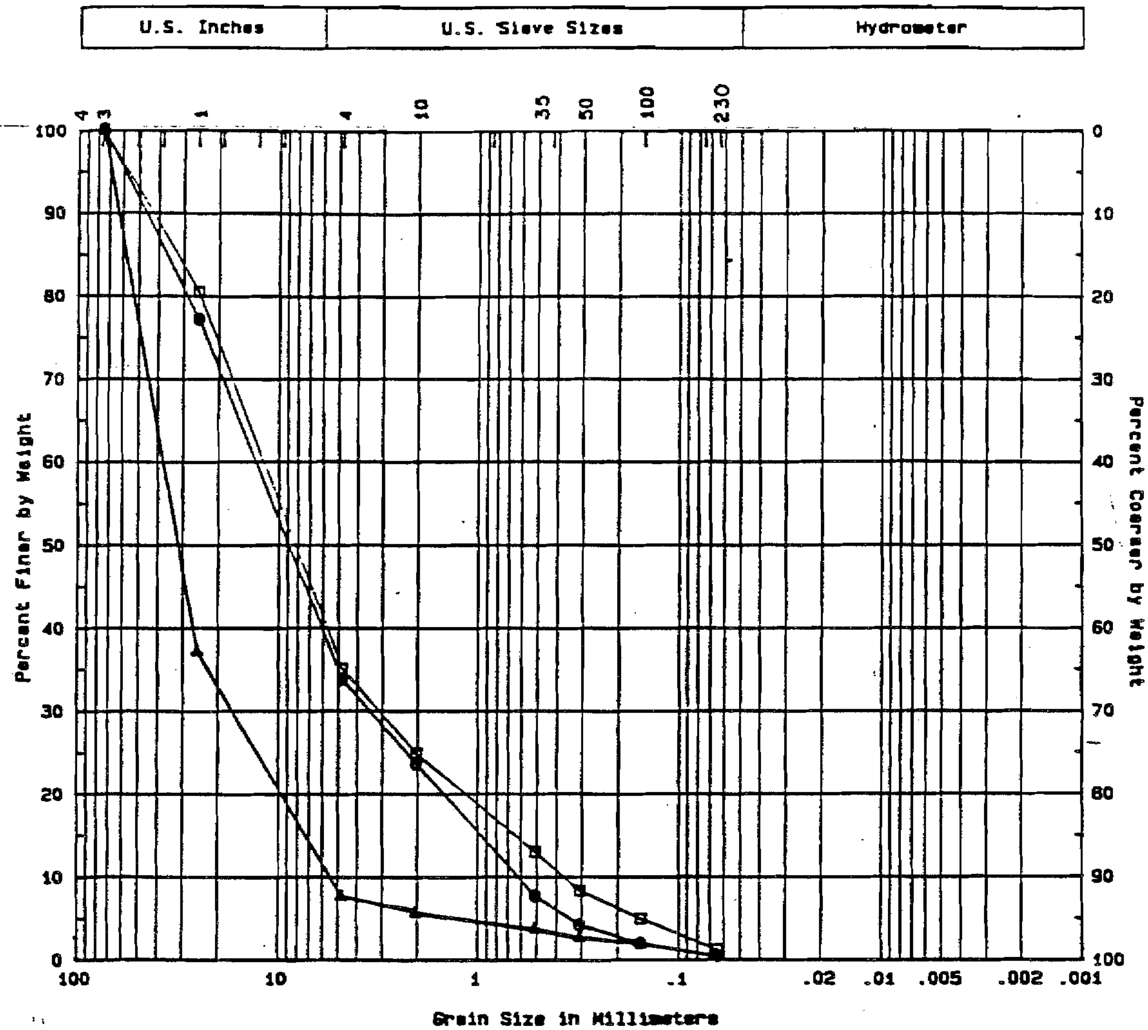


Figure 22. Depth integrated substrate composition by weight from redd number G-6 in Upper Sunset Side Channel.

Table 22. Substrate sieve analysis data for Upper Sunset Side Channel redd number 6A (R-6A).

SIDE CHANNEL	SAMPLE NUMBER	SIEVE NUMBER	SIEVE SIZE (IN)	CUM WEIGHT (GMS)	% PASSING	% PER CLASS
UPPER SUNSET	R6A-A	5.00	5			
UPPER SUNSET	R6A-A	3.00	3	0	100	63
UPPER SUNSET	R6A-A	1.00	1	609	37	29.5
UPPER SUNSET	R6A-A	4.00	0.187	894	7.5	1.9
UPPER SUNSET	R6A-A	10.00	0.0787	913	5.6	1.9
UPPER SUNSET	R6A-A	35.00	0.0197	931	3.7	1
UPPER SUNSET	R6A-A	50.00	0.0116	941	2.7	0.8
UPPER SUNSET	R6A-A	100.00	0.0059	949	1.9	1.4
UPPER SUNSET	R6A-A	230.00	0.0025	962	0.5	0.5
UPPER SUNSET	R6A-A	TOTAL		967		100
UPPER SUNSET	R6A-B	5.00	5			
UPPER SUNSET	R6A-B	3.00	3	0	100	20
UPPER SUNSET	R6A-B	1.00	1	176	80	45
UPPER SUNSET	R6A-B	4.00	0.187	583	35	10
UPPER SUNSET	R6A-B	10.00	0.0787	675	25	12
UPPER SUNSET	R6A-B	35.00	0.0197	781	13	4.6
UPPER SUNSET	R6A-B	50.00	0.0116	823	8.4	3.4
UPPER SUNSET	R6A-B	100.00	0.0059	853	5	3.7
UPPER SUNSET	R6A-B	230.00	0.0025	886	1.3	1.3
UPPER SUNSET	R6A-B	TOTAL		898		100
UPPER SUNSET	R6A-C	5.00	5			
UPPER SUNSET	R6A-C	3.00	3	0	100	23
UPPER SUNSET	R6A-C	1.00	1	104	77	43
UPPER SUNSET	R6A-C	4.00	0.187	301	34	10
UPPER SUNSET	R6A-C	10.00	0.0787	347	24	16.3
UPPER SUNSET	R6A-C	35.00	0.0197	419	7.7	3.5
UPPER SUNSET	R6A-C	50.00	0.0116	435	4.2	2.2
UPPER SUNSET	R6A-C	100.00	0.0059	445	2	1.6
UPPER SUNSET	R6A-C	230.00	0.0025	452	0.4	0.4
UPPER SUNSET	R6A-C	TOTAL		454		100

R6A-A: Substrate sample obtained from chum redd labeled R6A at a depth of 0-4 inches.
R6A-B: 5-8 inches
R6A-C: 9-12 inches
R6A-D: 13-16 inches



GRAVEL		SAND			SILT OR CLAY
Coarse	Fine	Coarse	Medium	Fine	

Sample Identification				Classification Data					Unified Class	Remarks
Sym	Hole	Samp	Depth	Cu	Cz	LL	PI	% Org		
▲	SS	R6A-A	SURFACE							
□	SS	R6A-B	4"							
O	SS	R6A-C	8"							

DWN
CKD
DATE 7/11/85
SCALE

R&M CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

ALASKA DEPT OF FISH & GAME
SUSITNA HABITAT SUBSTRATE
SS R6A

FB
GRID
PROJ.NO 551053
DWG NO

Figure 23. Depth integrated substrate composition, percent by weight passing sieve size for redd number 6A in Upper Sunset Side Channel.

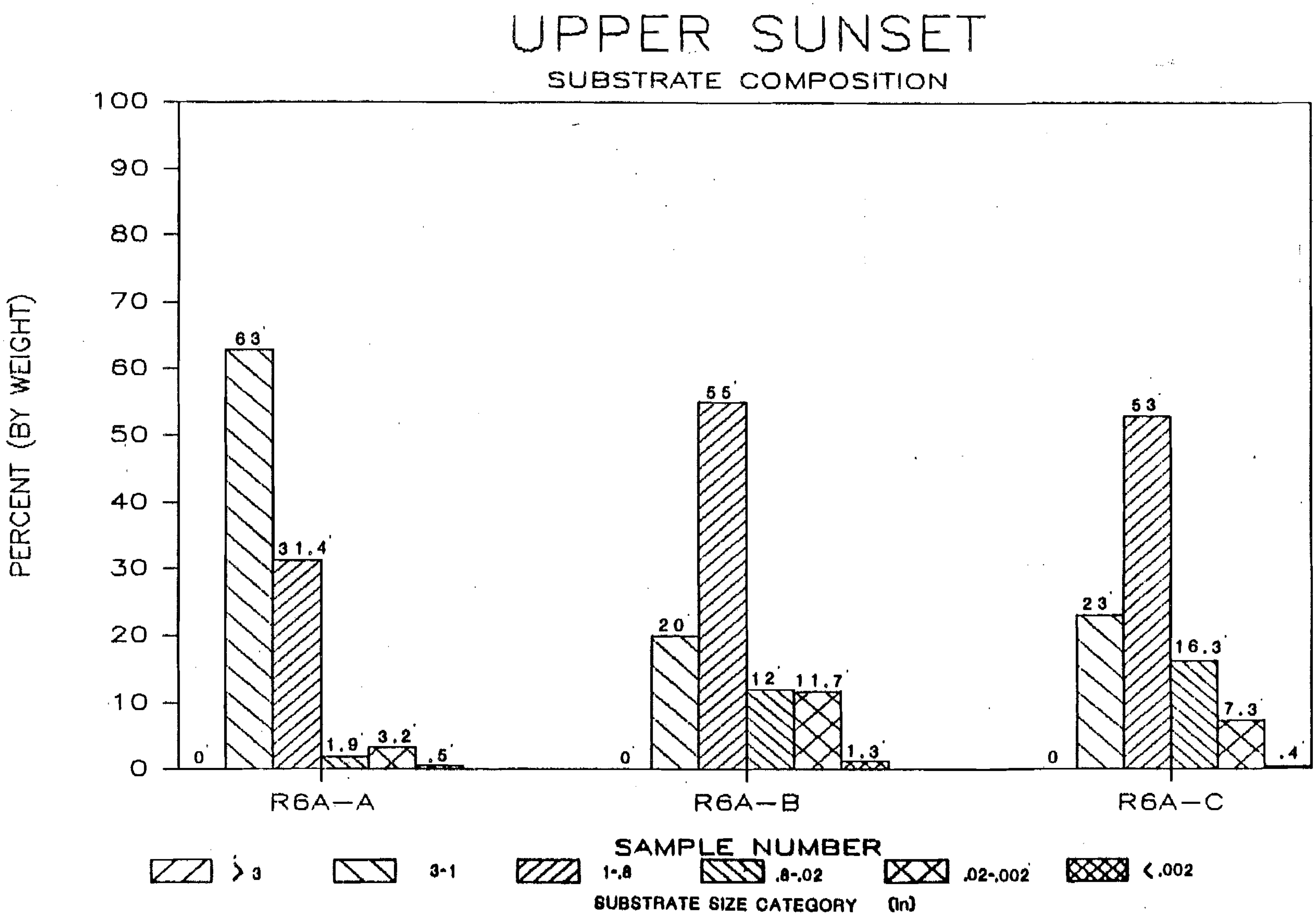
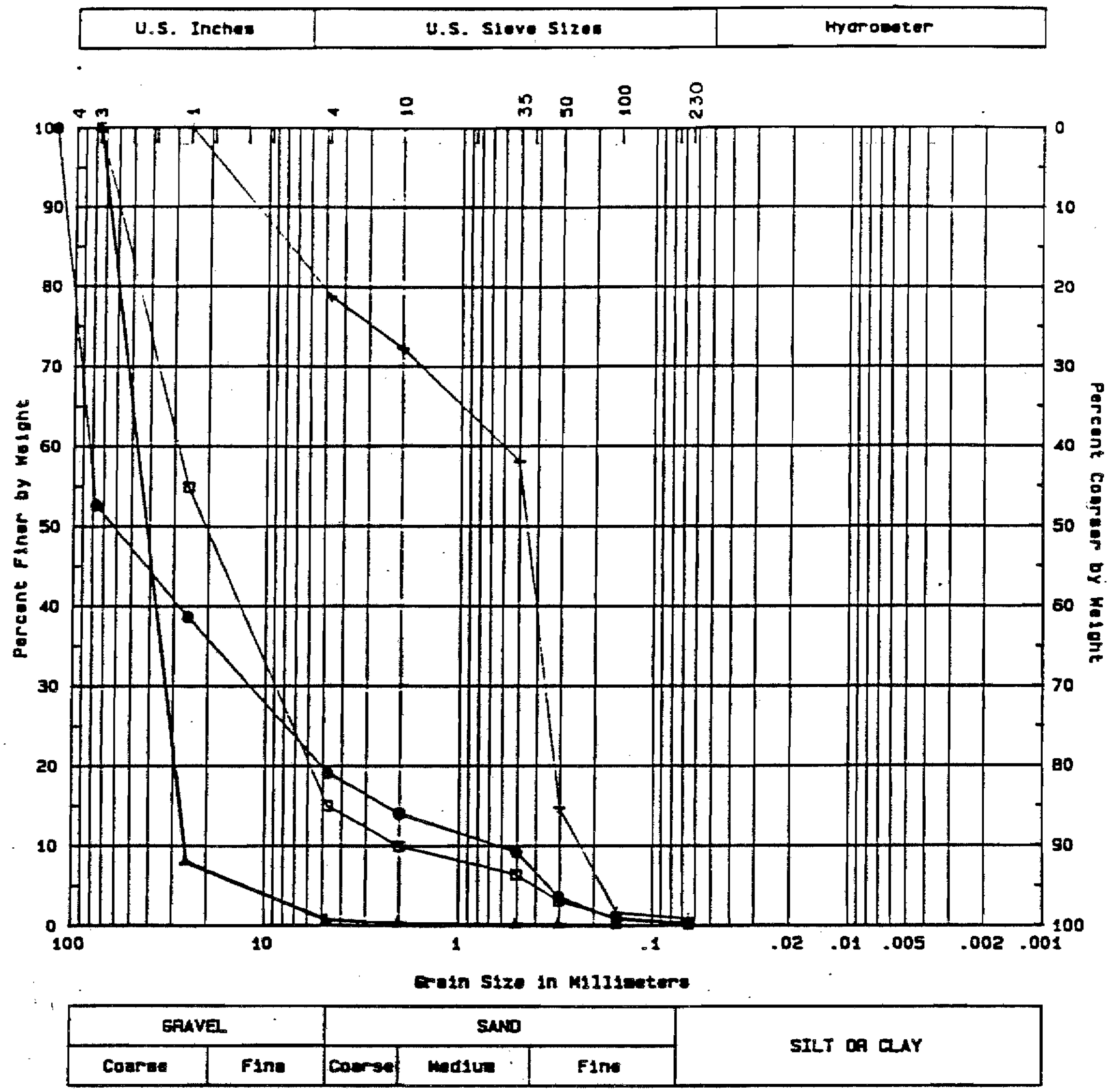


Figure 24. Depth integrated substrate composition by weight from redd number 6A in Upper Sunset Side Channel.

Table 23. Substrate sieve analysis data for Upper Sunset Side Channel redd number 7 (R-7).

SIDE CHANNEL	SAMPLE NUMBER[1]	SIEVE NUMBER	SIEVE SIZE (IN)	CUM WEIGHT (GMS)	% PASSING	% PER CLASS
UPPER SUNSET	R7-A	5.00	5			
UPPER SUNSET	R7-A	3.00	3	0	100	91.9
UPPER SUNSET	R7-A	1.00	1	849	8.1	7.3
UPPER SUNSET	R7-A	4.00	0.187	917	0.8	0.4
UPPER SUNSET	R7-A	10.00	0.0787	920	0.4	0.1
UPPER SUNSET	R7-A	35.00	0.0197	921	0.3	0
UPPER SUNSET	R7-A	50.00	0.0116	921	0.3	0.1
UPPER SUNSET	R7-A	100.00	0.0059	922	0.2	0
UPPER SUNSET	R7-A	230.00	0.0025	922	0.2	0.2
UPPER SUNSET	R7-A	TOTAL		924		100
UPPER SUNSET	R7-B	5.00	5			
UPPER SUNSET	R7-B	3.00	3	0	100	45
UPPER SUNSET	R7-B	1.00	1	865	55	40
UPPER SUNSET	R7-B	4.00	0.187	1628	15	5
UPPER SUNSET	R7-B	10.00	0.0787	1725	10	3.5
UPPER SUNSET	R7-B	35.00	0.0197	1792	6.5	3.4
UPPER SUNSET	R7-B	50.00	0.0116	1856	3.1	2.1
UPPER SUNSET	R7-B	100.00	0.0059	1896	1	0.7
UPPER SUNSET	R7-B	230.00	0.0025	1911	0.3	0.3
UPPER SUNSET	R7-B	TOTAL		1916		100
UPPER SUNSET	R7-C	5.00	5	0	100	47
UPPER SUNSET	R7-C	3.00	3	1138	53	14
UPPER SUNSET	R7-C	1.00	1	1473	39	20
UPPER SUNSET	R7-C	4.00	0.187	1940	19	5
UPPER SUNSET	R7-C	10.00	0.0787	2062	14	4.7
UPPER SUNSET	R7-C	35.00	0.0197	2177	9.3	5.6
UPPER SUNSET	R7-C	50.00	0.0116	2312	3.7	2.8
UPPER SUNSET	R7-C	100.00	0.0059	2380	0.9	0.5
UPPER SUNSET	R7-C	230.00	0.0025	2391	0.4	0.4
UPPER SUNSET	R7-C	TOTAL		2401		100
UPPER SUNSET	R7-D	5.00	5			
UPPER SUNSET	R7-D	3.00	3			
UPPER SUNSET	R7-D	1.00	1	0	100	21
UPPER SUNSET	R7-D	4.00	0.187	106	79	7
UPPER SUNSET	R7-D	10.00	0.0787	139	72	14
UPPER SUNSET	R7-D	35.00	0.0197	210	58	43
UPPER SUNSET	R7-D	50.00	0.0116	428	15	13.2
UPPER SUNSET	R7-D	100.00	0.0059	494	1.8	0.8
UPPER SUNSET	R7-D	230.00	0.0025	498	1	1
UPPER SUNSET	R7-D	TOTAL		503		100

[1] R7-A: Substrate sample obtained from chum redd labeled R7 at a depth of 0-4 inches.
R7-B: 5-8 inches
R7-C: 9-12 inches
R7-D: 13-16 inches



Sample Identification				Classification Data					Unified Class	Remarks
Sym	Hole	Samp	Depth	Cu	Cz	LL	PI	% Org		
▲	SS	R7-A	SURFACE							
□	SS	R7-B	4"							
○	SS	R7-C	8"							
+	SS	R7-D	12"							

DWN	
CKD	
DATE	7/11/85
SCALE	

R&M CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

AKASKA DEPT OF FISH & GAME
SUSITNA HABITAT SUBSTRATE
SS R7

FB.	
GRID	
PROJ.NO	551053
DWG NO	

Figure 25. Depth integrated substrate composition, percent by weight passing each sieve size for redd number 7 in Upper Sunset Side Channel.

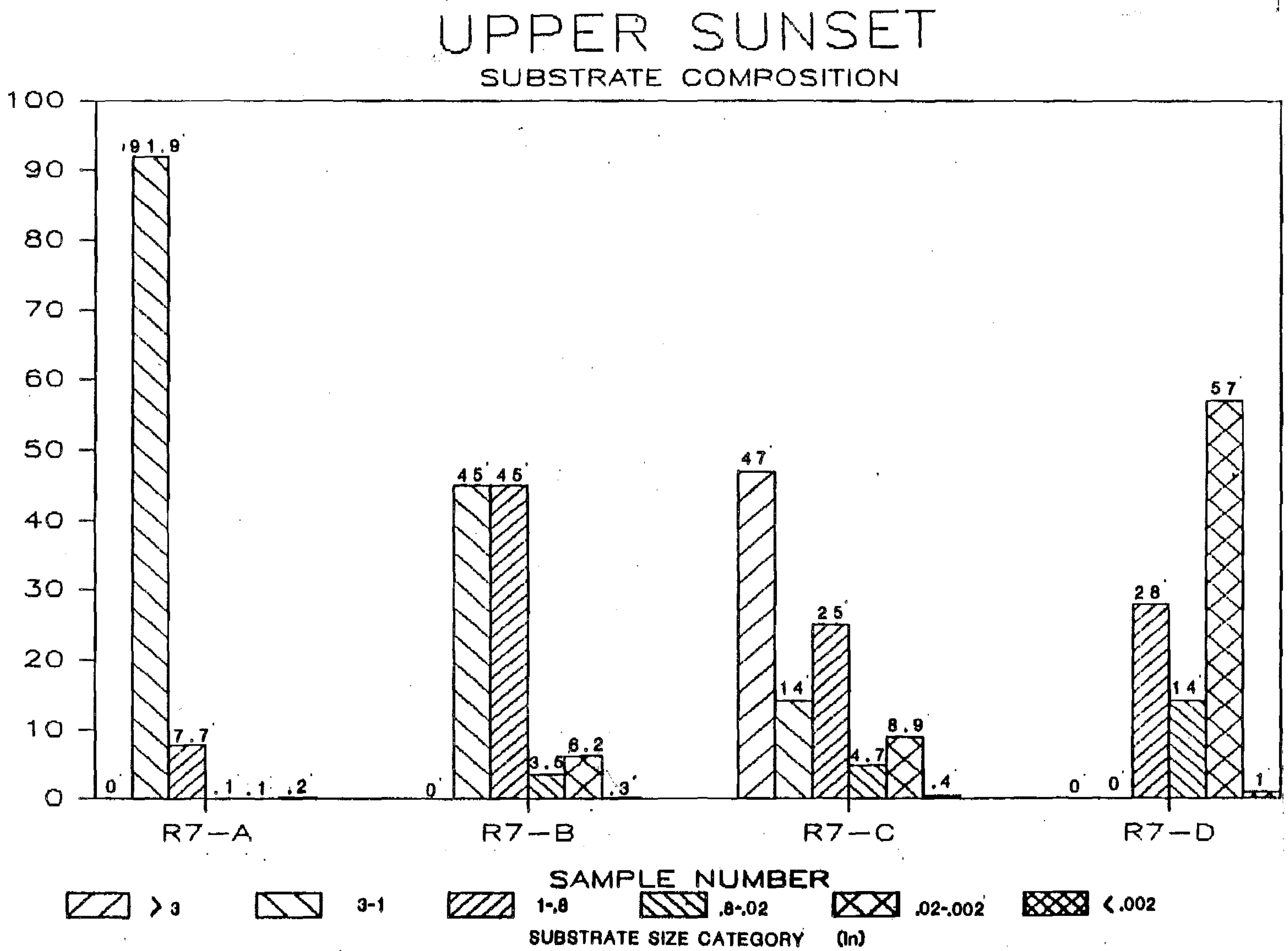
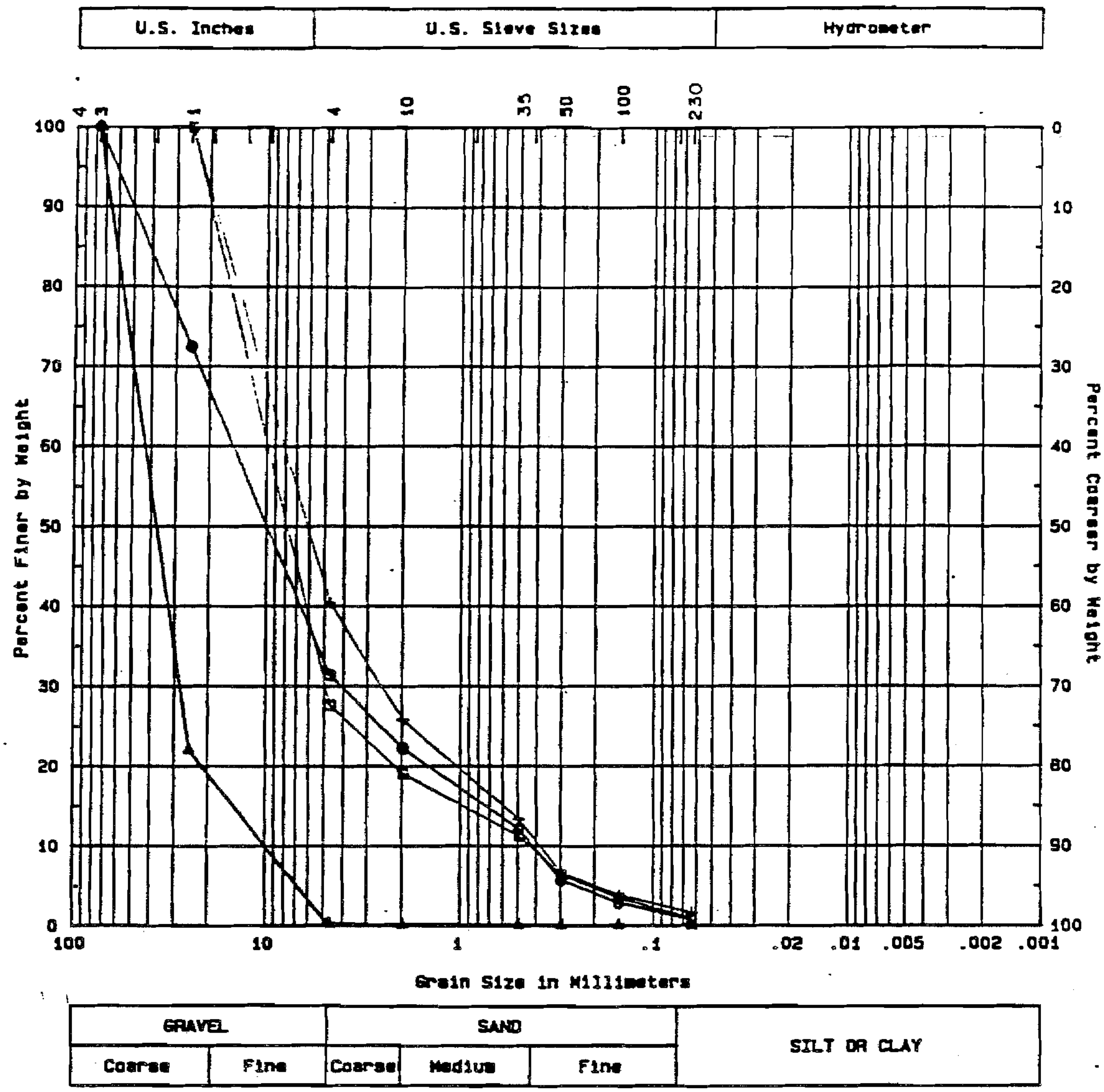


Figure 26. Depth integrated substrate composition by weight from redd number 7 in Upper Sunset Side Channel.

Table 24. Substrate sieve analysis data for Lower Sunset Side Channel redd number 3A (R-3A).

SIDE CHANNEL	SAMPLE[1] NUMBER	SIEVE NUMBER	SIEVE SIZE (IN)	CUM WEIGHT (GMS)	% PASSING	% PER CLASS
LOWER SUNSET	R3A-A	5.00	5			
LOWER SUNSET	R3A-A	3.00	3	0	100	78
LOWER SUNSET	R3A-A	1.00	1	862	22	21.7
LOWER SUNSET	R3A-A	4.00	0.187	1103	0.3	0.1
LOWER SUNSET	R3A-A	10.00	0.0787	1104	0.2	0
LOWER SUNSET	R3A-A	35.00	0.0197	1104	0.2	0.1
LOWER SUNSET	R3A-A	50.00	0.0116	1105	0.1	0
LOWER SUNSET	R3A-A	100.00	0.0059	1105	0.1	0.1
LOWER SUNSET	R3A-A	230.00	0.0025	1106	0	0
LOWER SUNSET	R3A-A	TOTAL		1106		100
LOWER SUNSET	R3A-B	5.00	5			
LOWER SUNSET	R3A-B	3.00	3			
LOWER SUNSET	R3A-B	1.00	1	0	100	72
LOWER SUNSET	R3A-B	4.00	0.187	770	28	9
LOWER SUNSET	R3A-B	10.00	0.0787	861	19	8
LOWER SUNSET	R3A-B	35.00	0.0197	944	11	4.6
LOWER SUNSET	R3A-B	50.00	0.0116	996	6.4	2.9
LOWER SUNSET	R3A-B	100.00	0.0059	1027	3.5	2.6
LOWER SUNSET	R3A-B	230.00	0.0025	1054	0.9	0.9
LOWER SUNSET	R3A-B	TOTAL		1064		100
LOWER SUNSET	R3A-C	5.00	5			
LOWER SUNSET	R3A-C	3.00	3	0	100	28
LOWER SUNSET	R3A-C	1.00	1	183	72	41
LOWER SUNSET	R3A-C	4.00	0.187	456	31	9
LOWER SUNSET	R3A-C	10.00	0.0787	517	22	10
LOWER SUNSET	R3A-C	35.00	0.0197	584	12	6.3
LOWER SUNSET	R3A-C	50.00	0.0116	627	5.7	2.8
LOWER SUNSET	R3A-C	100.00	0.0059	646	2.9	2.1
LOWER SUNSET	R3A-C	230.00	0.0025	660	0.8	0.8
LOWER SUNSET	R3A-C	TOTAL		665		100
LOWER SUNSET	R3A-D	5.00	5			
LOWER SUNSET	R3A-D	3.00	3			
LOWER SUNSET	R3A-D	1.00	1	0	100	60
LOWER SUNSET	R3A-D	4.00	0.187	106	40	14
LOWER SUNSET	R3A-D	10.00	0.0787	132	26	13
LOWER SUNSET	R3A-D	35.00	0.0197	154	13	6.3
LOWER SUNSET	R3A-D	50.00	0.0116	166	6.7	2.8
LOWER SUNSET	R3A-D	100.00	0.0059	171	3.9	2.2
LOWER SUNSET	R3A-D	230.00	0.0025	175	1.7	1.7
LOWER SUNSET	R3A-D	TOTAL		178		100

[1] R3A-A: Substrate sample obtained from chum redd labeled R3A at a depth of 0-4 inches.
R3A-B: 5-8 inches
R3A-C: 9-12 inches
R3A-D: 13-16 inches



Sample Identification				Classification Data					Unified Class	Remarks
Sym	Hole	Samp	Depth	Cu	Cz	LL	PI	% Org		
▲	SS	R3A-A	SURFACE							
□	SS	R3A-B	4"							
○	SS	R3A-C	6"							
+	SS	R3A-D	12"							

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SS R3A

F.B.
GRID.
PROJ.NO 551053
DWG.NO

Figure 27. Depth integrated substrate composition, percent by weight passing each sieve size for redd number 3A in Lower Sunset Side Channel.

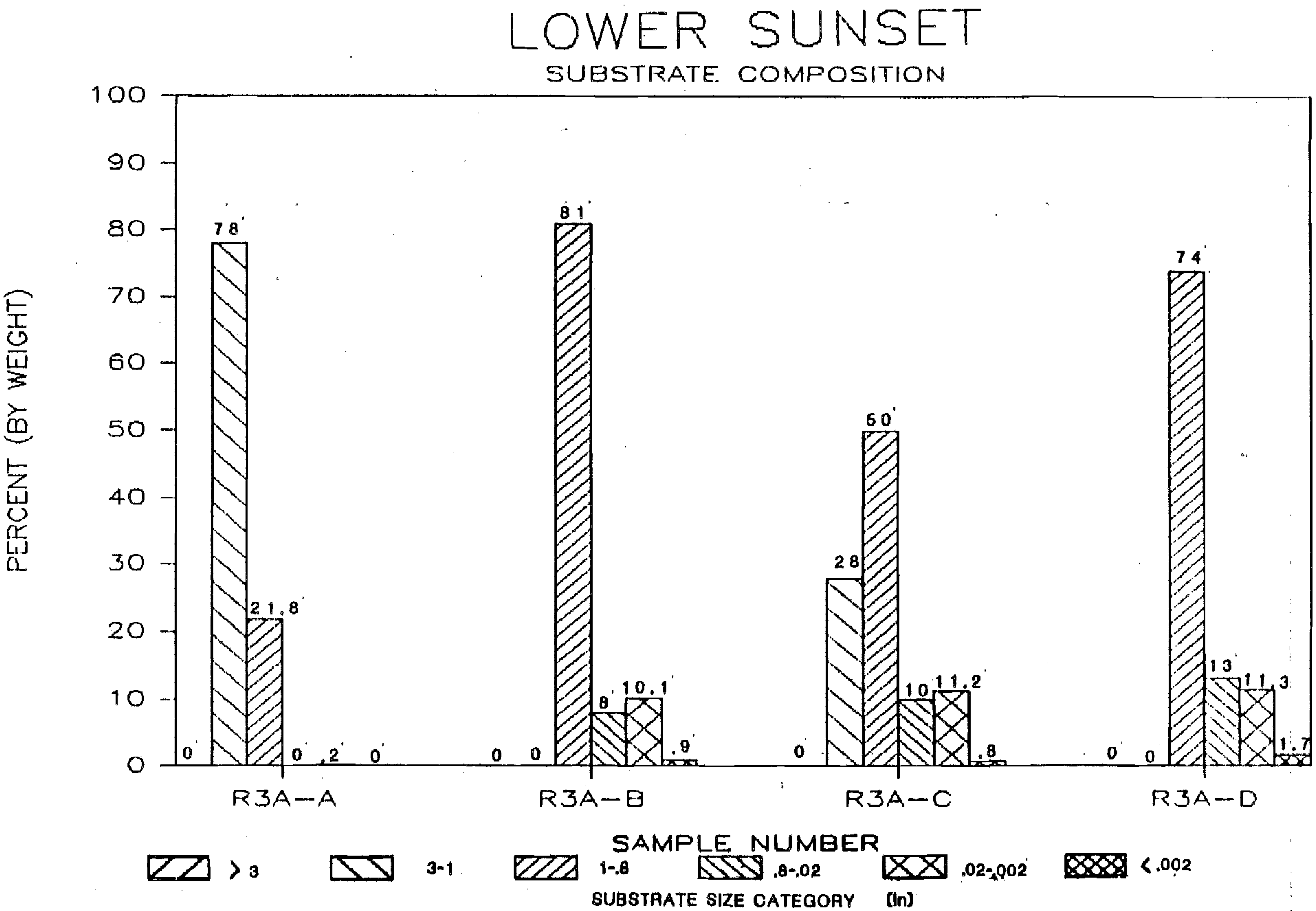
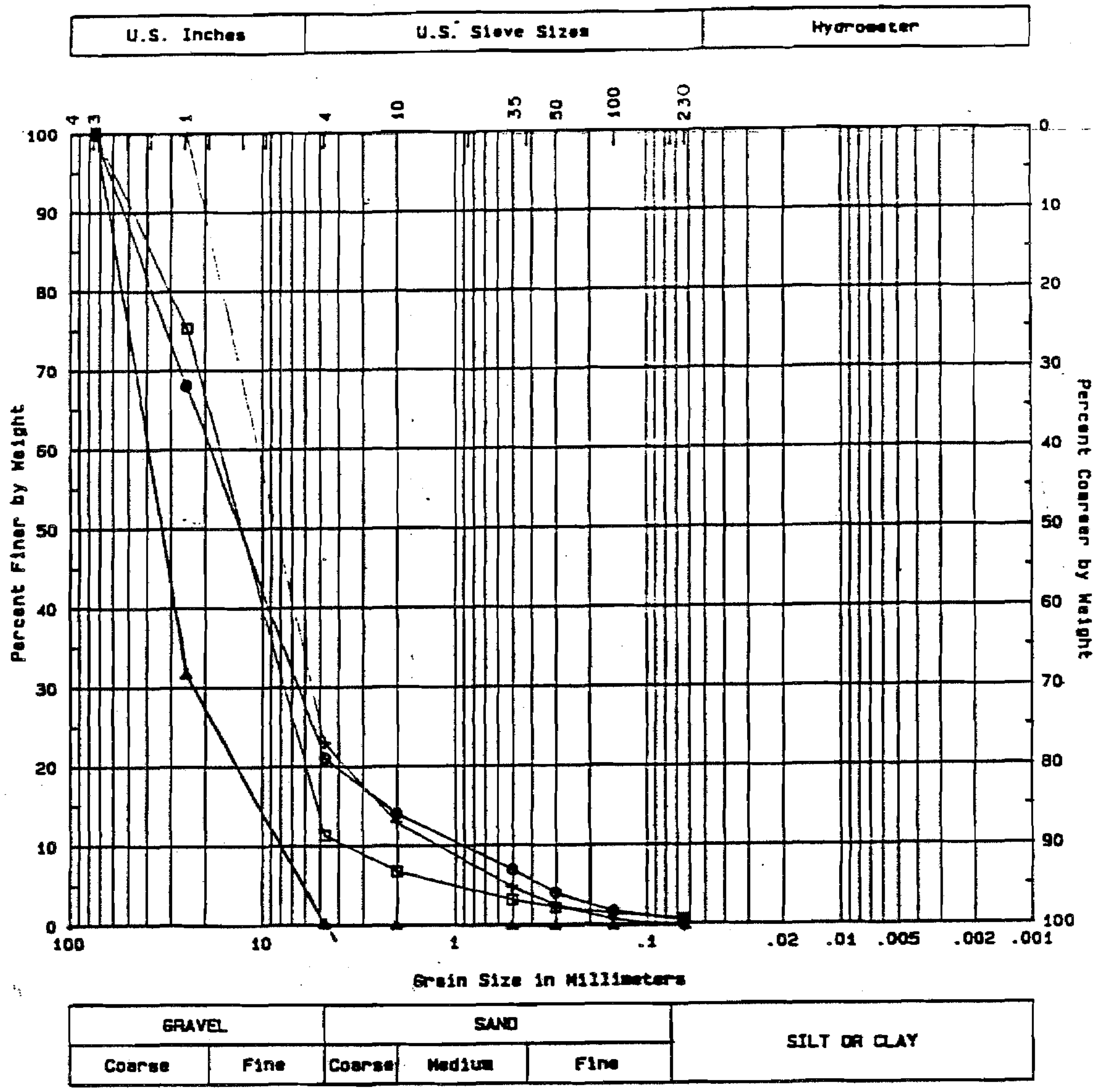


Figure 28. Depth integrated substrate composition by weight from redd number 3A in Lower Sunset Side Channel.

Table 25. Substrate sieve analysis data for Lower Sunset Side Channel redd number 4 (R-4).

SIDE CHANNEL	SAMPLE[1] NUMBER	SIEVE NUMBER	SIEVE SIZE (IN)	CUM WEIGHT (GMS)	% PASSING	% PER CLASS
LOWER SUNSET	R4-A	5.00	5			
LOWER SUNSET	R4-A	3.00	3	0	100	68
LOWER SUNSET	R4-A	1.00	1	600	32	31.8
LOWER SUNSET	R4-A	4.00	0.187	877	0.2	0.1
LOWER SUNSET	R4-A	10.00	0.0787	878	0.1	0.1
LOWER SUNSET	R4-A	35.00	0.0197	879	0	0
LOWER SUNSET	R4-A	50.00	0.0116	879	0	0
LOWER SUNSET	R4-A	100.00	0.0059	879	0	0
LOWER SUNSET	R4-A	230.00	0.0025	879	0	0
LOWER SUNSET	R4-A	TOTAL		879		100
LOWER SUNSET	R4-B	5.00	5			
LOWER SUNSET	R4-B	3.00	3	0	100	25
LOWER SUNSET	R4-B	1.00	1	227	75	64
LOWER SUNSET	R4-B	4.00	0.187	813	11	4.3
LOWER SUNSET	R4-B	10.00	0.0787	855	6.7	3.6
LOWER SUNSET	R4-B	35.00	0.0197	888	3.1	1
LOWER SUNSET	R4-B	50.00	0.0116	897	2.1	0.8
LOWER SUNSET	R4-B	100.00	0.0059	904	1.3	0.6
LOWER SUNSET	R4-B	230.00	0.0025	910	0.7	0.7
LOWER SUNSET	R4-B	TOTAL		916		100
LOWER SUNSET	R4-C	5.00	5			
LOWER SUNSET	R4-C	3.00	3	0	100	32
LOWER SUNSET	R4-C	1.00	1	357	68	47
LOWER SUNSET	R4-C	4.00	0.187	885	21	7
LOWER SUNSET	R4-C	10.00	0.0787	963	14	6.9
LOWER SUNSET	R4-C	35.00	0.0197	1043	7.1	2.9
LOWER SUNSET	R4-C	50.00	0.0116	1076	4.2	2.3
LOWER SUNSET	R4-C	100.00	0.0059	1102	1.9	1.2
LOWER SUNSET	R4-C	230.00	0.0025	1115	0.7	0.7
LOWER SUNSET	R4-C	TOTAL		1123		100
LOWER SUNSET	R4-D	5.00	5			
LOWER SUNSET	R4-D	3.00	3			
LOWER SUNSET	R4-D	1.00	1	0	100	77
LOWER SUNSET	R4-D	4.00	0.187	169	23	10
LOWER SUNSET	R4-D	10.00	0.0787	191	13	8
LOWER SUNSET	R4-D	35.00	0.0197	209	5	2.3
LOWER SUNSET	R4-D	50.00	0.0116	214	2.7	1.8
LOWER SUNSET	R4-D	100.00	0.0059	218	0.9	0.9
LOWER SUNSET	R4-D	230.00	0.0025	220	0	0
LOWER SUNSET	R4-D	TOTAL		220		100

[1] R4-A: Substrate sample obtained from chum redd labeled R4 at a depth of 0-4 inches.
R4-B: 5-8 inches
R4-C: 9-12 inches
R4-D: 13-16 inches



Sample Identification				Classification Data					Unified Class	Remarks
Sym	Hole	Samp	Depth	Cu	Cz	LL	PI	% Org		
▲	SS	R4-A	SURFACE							
□	SS	R4-B	4"							
o	SS	R4-C	8"							
+	SS	R4-D	12"							

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SS R4

FB	
GRID	
PROJ NO	551053
DWG NO	

Figure 29. Depth integrated substrate composition, percent by weight passing each sieve size for redd number 4 in Lower Sunset Side Channel.

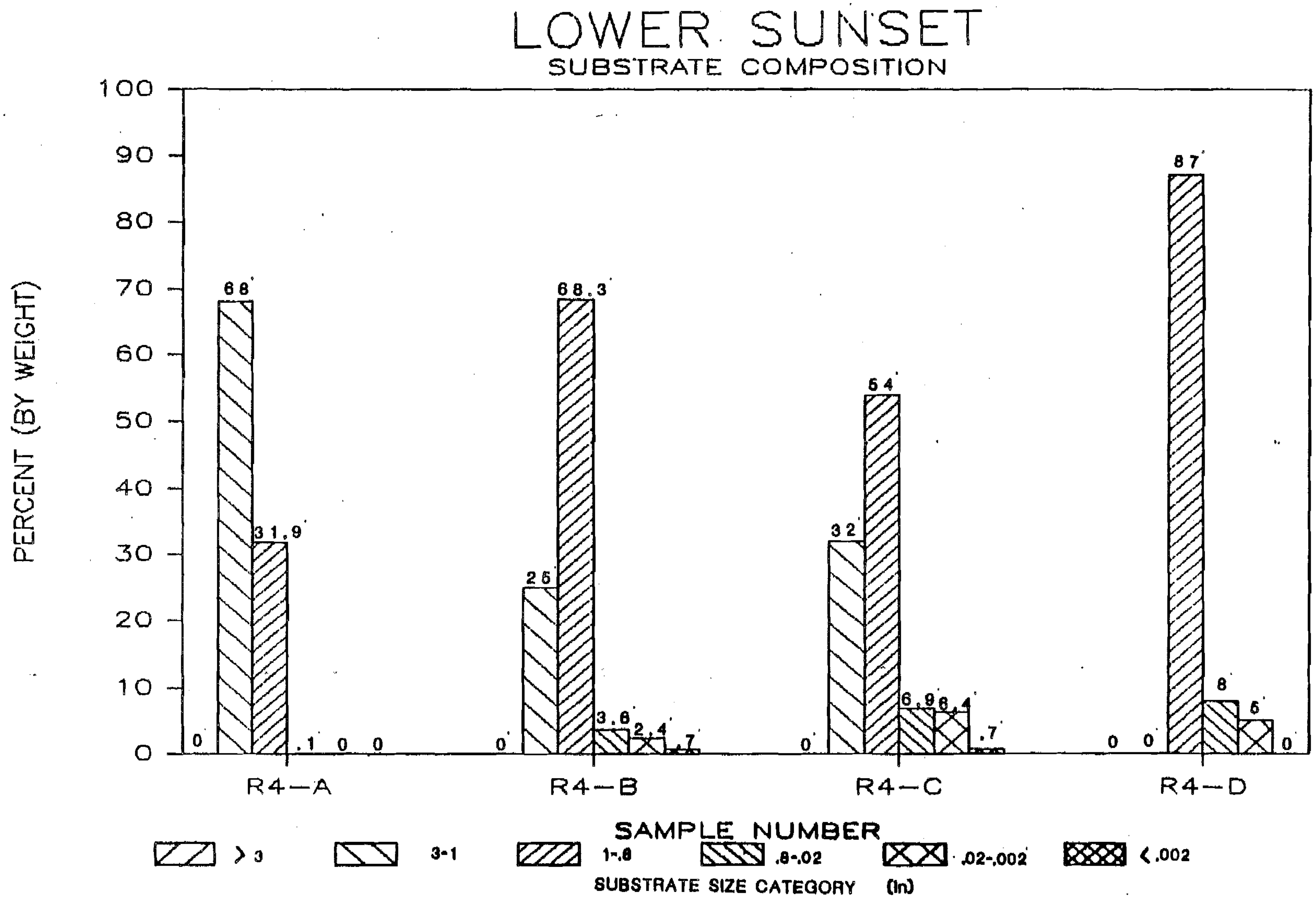
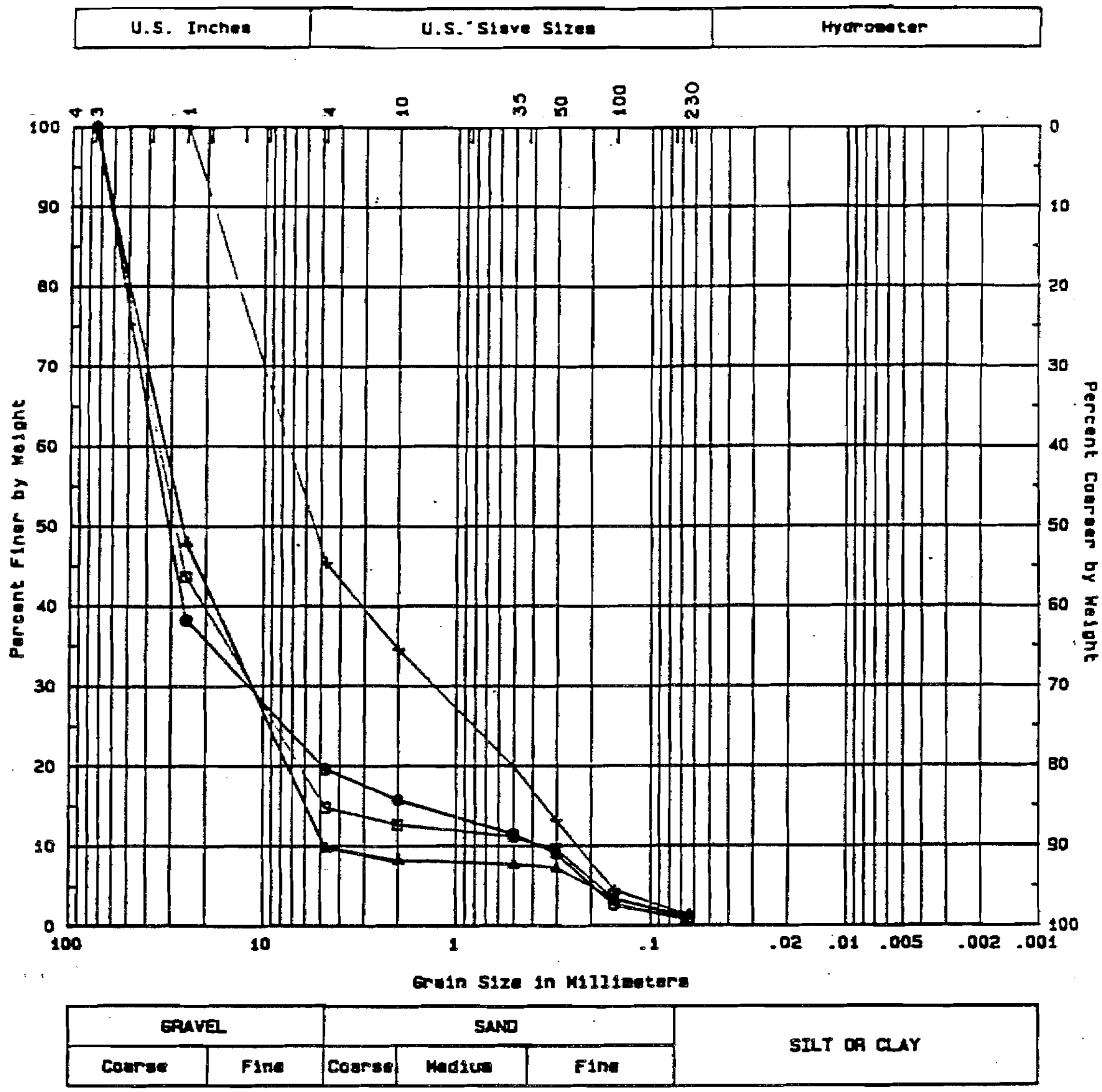


Figure 30. Depth integrated substrate composition by weight from redd number 4 in Lower Sunset Side Channel.

Table 26. Substrate sieve analysis data for Circular Side Channel redd number 1 (R-1).

SIDE CHANNEL	SAMPLE[1] NUMBER	SIEVE NUMBER	SIEVE SIZE (IN)	CUM WEIGHT (GMS)	% PASSING	% PER CLASS
CIRCULAR	R1-A	5	5			
CIRCULAR	R1-A	3	3	0	100	52
CIRCULAR	R1-A	1	1	418	48	38.3
CIRCULAR	R1-A	4	0.187	726	9.7	1.5
CIRCULAR	R1-A	10	0.0787	738	8.2	0.5
CIRCULAR	R1-A	35	0.0197	742	7.7	0.5
CIRCULAR	R1-A	50	0.0116	746	7.2	3.8
CIRCULAR	R1-A	100	0.0059	777	3.4	2.2
CIRCULAR	R1-A	230	0.0025	794	1.2	1.2
CIRCULAR	R1-A	TOTAL		804		100
CIRCULAR	R1-B	5	5			
CIRCULAR	R1-B	3	3	0	100	56
CIRCULAR	R1-B	1	1	1434	44	29
CIRCULAR	R1-B	4	0.187	2169	15	2
CIRCULAR	R1-B	10	0.0787	2225	13	2
CIRCULAR	R1-B	35	0.0197	2264	11	1.2
CIRCULAR	R1-B	50	0.0116	2301	9.8	6.3
CIRCULAR	R1-B	100	0.0059	2462	3.5	2.4
CIRCULAR	R1-B	230	0.0025	2522	1.1	1.1
CIRCULAR	R1-B	TOTAL		2550		100
CIRCULAR	R1-C	5	5			
CIRCULAR	R1-C	3	3	0	100	62
CIRCULAR	R1-C	1	1	1933	38	18
CIRCULAR	R1-C	4	0.187	2518	20	4
CIRCULAR	R1-C	10	0.0787	2638	16	5
CIRCULAR	R1-C	35	0.0197	2772	11	2
CIRCULAR	R1-C	50	0.0116	2849	9	6.4
CIRCULAR	R1-C	100	0.0059	3050	2.6	1.9
CIRCULAR	R1-C	230	0.0025	3108	0.7	0.7
CIRCULAR	R1-C	TOTAL		3131		100
CIRCULAR	R1-D	5	5			
CIRCULAR	R1-D	3	3			
CIRCULAR	R1-D	1	1	0	100	55
CIRCULAR	R1-D	4	0.187	337	45	10
CIRCULAR	R1-D	10	0.0787	404	35	15
CIRCULAR	R1-D	35	0.0197	494	20	7
CIRCULAR	R1-D	50	0.0116	536	13	8.5
CIRCULAR	R1-D	100	0.0059	590	4.5	3
CIRCULAR	R1-D	230	0.0025	609	1.5	1.5
CIRCULAR	R1-D	TOTAL		618		100

[1] R1-A: Substrate sample obtained from chum redd labeled R1 at a depth of 0-4 inches.
R1-B: 5-8 inches
R1-C: 9-12 inches
R1-D: 13-16 inches



Sample Identification				Classification Data					Unified Class	Remarks
Sym	Hole	Samp	Depth	Cu	Cz	LL	PI	% Org		
▲	CIRC	R1-A	SURFACE							
□	CIRC	R1-B	4"							
○	CIRC	R1-C	8"							
+	CIRC	R1-D	12"							

DWN CKD DATE 7/11/85 SCALE	R&M CONSULTANTS, INC.	ALASKA DEPT OF FISH & GAME SUSITNA HABITAT SUBSTRATE CIRC R1	FB. GRID. PROJ.NO 551053 DWG NO

Figure 31. Depth integrated substrate composition, percent by weight passing each sieve size for redd number 1 in Circular Side Channel.

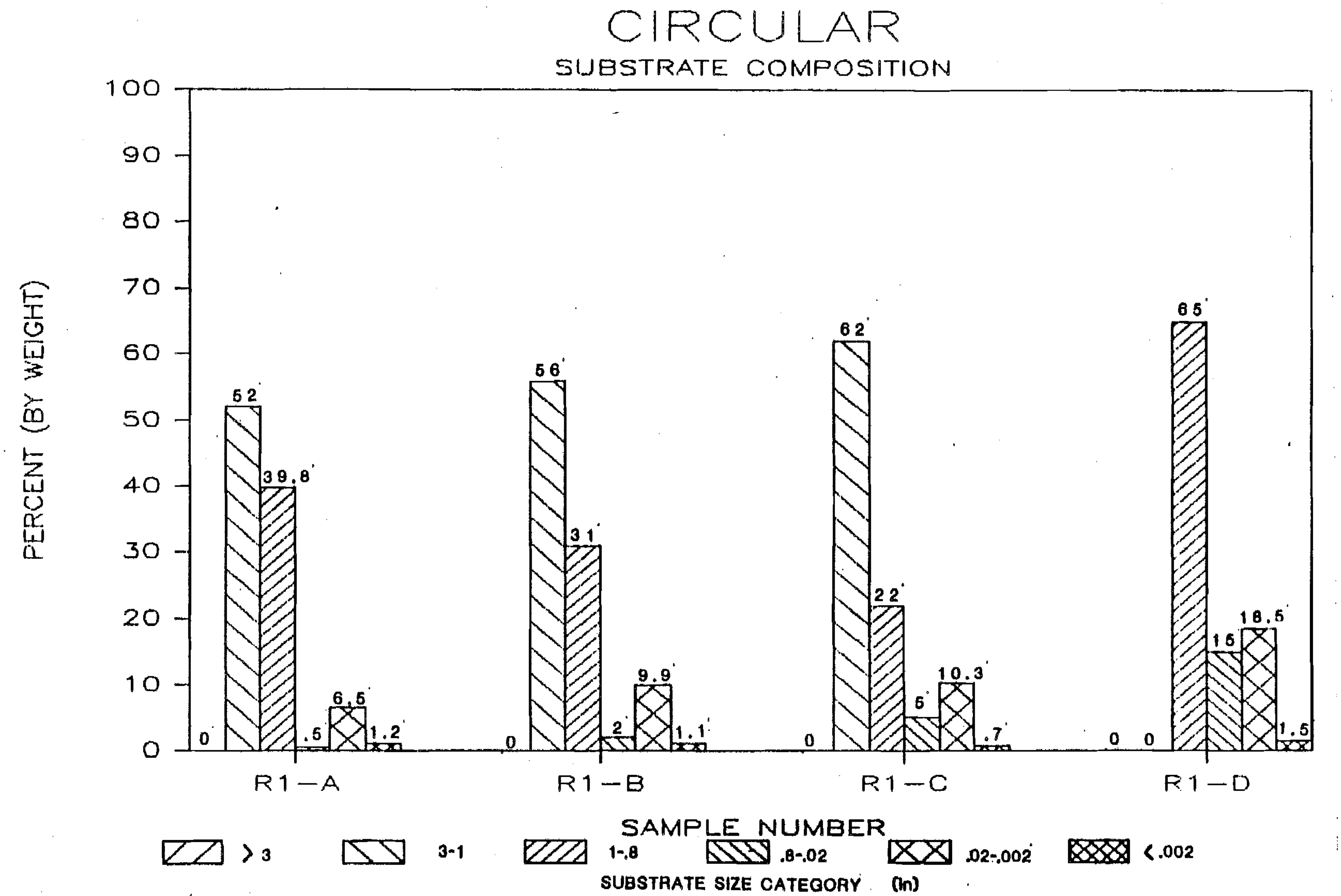
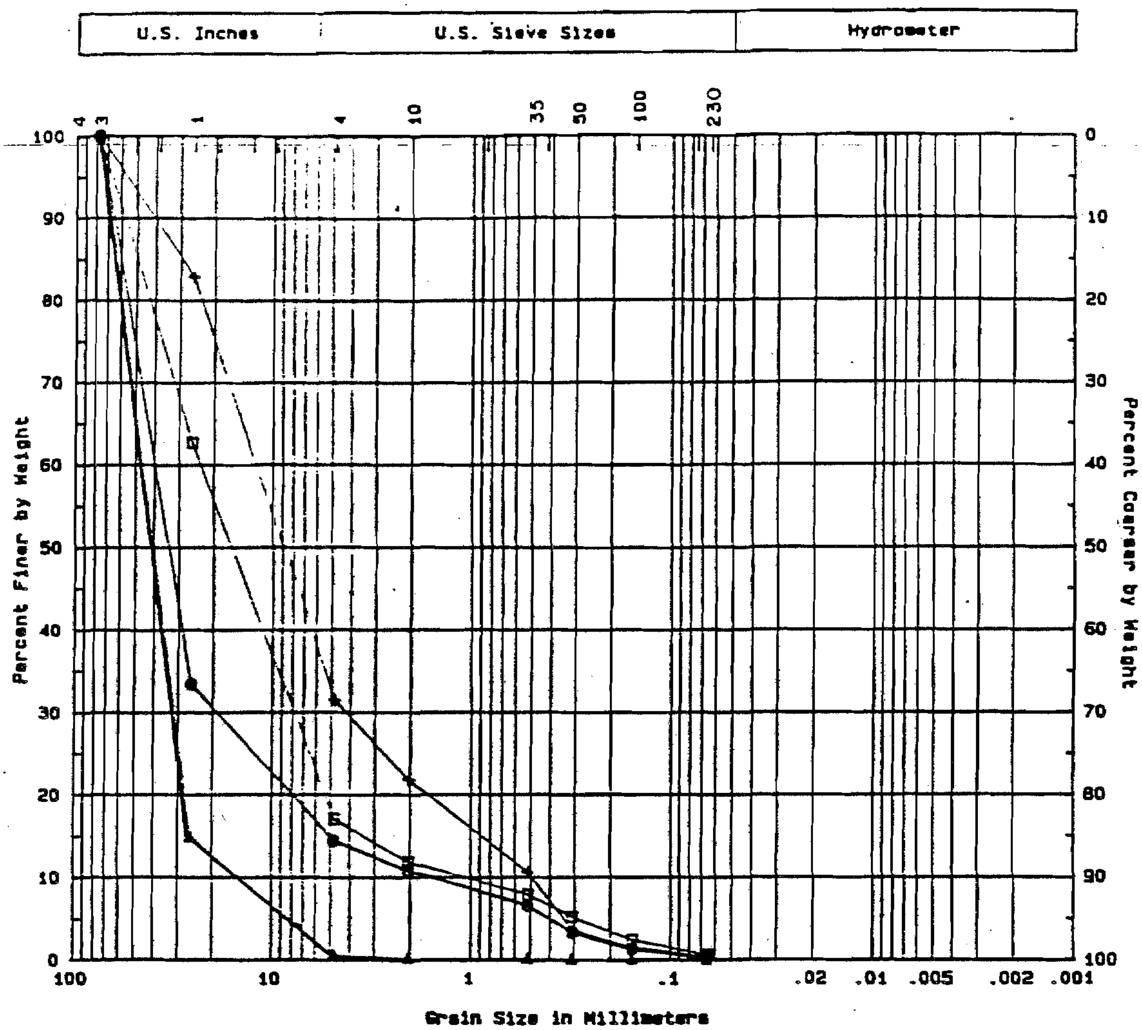


Figure 32. Depth integrated substrate composition by weight from redd number 1 in Circular Side Channel.

Table 27. Substrate sieve analysis data for Circular Side Channel redd number 3 (R-3).

SIDE CHANNEL	SAMPLE NUMBER[1]	SIEVE NUMBER	SIEVE SIZE (IN)	CUM WEIGHT (GMS)	% PASSING	% PER CLASS
CIRCULAR	R3-A	5	5			
CIRCULAR	R3-A	3	3	0	100	85
CIRCULAR	R3-A	1	1	1423	15	14.6
CIRCULAR	R3-A	4	0.187	1661	0.4	0.3
CIRCULAR	R3-A	10	0.0787	1666	0.1	0
CIRCULAR	R3-A	35	0.0197	1667	0.1	0.1
CIRCULAR	R3-A	50	0.0116	1668	0	0
CIRCULAR	R3-A	100	0.0059	1668	0	0
CIRCULAR	R3-A	230	0.0025	1668	0	0
CIRCULAR	R3-A	TOTAL		1668		100
CIRCULAR	R3-B	5	5			
CIRCULAR	R3-B	3	3	0	100	37
CIRCULAR	R3-B	1	1	893	63	46
CIRCULAR	R3-B	4	0.187	1985	17	5
CIRCULAR	R3-B	10	0.0787	2110	12	4
CIRCULAR	R3-B	35	0.0197	2204	8	2.7
CIRCULAR	R3-B	50	0.0116	2268	5.3	2.8
CIRCULAR	R3-B	100	0.0059	2335	2.5	1.7
CIRCULAR	R3-B	230	0.0025	2377	0.8	0.8
CIRCULAR	R3-B	TOTAL		2396		100
CIRCULAR	R3-C	5	5			
CIRCULAR	R3-C	3	3	0	100	67
CIRCULAR	R3-C	1	1	1478	33	19
CIRCULAR	R3-C	4	0.187	1899	14	3
CIRCULAR	R3-C	10	0.0787	1979	11	4.4
CIRCULAR	R3-C	35	0.0197	2072	6.6	3.3
CIRCULAR	R3-C	50	0.0116	2145	3.3	2
CIRCULAR	R3-C	100	0.0059	2190	1.3	1
CIRCULAR	R3-C	230	0.0025	2213	0.3	0.3
CIRCULAR	R3-C	TOTAL		2219		100
CIRCULAR	R3-D	5	5			
CIRCULAR	R3-D	3	3	0	100	17
CIRCULAR	R3-D	1	1	32	83	51
CIRCULAR	R3-D	4	0.187	128	32	10
CIRCULAR	R3-D	10	0.0787	146	22	11
CIRCULAR	R3-D	35	0.0197	167	11	7.3
CIRCULAR	R3-D	50	0.0116	180	3.7	2.1
CIRCULAR	R3-D	100	0.0059	184	1.6	1.1
CIRCULAR	R3-D	230	0.0025	186	0.5	0.5
CIRCULAR	R3-D	TOTAL		187		100

[1] R3-A: Substrate sample obtained from chum redd labeled R3 at a depth of 0-4 inches.
R3-B: 5-8 inches
R3-C: 9-12 inches
R3-D: 13-16 inches



GRAVEL		SAND			SILT OR CLAY
Coarse	Fine	Coarse	Medium	Fine	

Sample Identification				Classification Data					Unified Class	Remarks
Sym	Hole	Samp	Depth	Cu	Cz	LL	PI	% Org		
▲	CIRC	R3-A	SURFACE							
□	CIRC	R3-B	4"							
o	CIRC	R3-C	8"							
+	CIRC	R3-D	12"							

DWN CKD DATE 7/11/85 SCALE	R&M CONSULTANTS, INC.	ALASKA DEPT OF FISH & GAME SUSITNA HABITAT SUBSTRATE CIRC R3	FB. GRID PROJ.NO 551053 DWG NO

Figure 33. Depth integrated substrate composition, percent by weight passing each sieve size for redd number 3 in Circular Side Channel.

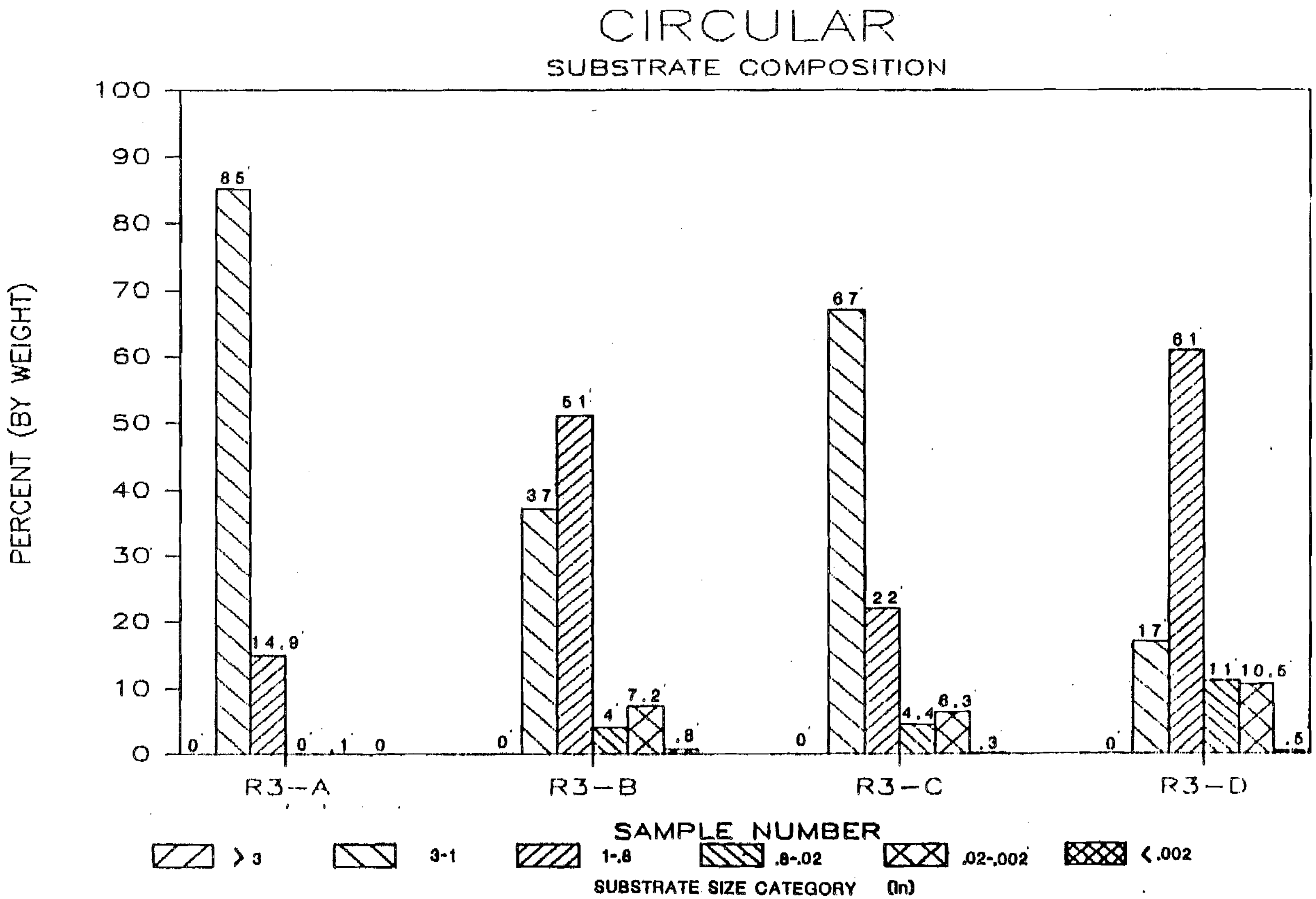
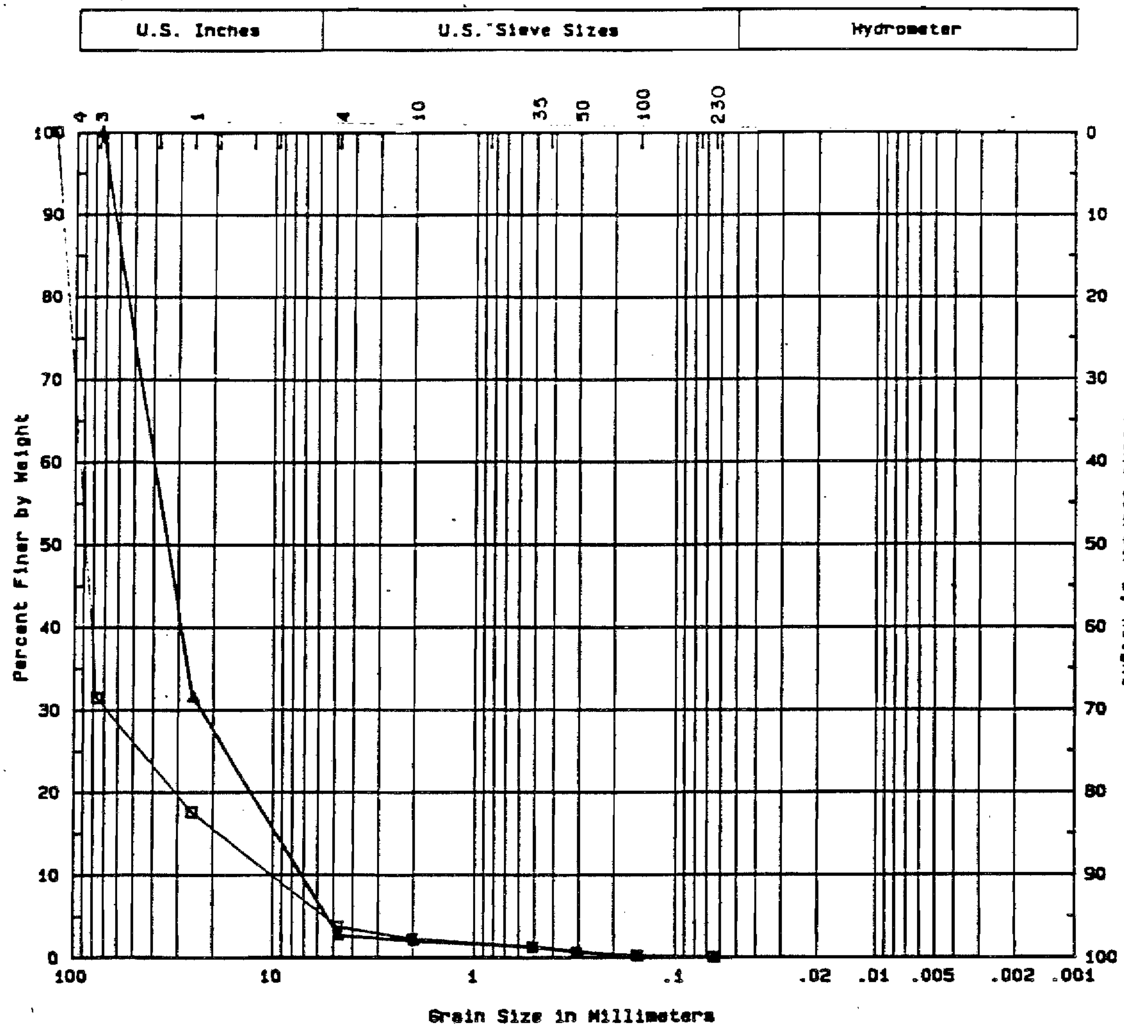


Figure 34. Depth integrated substrate composition by weight from redd number 3 in Circular Side Channel.

Table 28. Substrate sieve analysis data for Circular Side Channel redd number 5E (R-5E).

SIDE CHANNEL	SAMPLE NUMBER	SIEVE NUMBER	SIEVE SIZE (IN)	CUM WEIGHT (GMS)	% PASSING	% PER CLASS
CIRCULAR	R5E-A	5	5			
CIRCULAR	R5E-A	3	3	0	100	69
CIRCULAR	R5E-A	1	1	520	31	28.4
CIRCULAR	R5E-A	4	0.187	738	2.6	0.6
CIRCULAR	R5E-A	10	0.0787	743	2	0.7
CIRCULAR	R5E-A	35	0.0197	748	1.3	0.5
CIRCULAR	R5E-A	50	0.0116	752	0.8	0.7
CIRCULAR	R5E-A	100	0.0059	757	0.1	0.1
CIRCULAR	R5E-A	230	0.0025	758	0	0
CIRCULAR	R5E-A	TOTAL		758		100
CIRCULAR	R5E-B	5	5	0	100	69
CIRCULAR	R5E-B	3	3	2693	31	13
CIRCULAR	R5E-B	1	1	3236	18	14.2
CIRCULAR	R5E-B	4	0.187	3779	3.8	1.5
CIRCULAR	R5E-B	10	0.0787	3836	2.3	1
CIRCULAR	R5E-B	35	0.0197	3875	1.3	0.6
CIRCULAR	R5E-B	50	0.0116	3900	0.7	0.3
CIRCULAR	R5E-B	100	0.0059	3914	0.4	0.2
CIRCULAR	R5E-B	230	0.0025	3921	0.2	0.2
CIRCULAR	R5E-B	TOTAL		3928		100

R5E-A: Substrate sample obtained from chum redd labeled R5E at a depth of 0-4 inches.
R5E-B: 5-8 inches
R5E-C: 9-12 inches
R5E-D: 13-16 inches



GRAVEL		SAND			SILT OR CLAY
Coarse	Fine	Coarse	Medium	Fine	

Sample Identification				Classification Data					Unified Class	Remarks
Sym	Hole	Samp	Depth	Cu	Cz	LL	PI	% Org		
▲	CIRC	R5E-A	SURFACE							
□	CIRC	R5E-B	4"							

DWN	
CKD	
DATE	7/11/85
SCALE	

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SUSITNA HABITAT SUBSTRATE
CIRC R5E

FB	
GRID	
PROJ NO	551053
DWG NO	

Figure 35. Depth integrated substrate composition, percent by weight passing each sieve size for redd number 5E in Circular Side Channel.

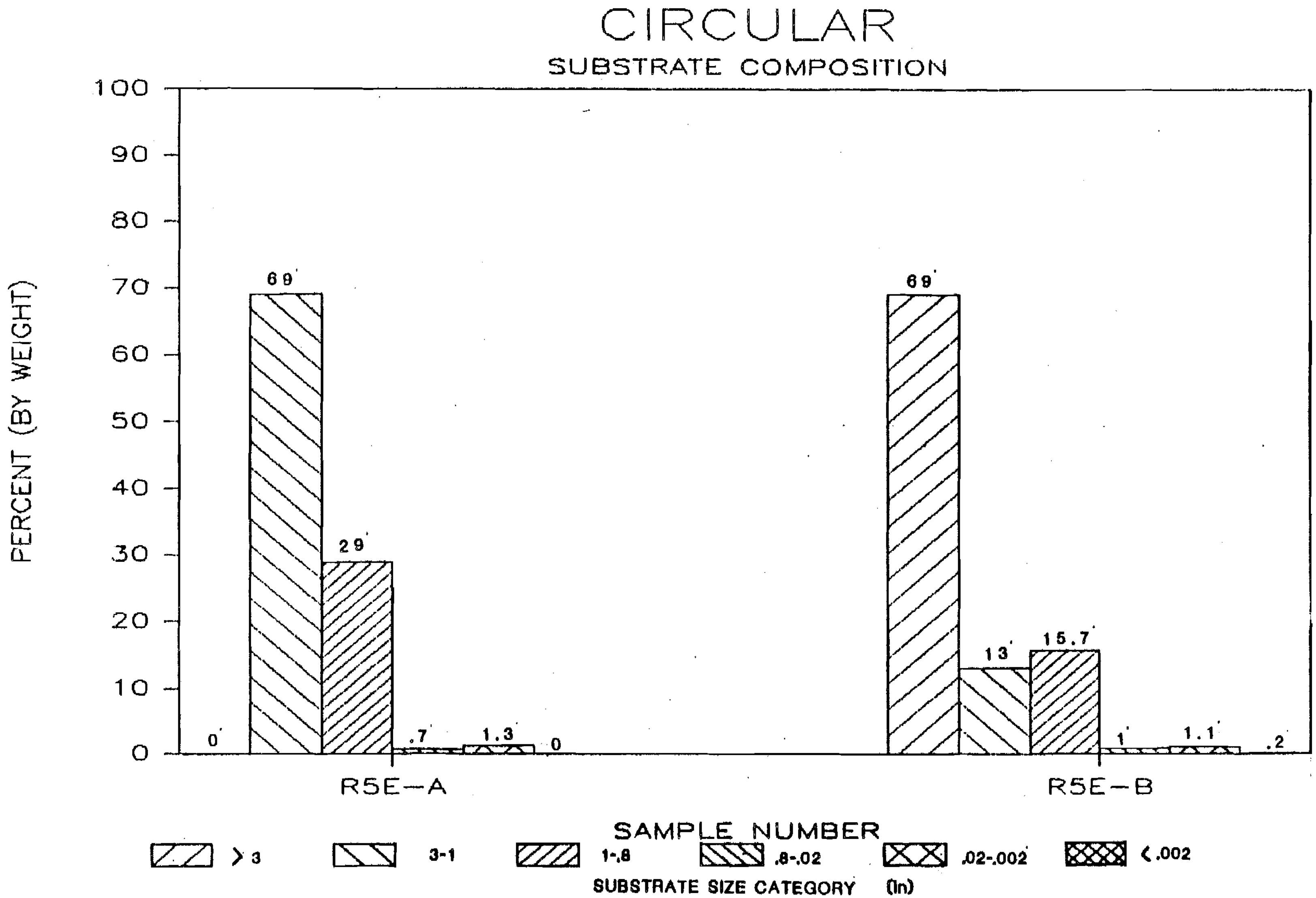

Figure 36. Depth integrated substrate composition by weight from redd number 5E in Circular Side Channel.

Side Channels are depicted in Plates 1 through 4. These plates show the relative locations of the observed spawning activities to other monitoring activities in each of the study sites. Spawning was also observed in the mainstem adjacent to the Birch Creek ADF&G camp, Island and Mainstem West Bank side channels.

Chum Salmon Spawning WUA

Figures 37 through 40 present projections of gross surface area and WUA of chum salmon spawning habitat as a function of site flow and mainstem discharge for the IFG-4 modeling sites at which chum salmon were observed to spawn in 1984. Data used to develop these plots are presented in Tables 29 through 32. These results are discussed below by study site.

Mainstem West Bank Side Channel

The Mainstem West Bank Side Channel hydraulic model was run through the HABTAT model using observed upwelling codes. The projected WUA's peaked just after the site flow (13 cfs) was controlled by mainstem discharge (19,600 cfs) and declined rapidly as discharge increased (Figure 37). The time series plot in Figure 41 indicates that WUAs in this site were relatively low throughout most of the open water season. When site flows dropped during September, WUAs were highest.

Circular Side Channel

The first run of the Circular Side Channel hydraulic model through the HABTAT model included cells coded for a small amount of observed upwelling. The only upwelling observed was in 3 cells in transect 1. Suitability criteria gives a value of 0 for cells without upwelling and the proportion of upwelling cells was so small that the resulting WUAs were all zero. When a second run was completed using simulated upwelling, the results followed similar trends to those in Mainstem West Bank and Sunset Side Channel. Projections of WUA of chum salmon spawning habitat peaked just after the site flow (27 cfs) was controlled by mainstem discharge (36,000 cfs) and decreased gradually as discharge increased (Figure 38). Simulated WUA projections in Circular Side Channel remained more constant over time than in the other three study sites evaluated (Figure 42).

Sunset Side Channel

Using observed upwelling codes, the Sunset Side Channel hydraulic model was run through the HABTAT model. The resulting WUAs peaked soon after the site flow (43 cfs) was controlled by mainstem discharge (32,000 cfs) and decreased with increased discharge (Figure 39). WUA projections in Sunset Side Channel varied considerably over time (Figure 43).

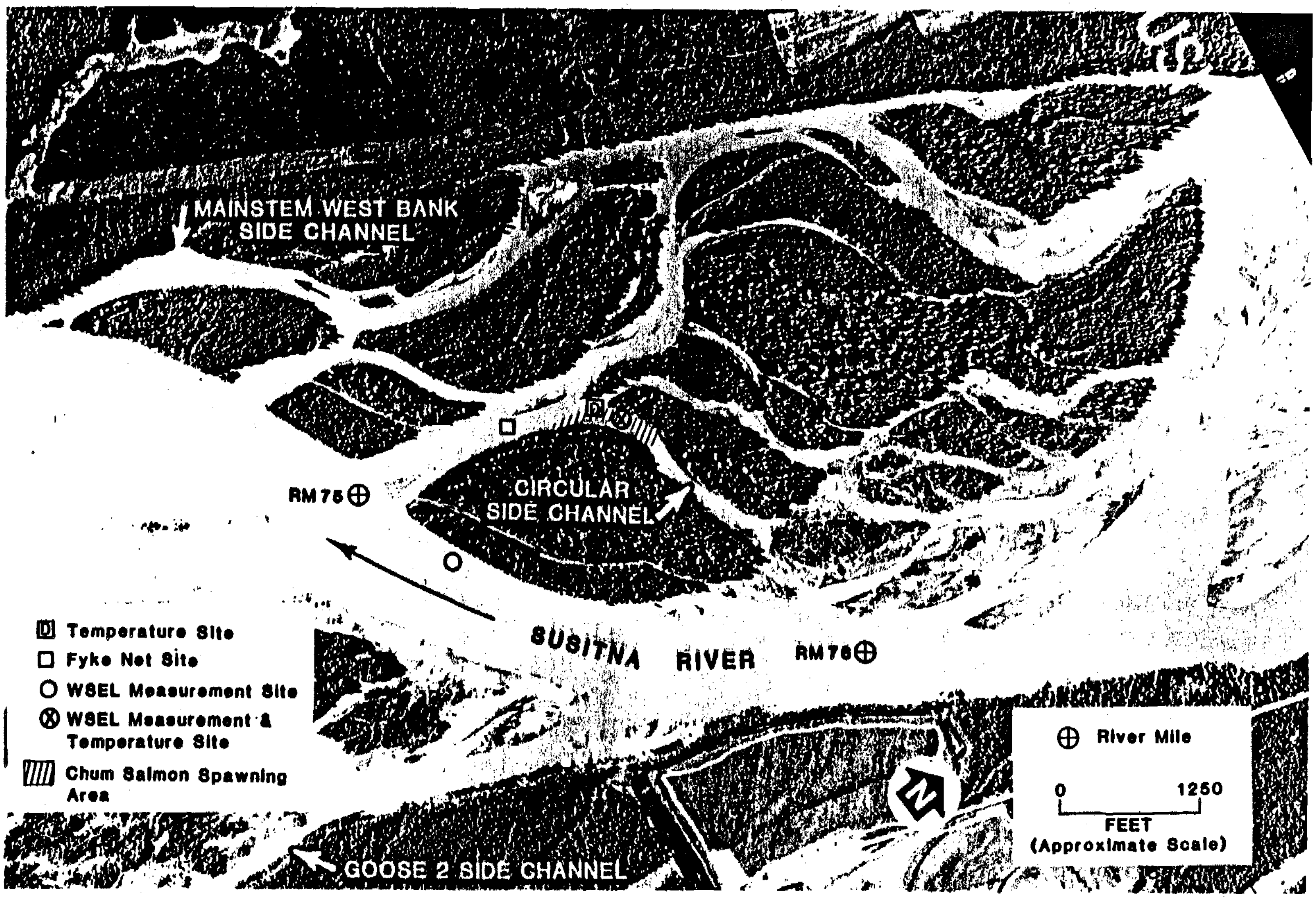

Plate 1. Aerial photograph of Circular Side Channel and Mainstem West Bank Side Channel with spawning areas and sampling sites indicated.

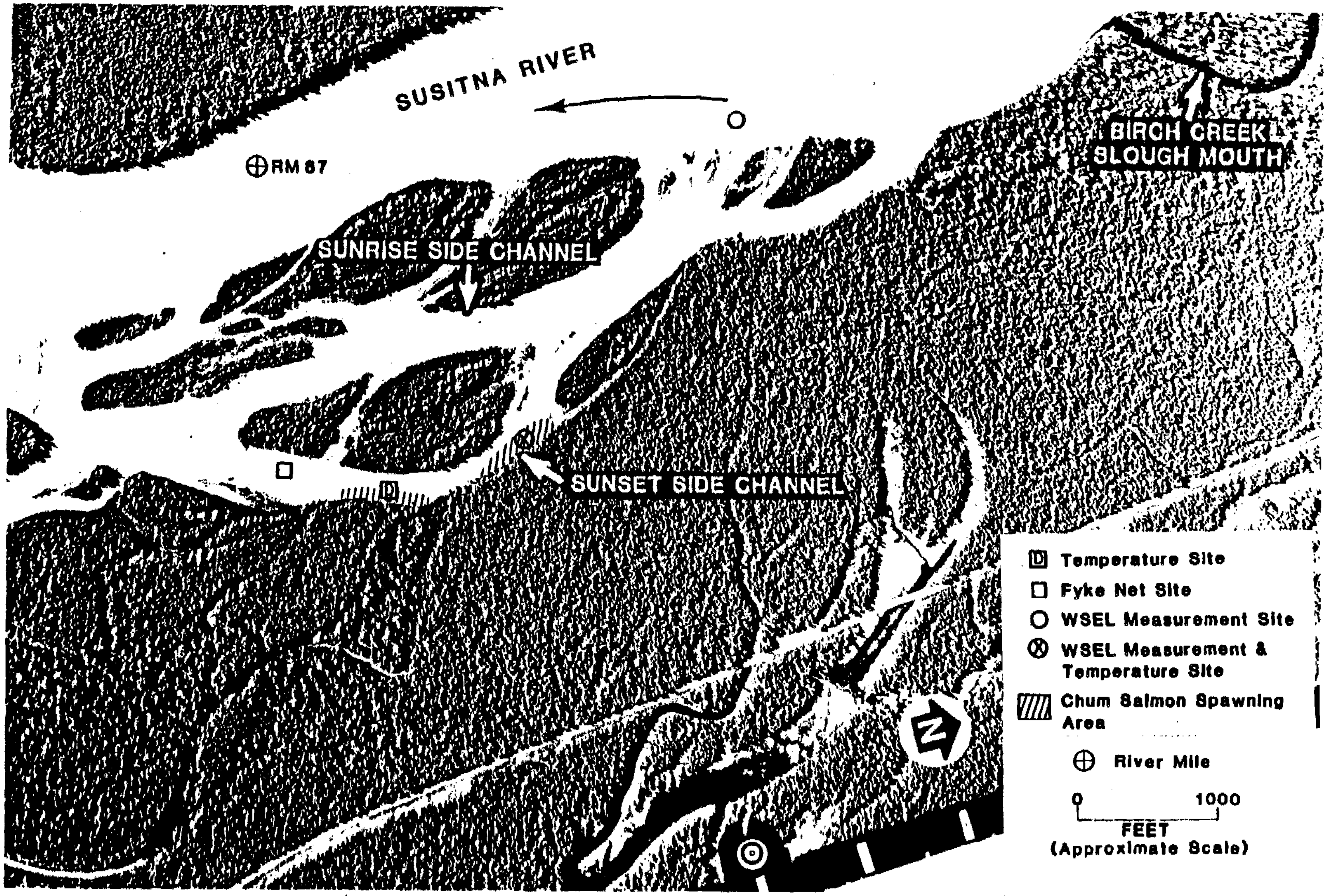

Plate 2. Aerial photograph of Sunset Side Channel with spawning areas and sampling sites indicated.

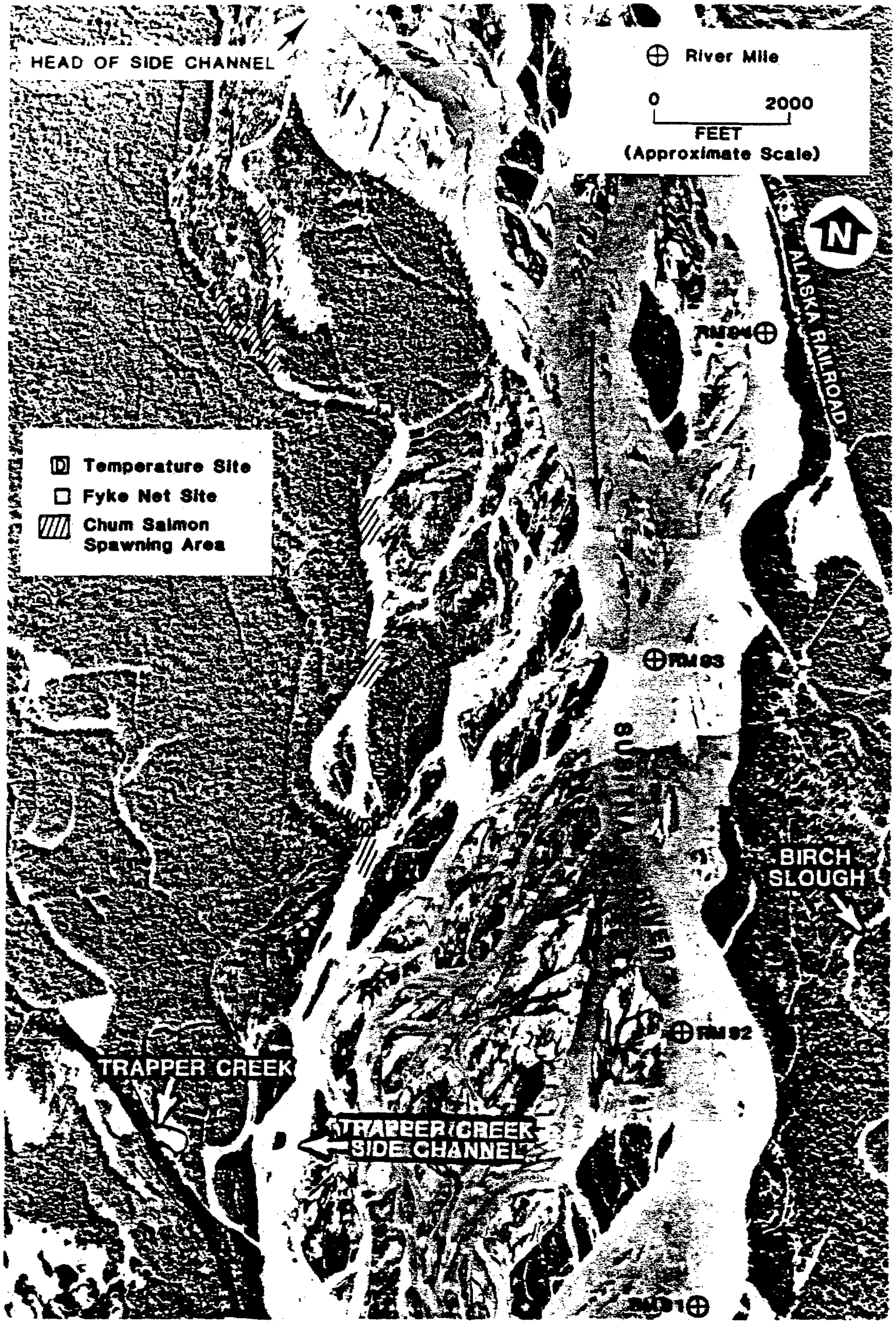

Plate 3. Aerial photograph of Lower Trapper Side Channel with spawning areas and sampling sites indicated.

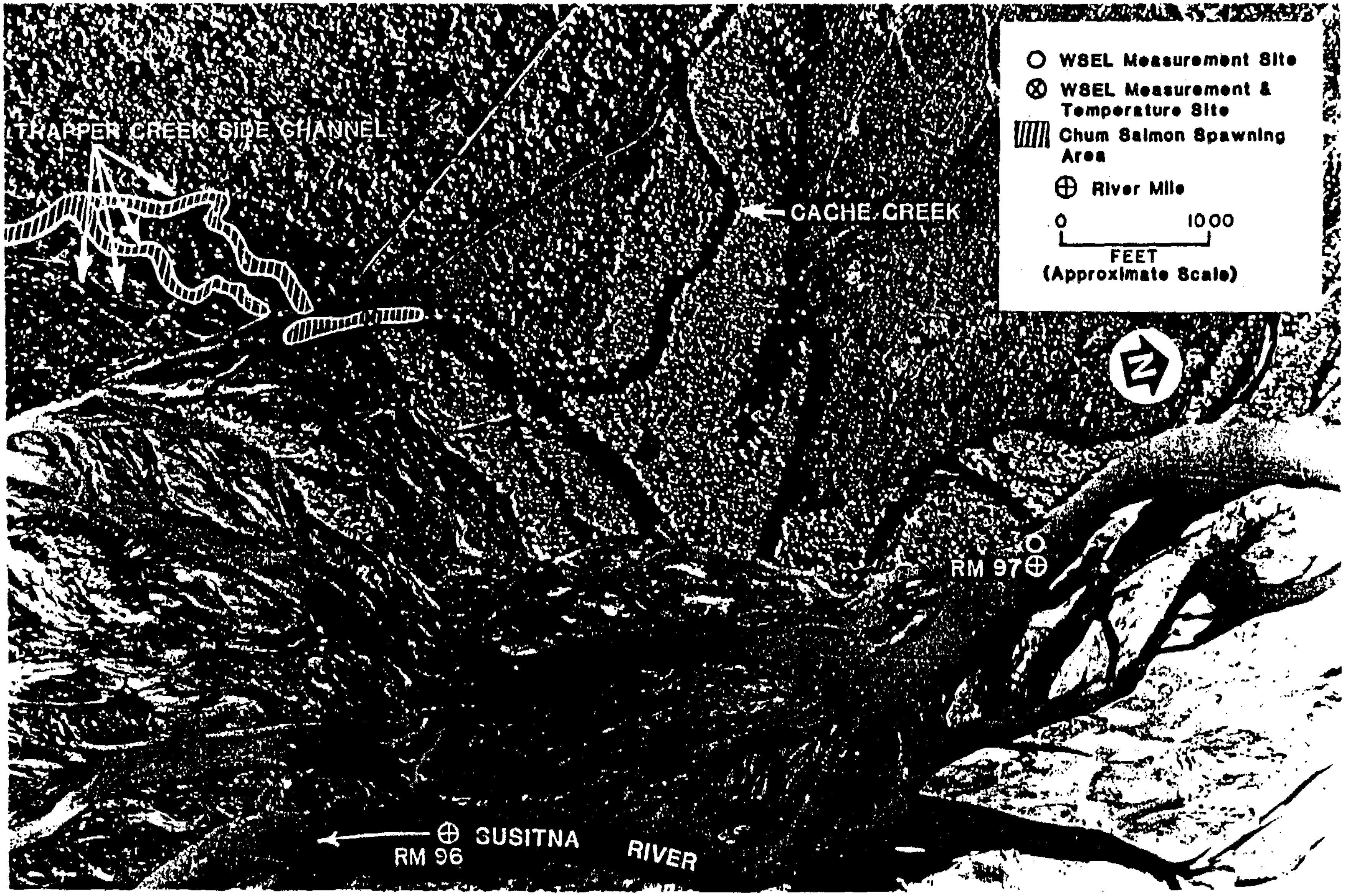

Plate 4. Aerial photograph of Upper Trapper Creek with spawning areas and sampling sites indicated.

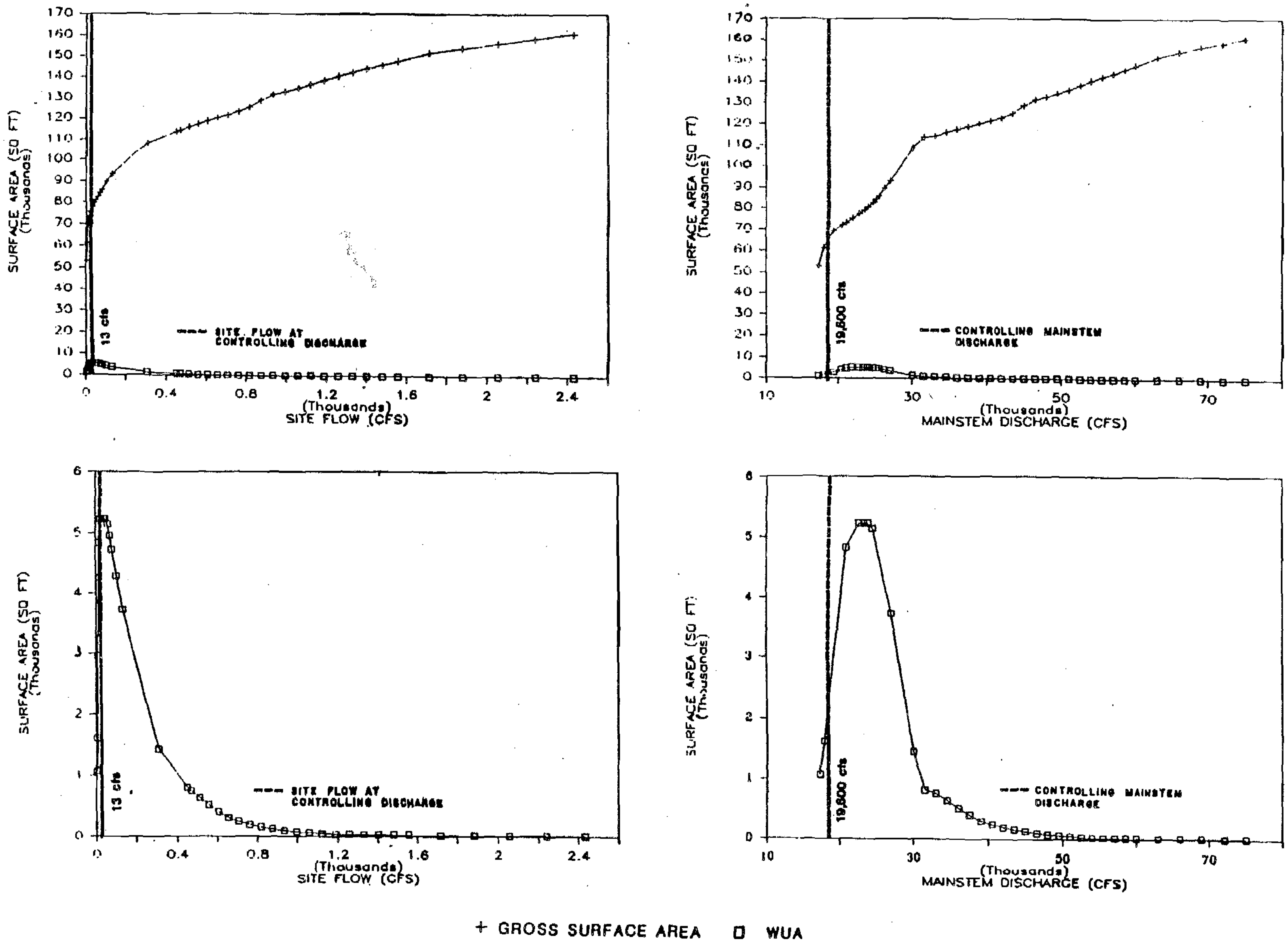

Figure 37. Projections of gross surface area and WUA of chum salmon spawning habitat as a function of site flow and mainstem discharge for the Mainstem West Bank modeling site.

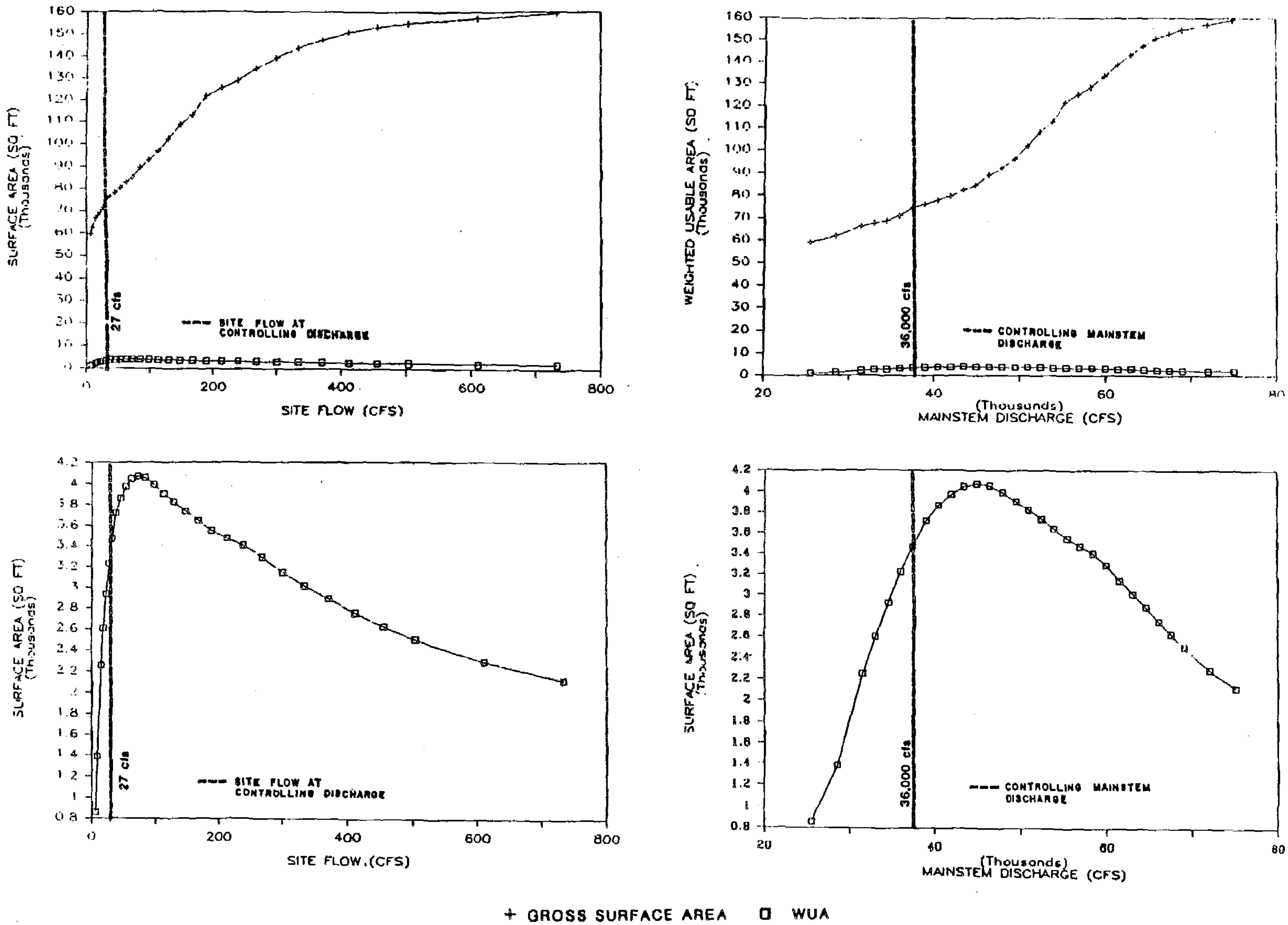

Figure 38. Projections of gross surface area and WUA of chum salmon spawning habitat as a function of site flow and mainstem discharge for the Circular Side Channel modeling site.

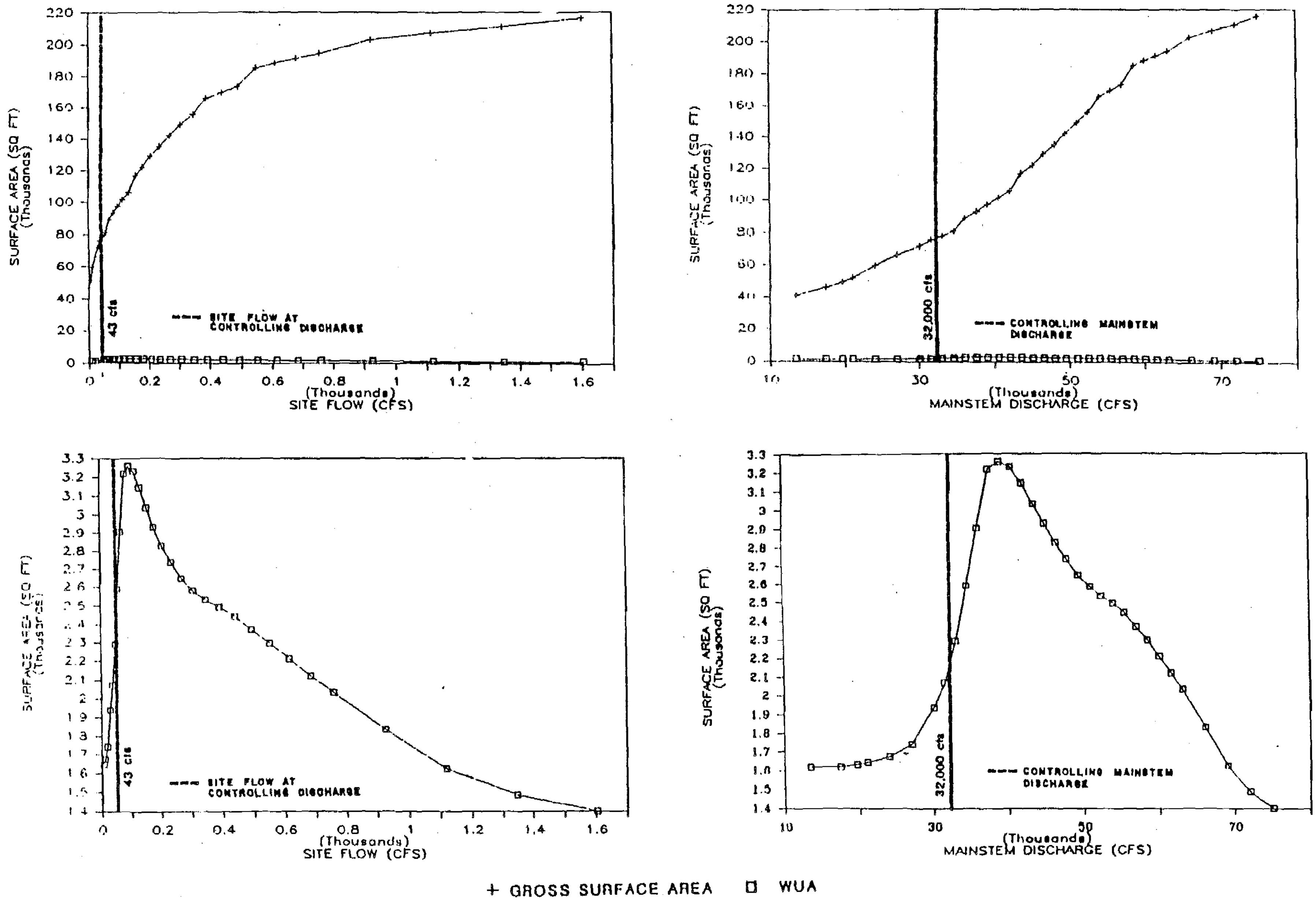

Figure 39. Projections of gross surface area and WUA of chum salmon spawning habitat as a function of site flow and mainstem discharge for the Sunset Side Channel modeling site.

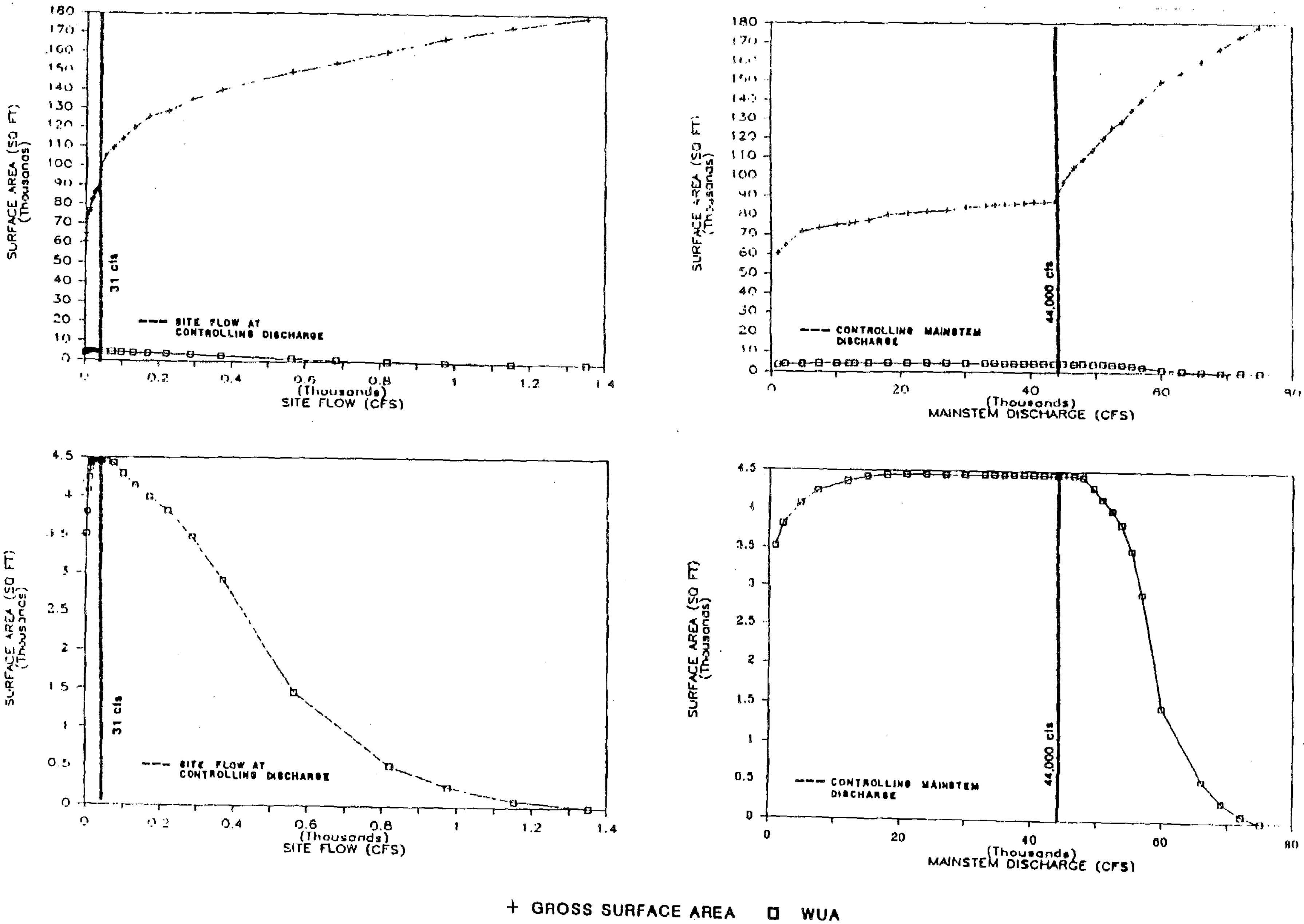

Figure 40. Projections of gross surface area and WUA of chum salmon spawning habitat as a function of site flow and mainstem discharge for the Trapper Creek Side Channel modeling site.

Table 29. Projections of gross surface area and WUA of chum salmon spawning habitat at Mainstem West Bank Side Channel.

SITE FLOW (CFS)	MAINSTEM DISCHARGE (CFS)	WUA	GROSS	PERCENT
4	17400	1075.41	53320	2.00
6	18000	1620.00	61603	2.63
19	21000	4842.73	73426	6.60
35	22759	5237.38	77743	6.74
45	23499	5237.38	79601	6.58
53	24000	5237.38	80904	6.47
65	24627	5148.17	82890	6.21
134	27000	3730.76	93353	4.00
307	30000	1449.38	108613	1.33
451	31500	816.83	114025	0.72
470	33000	757.43	114738	0.66
513	34500	641.29	116290	0.55
559	36000	523.90	117696	0.45
607	37500	408.06	119078	0.34
657	39000	308.79	120505	0.26
708	40500	249.50	121901	0.20
762	42000	198.05	123397	0.16
817	43500	163.09	125626	0.13
874	45000	130.54	129211	0.10
934	46500	100.81	132237	0.08
995	48000	84.20	133649	0.06
1058	49500	68.16	135109	0.05
1123	51000	52.80	136885	0.04
1191	52500	40.21	138845	0.03
1260	54000	36.88	140761	0.03
1331	55500	33.78	142526	0.02
1404	57000	30.92	144269	0.02
1479	58500	28.31	145996	0.02
1555	60000	25.99	147899	0.02
1715	63000	22.07	151842	0.01
1882	66000	19.21	154205	0.01
2057	69000	17.42	156425	0.01
2241	72000	16.71	158522	0.01
2431	75000	17.09	160818	0.01

Table 30. Projections of gross surface area and WUA of chum salmon spawning habitat at Circular Side Channel.

SITE FLOW (CFS)	MAINSTEM DISCHARGE (CFS)	WUA	GROSS	PERCENT
6	25500	863.36	59464	1.45
9	28500	1386.12	62443	2.22
15	31500	2258.26	66672	3.39
18	33000	2604.95	68172	3.82
22	34500	2932.24	69401	4.23
27	36000	3230.96	71590	4.51
32	37500	3469.87	74958	4.63
38	39000	3720.11	76534	4.86
46	40500	3862.24	78289	4.93
54	42000	3969.12	80557	4.93
63	43500	4045.98	82962	4.88
73	45000	4072.96	85140	4.78
85	46500	4054.99	89630	4.52
98	48000	3988.53	92944	4.29
113	49500	3905.66	96923	4.03
129	51000	3827.92	102530	3.73
147	52500	3737.77	109035	3.43
167	54000	3648.32	113323	3.22
189	55500	3550.19	122067	2.91
213	57000	3477.77	125753	2.77
239	58500	3409.49	128955	2.64
268	60000	3296.24	134218	2.46
300	61500	3145.33	139166	2.26
334	63000	3015.39	143575	2.10
371	64500	2891.60	147440	1.96
412	66000	2755.44	150869	1.83
456	67500	2627.87	153146	1.72
503	69000	2506.91	154657	1.62
610	72000	2295.74	157074	1.46
733	75000	2119.94	159211	1.33

Table 31. Projections of gross surface area and WUA of chum salmon spawning habitat at Sunset Side Channel.

SITE FLOW (CFS)	MAINSTEM DISCHARGE (CFS)	WUA	GROSS	PERCENT
1	13477	1620.67	41329	3.92
3	17400	1622.58	46180	3.51
5	19594	1635.93	49562	3.30
7	21000	1646.52	52120	3.16
12	24000	1677.50	59834	2.80
20	27000	1742.95	66575	2.62
31	30000	1939.56	72136	2.69
38	31500	2070.24	76222	2.72
47	33000	2292.32	78488	2.92
57	34500	2591.74	81618	3.18
68	36000	2906.95	89472	3.25
81	37500	3219.76	93660	3.44
96	39000	3260.92	97943	3.33
113	40500	3231.93	101876	3.17
132	42000	3144.49	106320	2.96
154	43500	3036.19	117194	2.59
178	45000	2932.83	122338	2.40
205	46500	2831.39	129392	2.19
235	48000	2736.98	135476	2.02
268	49500	2649.22	142276	1.86
305	51000	2584.08	149248	1.73
346	52500	2533.30	155825	1.63
390	54000	2495.48	165990	1.50
439	55500	2444.49	169787	1.44
492	57000	2371.20	173483	1.37
551	58500	2297.22	185336	1.24
614	60000	2212.36	188419	1.17
683	61500	2121.44	191398	1.11
757	63000	2033.02	194419	1.05
925	66000	1834.12	203000	0.90
1119	69000	1625.87	206972	0.79
1345	72000	1488.11	210728	0.71
1603	75000	1402.62	215861	0.65

Table 32. Projections of gross surface area and WUA of chum salmon spawning habitat at Trapper Creek Side Channel.

SITE FLOW (CFS)	MAINSTEM DISCHARGE (CFS)	WUA	GROSS	PERCENT
1	1089	3515.26	60705	5.79
2	2292	3801.18	64646	5.88
4	4823	4080.73	71757	5.69
6	7453	4245.94	73681	5.76
9	12000	4364.55	75927	5.75
12	15000	4421.75	77703	5.69
14	18000	4440.10	80925	5.49
16	21000	4449.11	81665	5.45
18	24000	4449.11	82503	5.39
20	27000	4449.11	83191	5.35
22	30000	4449.11	84833	5.24
24	33000	4449.11	85598	5.20
25	34500	4449.11	85917	5.18
26	36000	4449.11	86228	5.16
27	37500	4449.11	86472	5.15
28	39000	4449.11	86895	5.12
29	40500	4449.11	87222	5.10
30	42000	4449.11	87541	5.08
31	43500	4449.11	87853	5.06
39	45000	4449.11	97612	4.56
53	46600	4449.11	105163	4.23
72	48000	4429.08	109537	4.04
97	49500	4294.86	114306	3.76
129	51000	4150.76	119963	3.46
169	52500	3996.94	125967	3.17
221	54000	3821.62	129078	2.96
287	55500	3481.33	135178	2.58
370	57000	2918.17	140223	2.08
564	60000	1467.05	149941	0.98
819	66000	528.39	160807	0.33
975	69000	256.17	167356	0.15
1151	72000	83.30	173256	0.05
1351	75000	0.00	178354	0.00

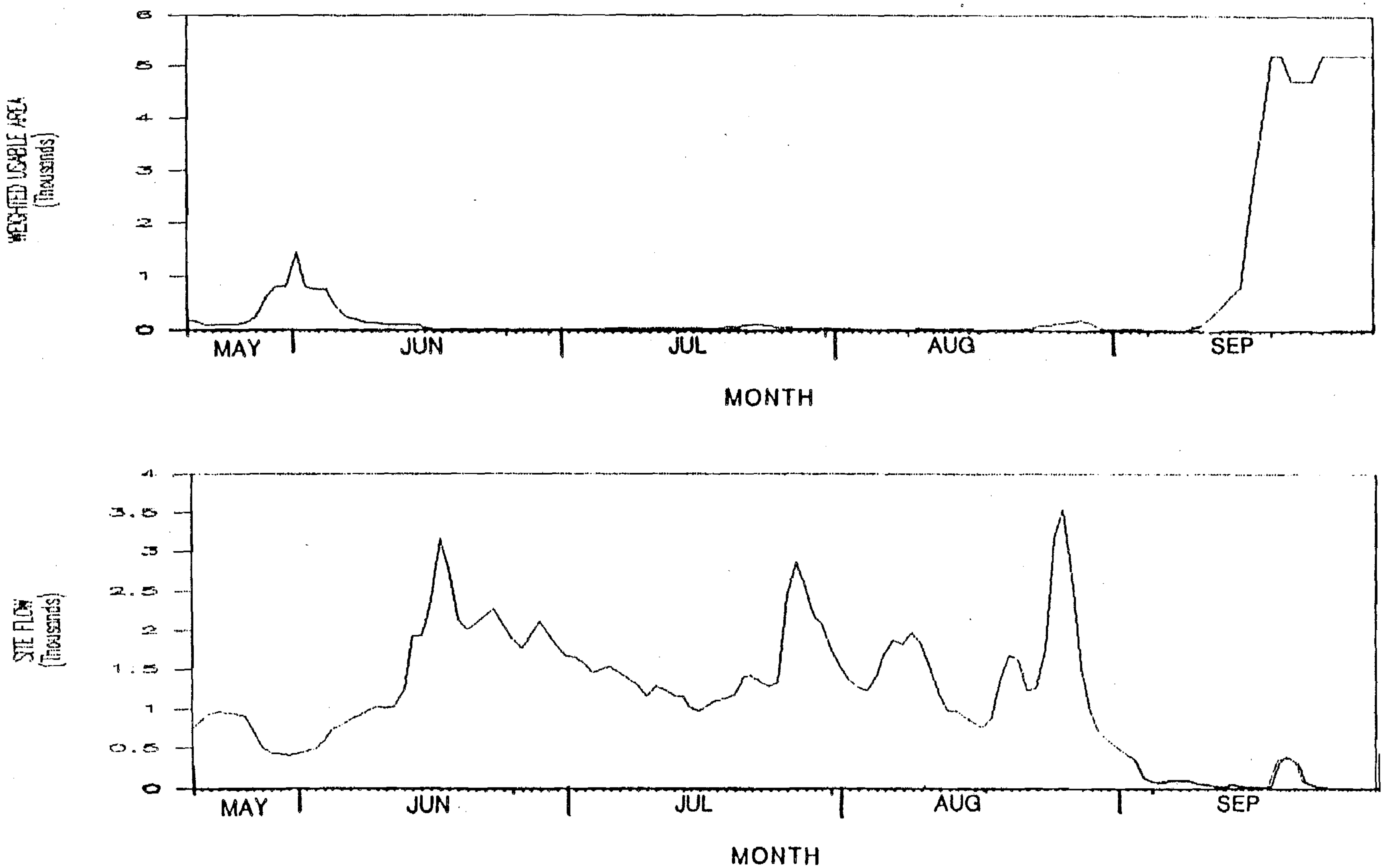

Figure 41. Time series plots of spawning chum salmon WUA as a function of discharge from May 20 to September 30, 1984 in Mainstem West Bank Side Channel modeling site.

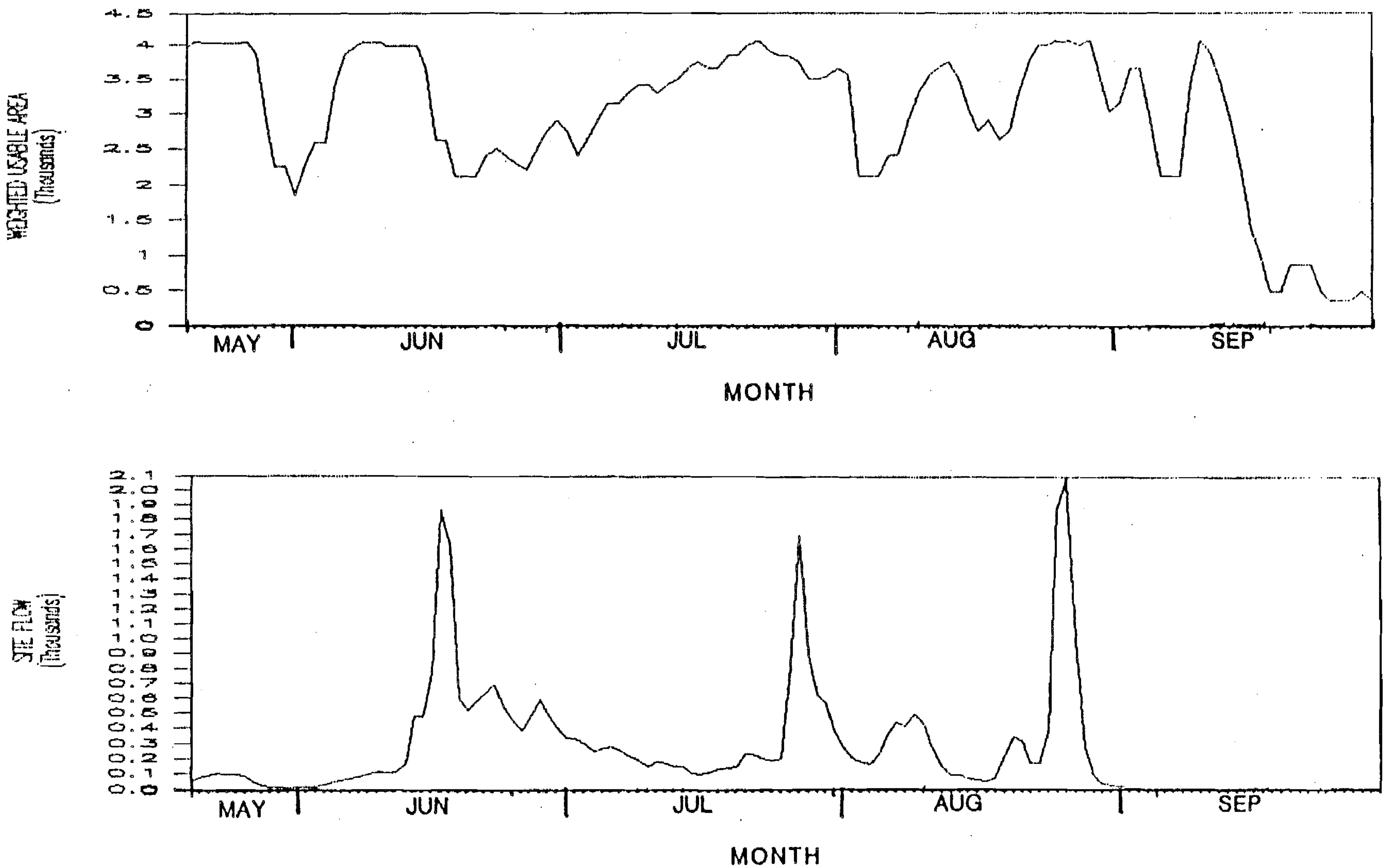

Figure 42. Time series plots of spawning chum salmon WUA as a function of discharge from May 20 to September 30, 1984 in Circular Side Channel modeling site.

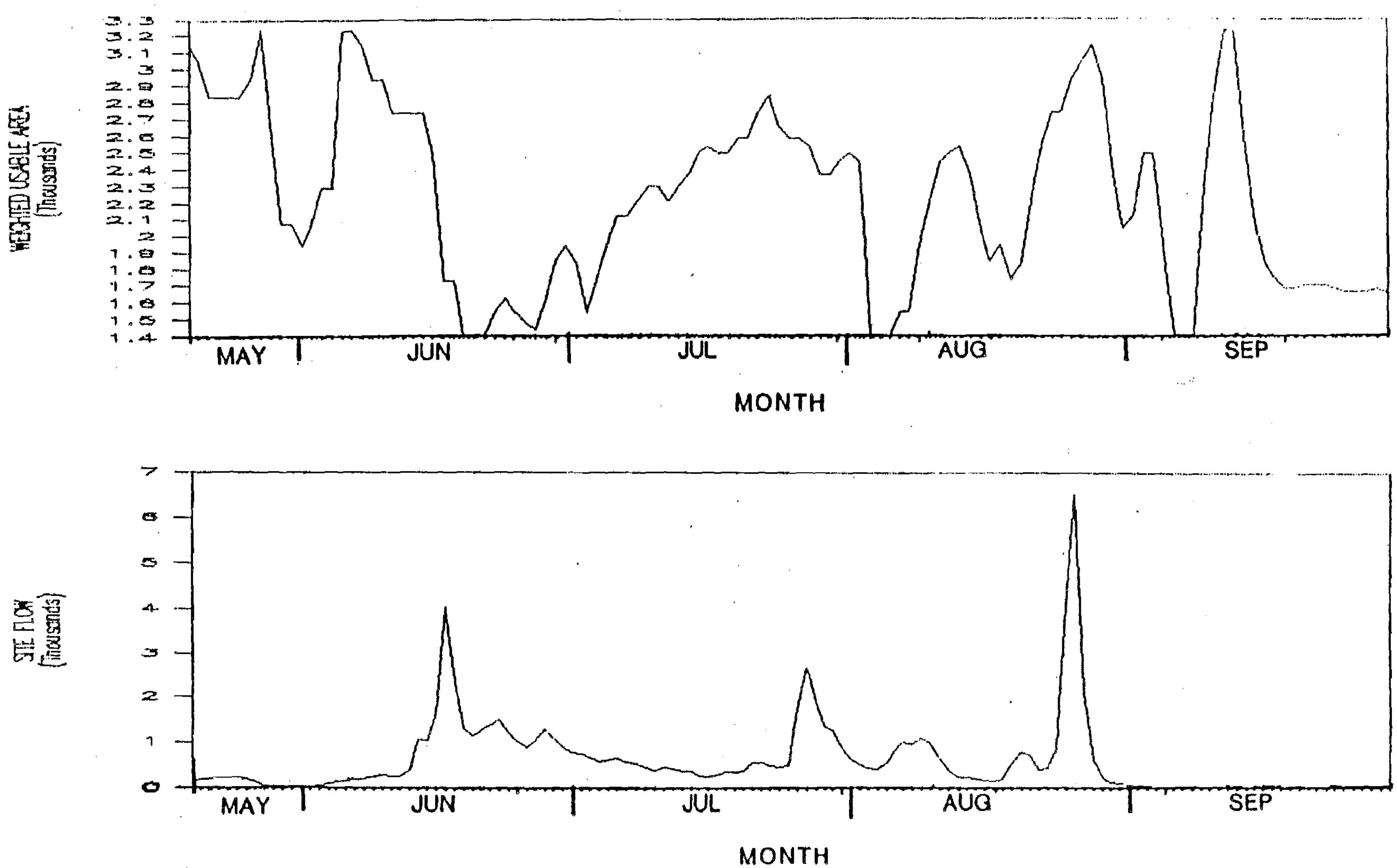

Figure 43. Time series plots of spawning chum salmon WUA as a function of discharge from May 20 to September 30, 1984 in Sunset Side Channel modeling site.

Trapper Creek Side Channel

The Trapper Creek Side Channel hydraulic model was first run through the HABTAT model using observed upwelling codes. There was no upwelling observed in this study site and the suitability curves assign a value of zero to cells without upwelling so WUA projections for this run resulted in zero. When simulated upwelling was used in the model, the resulting projected WUAs peaked well before the site flow (31 cfs) was controlled by mainstem discharge (44,000 cfs), remained relatively constant until after the controlling mainstem discharge was reached, then dropped as discharge increased (Figure 40). According to the time series plots in Figure 44, WUA projections in Trapper Creek Side Channel are highly variable over time.

Embryo Survival and Development

Chum salmon embryos were sampled for survival and development from Trapper Side Channel, Sunset Side Channel, Circular Side Channel and Birch Camp Mainstem to determine relative overwintering success and survival. The development and survival of embryos were determined and are presented in Table 34.

Upper Trapper Side Channel

Embryos were collected in the upper portion of the chum salmon spawning area in Trapper Side Channel from four redds on January 24 and 30. Embryos were obtained by freeze core sampling and egg pump. A total of 56 embryos were collected, five of which were mortalities. Development of the embryos ranged from the caudal bud free stage to pigmentation on the head. Embryos collected by the freeze core method were at depths ranging from 1 to 12 inches. The depths of eggs collected with an egg pump cannot be accurately ascertained.

Lower Trapper Side Channel

Chum salmon embryos collected from the lower portion of the spawning area in Trapper Side Channel were obtained from one redd by hand excavation on January 24. A total of 31 embryos were collected, four of which were mortalities. The dead embryos were observed as empty shells. Development of the live embryos ranged from the caudal bud free stage to pigmentation on the head.

Sunset Side Channel

Chum salmon embryos were collected from five redds at Sunset Side Channel on January 29 and January 30 using both freeze core methods and egg pumping. A total of 56 embryos were collected, 36 of which were mortalities. All live embryos were developed to the eyed stage. Embryos sampled by freeze core method were found at depths of 1 to 4 inches.

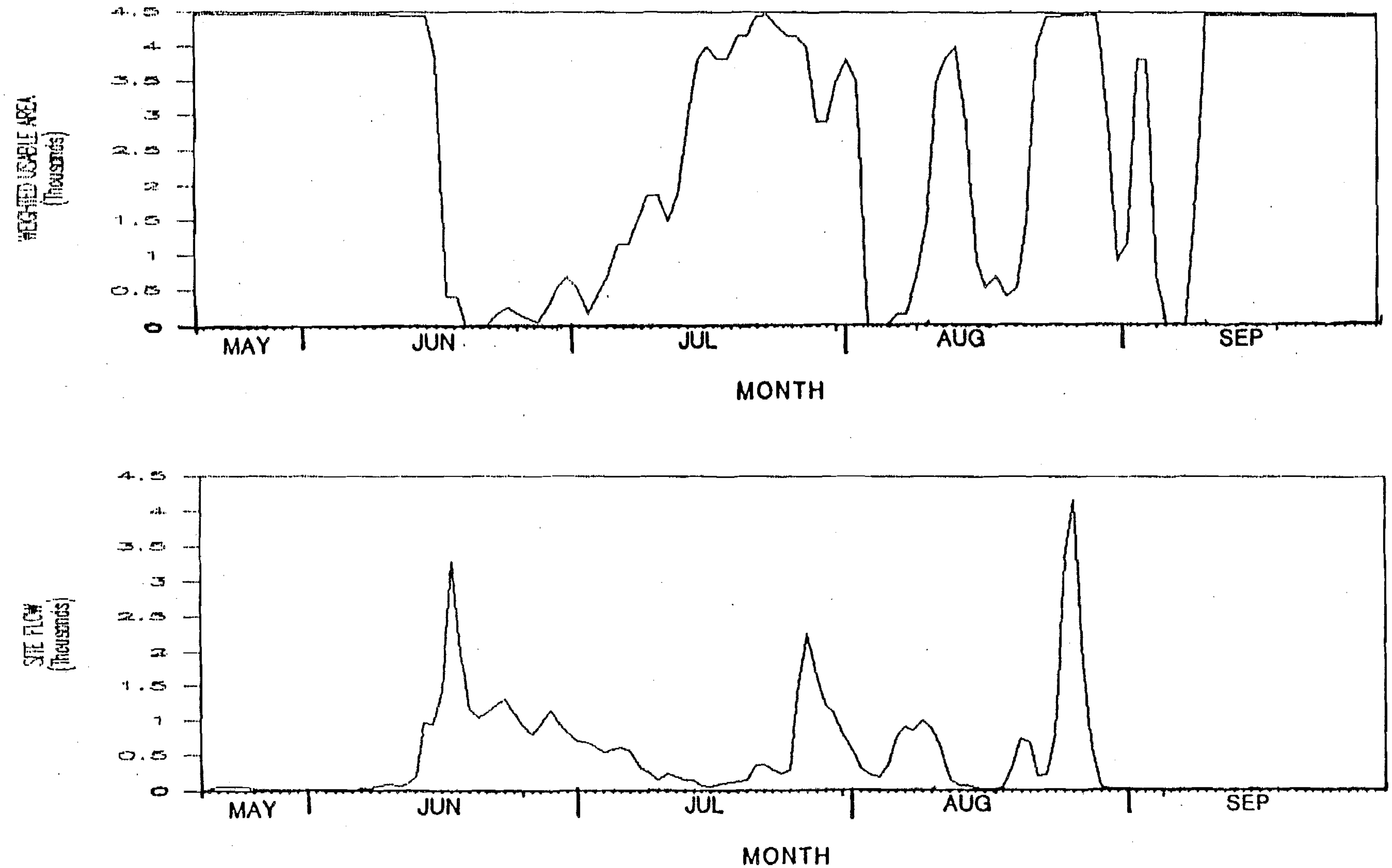

Figure 44. Time series plots of spawning chum salmon WUA as a function of discharge from May 20 to September 30, 1984 in Trapper Creek Side Channel modeling site.

Table 34. Development stage of chum salmon eggs collected from redds in Lower Susitna River side channel sites, January 1985.

					ORGANOGENESIS					EGGS		DEPTH IN	
SITE[1]	DATE	STPP	CAUDAL BUD FREE	YOLK VASCUL.	EYED	ANAL FIN	DORSAL FIN	PELVIC BUDS	PIGMENTATION	LIVE	DEAD	SUBSTRATE (IN.)	COMMENTS
UPPER TRAPPER R-1	850130	EGG PUMP								0	3		EMPTY SHELLS
UPPER TRAPPER R-1	850130	EGG PUMP			X	X	X	X		34	0		
UPPER TRAPPER R-1	850130	EGG PUMP	X	X						1	0		POSSIBLY DEFORMED
UPPER TRAPPER R-1	850130	EGG PUMP			X	X	X	X	X	4	0		
UPPER TRAPPER R-1	850130	EGG PUMP			X					2	0		
UPPER TRAPPER R-2(C)	850124	FREEZE CORE		X	X					1	0	9-12	
UPPER TRAPPER R-2(C)	850124	FREEZE CORE								0	2	9-12	EMPTY SHELLS
UPPER TRAPPER R-3(B)	850124	FREEZE CORE				X	X	X		1	0	5-8	
UPPER TRAPPER R-4(A)	850124	FREEZE CORE			X	X	X	X		1	0	5-8	
UPPER TRAPPER R-4(B)	850124	FREEZE CORE				X	X	X		6	0	5-8	
UPPER TRAPPER R-4(B)	850124	FREEZE CORE				X	X			2	0	1-4	
LOWER TRAPPER R-2	850124	HAND PICKED	X							5	0		
LOWER TRAPPER R-2	850124	HAND PICKED				X	X	X		2	0		
LOWER TRAPPER R-2	850124	HAND PICKED				X	X	X	X	20	0		PIGMENT FAINT ON HEADS
LOWER TRAPPER R-2	850124	HAND PICKED								0	4		EMPTY SHELLS
SUNSET R-4	850130	EGG PUMP		X	X					2	0		
SUNSET R-4	850130	EGG PUMP		X	X					7	0		
SUNSET R-6A(A)	850130	FREEZE CORE								0	1	1-4	EMPTY SHELL
SUNSET R-6C	850128	EGG PUMP								0	18		UNFERTILIZED OR DIED EARLY
SUNSET R-7(A)	850128	FREEZE CORE								0	17	1-4	UNFERTILIZED OR DIED EARLY
SUNSET R-10	850130	EGG PUMP		X	X					10	0		
SUNSET R-10	850130	EGG PUMP		X	X					1	0		
CIRCULAR R-1(B)	850129	FREEZE CORE	X							0	1	5-8	
CIRCULAR R-1(B)	850129	FREEZE CORE								0	12	5-8	RUPTURED EGGS/SHELLS UNIDENTIFIED
CIRCULAR R-1(B)	850129	FREEZE CORE				X	X	X		3	0	5-8	LOOSE EMBRYOS
CIRCULAR R-3(B)	850128	FREEZE CORE			X					0	2	9-12	
CIRCULAR R-3(B)	850128	FREEZE CORE				X	X	X		7	0	9-12	
CIRCULAR R-3(B)	850128	FREEZE CORE			X	X				3	0	9-12	
CIRCULAR R-3(B)	850128	FREEZE CORE								0	2	9-12	
CIRCULAR R-3(C)	850128	FREEZE CORE								0	1	9-12	EMPTY SHELL
CIRCULAR R-4	850128	HAND PICKED				X	X	X	X	5	0		
CIRCULAR R-5E(A)	850128	FREEZE CORE				X	X	X		3	0		
CIRCULAR R-5E(A)	850128	FREEZE CORE				X				0	1		
CIRCULAR R-5E(A)	850128	FREEZE CORE								0	2		UNFERTILIZED OR DIED EARLY
CIRCULAR R-5E(A)	850128	FREEZE CORE				X	X	X	X	2	0		
CIRCULAR R-5E(A)	850128	FREEZE CORE				X	X	X	X	8	0		
CIRCULAR R-5E(A)	850128	FREEZE CORE								0	3		EMPTY SHELLS
CIRCULAR R-5E(B)	850128	FREEZE CORE				X	X	X		15	0	5-8	
CIRCULAR R-5E(B)	850128	FREEZE CORE								0	1	5-8	UNFERTILIZED OR DIED EARLY
CIRCULAR R-5E(B)	850128	FREEZE CORE			X					1	0	5-8	
CIRCULAR R-5E(B)	850128	FREEZE CORE			X					1	0	5-8	
CIRCULAR R-5E(B)	850128	FREEZE CORE								0	3	5-8	EMPTY SHELLS
CIRCULAR R-5E(B)	850128	FREEZE CORE				X	X	X	X	13	0	5-8	
BIRCH CREEK MS	850130	HAND PICKED			X	X	X	X	X	26	4		

[1] Letters in () denote egg depth as follows: A=0-4"; B=5-8"; C=9-12".

Circular Side Channel

Chum salmon embryos were collected on January 28 and 29 by the freeze core method and by hand excavation. A total of 89 embryos were collected, 28 of which were mortalities. Development for the embryos ranged from eye development to pigmentation on the head. Embryos collected by the freeze core method were found at depths ranging from 5 to 12 inches.

Birch Camp Mainstem

Chum salmon embryos collected from this site were obtained from two redds by hand excavation on January 30. A total of 30 embryos were collected. All embryos sampled were fully developed and very close to "hatching". Depths of embryos sampled were found to be from 1-4 inches.

Outmigration Occurrence

Fyke nets were placed in Trapper, Sunset, and Circular side channels during the spring to monitor outmigrant juvenile salmon activities. Each net was placed below areas where significant numbers of chum redds were known to exist. Nets were monitored once or twice daily depending on the numbers of fish being caught. The results of the outmigrant captures are presented in Table 33.

Trapper Side Channel

In Trapper Side Channel, a net was placed 1/2 to 3/4 miles above the mouth of the side channel. Approximately 15 percent of the chum salmon spawning activity during 1984 occurred below the net. The entire length of the side channel could not be sampled due to channel geometry. The net did, however, sample 80-90 percent of the width of the side channel.

The Trapper net was installed April 14 and monitored through May 28. Total catches are as follows: King salmon, 372; sockeye, 671; coho, 436; pink, 45; chum, 32.

Sunset Side Channel

The Sunset net was placed below the downstream most chum salmon redd which was approximately 1/4 mile upstream from the mouth of the side channel. The entire width of the side channel was sampled.

The Sunset net was installed on April 16 and monitored through May 26. Total catches are as follows: King salmon, 2; sockeye, 0; coho, 4; pink, 2; chum, 165.

Circular Side Channel

The Circular net was placed below the lowest chum salmon redd which was 150 to 200 yards upstream from the mouth of the side channel. Approximately 60 percent of the width of the channel was sampled.

Table 33. Outmigrant fyke net catch data from Lower Susitna River sites, April - May, 1985.

SITE	DATE SET	DATE CHECKED	TIME SET	TIME CHECKED	SPECIES KING	SOCKEYE	COHO	PINK	CHUM	RWF	GRAYLING	SUCKER	DOLLY	SCULPIN	RBT
TRAPPER SIDE CHANNEL[1]	850415	850417	700	800	0	1	10	0	0	0	0	0	0	1	0
TRAPPER SIDE CHANNEL	850417	850418	900	1000	17	12	11	0	0	0	0	0	0	8	1
TRAPPER SIDE CHANNEL	850418	850419	1000	800	3	3	7	0	0	1	0	0	0	7	1
TRAPPER SIDE CHANNEL	850422	850423	1900	1030	33	17	50	0	0	0	0	0	0	18	13
TRAPPER SIDE CHANNEL	850423	850424	1100	1400	17	1	9	0	0	1	0	0	0	10	1
TRAPPER SIDE CHANNEL	850425	850426	1800	900	10	4	7	0	0	1	0	0	0	11	1
TRAPPER SIDE CHANNEL	850430	850501	1200	1200	42	9	43	0	1	3	0	0	0	15	9
TRAPPER SIDE CHANNEL	850501	850502	1200	920	54	8	85	0	0	1	0	1	0	16	7
TRAPPER SIDE CHANNEL	850508	850509	1500	1100	17	29	17	0	0	0	0	0	1	0	1
TRAPPER SIDE CHANNEL	850509	850510	1100	900	18	9	18	0	0	1	0	0	0	25	1
TRAPPER SIDE CHANNEL	850511	850512	1800	1000	17	4	10	0	0	0	2	0	0	0	0
TRAPPER SIDE CHANNEL	850514	850515	1800	1000	8	2	6	1	1	0	0	0	0	22	0
TRAPPER SIDE CHANNEL	850515	850516	1800	1000	0	0	0	0	0	0	0	0	0	0	0
TRAPPER SIDE CHANNEL	850515	850516	1930	1000	21	2	1	0	1	0	0	0	0	14	0
TRAPPER SIDE CHANNEL	850515	850515	1000	1930	7	3	5	0	0	0	0	0	0	7	0
TRAPPER SIDE CHANNEL	850516	850517	1000	1000	14	5	9	1	0	0	0	0	0	5	0
TRAPPER SIDE CHANNEL[2]	850519	850520	1700	1330	5	200[3]	38	0	0	0	0	0	0	0	8
TRAPPER SIDE CHANNEL	850519	850519	1030	1700	20	1	6	0	0	0	0	0	0	8	0
TRAPPER SIDE CHANNEL[2]	850520	850521	1330	1000	54	288	84	1	1	0	0	0	0	8	2
TRAPPER SIDE CHANNEL	850523	850523	800	1800	1	1	1	1	0	0	0	0	0	0	0
TRAPPER SIDE CHANNEL	850524	850525	1800	900	4	51	12	1	11	0	0	0	0	0	0
TRAPPER SIDE CHANNEL	850525	850525	900	1800	3	3	0	0	1	0	0	0	0	0	0
TRAPPER SIDE CHANNEL	850525	850527	900	1800	0	4	0	9	3	0	0	0	0	0	0
TRAPPER SIDE CHANNEL	850525	850526	1800	900	5	4	3	6	1	0	0	0	0	0	0
TRAPPER SIDE CHANNEL	850526	850527	1800	900	1	5	3	11	3	0	0	0	0	0	0
TRAPPER SIDE CHANNEL	850526	850526	900	1800	0	0	0	13	1	0	0	0	0	0	0
TRAPPER SIDE CHANNEL	850527	850528	1800	900	1	5	1	1	8	0	0	0	0	0	0
TOTAL					372	671	436	45	32	8	2	1	1	175	45
SUNSET SIDE CHANNEL[4]	850524	850525	1800	1000	0	0	1	2	9	0	0	0	0	0	0
SUNSET SIDE CHANNEL	850525	850525	1000	1830	1	0	2	0	18	0	0	0	0	0	0
SUNSET SIDE CHANNEL	850526	850527	1830	1000	1	0	1	0	138	0	0	0	0	0	0
TOTAL					2	0	4	2	165	0	0	0	0	0	0
CIRCULAR SIDE CHANNEL[5]	850430	850502	1000	740	2	0	0	0	0	3	0	0	0	0	0
CIRCULAR SIDE CHANNEL	850509	850510	1000	1000	13	0	8	0	0	0	0	4	0	0	0
CIRCULAR SIDE CHANNEL	850515	850516	1800	1200	0	0	0	0	0	0	0	0	0	0	0
CIRCULAR SIDE CHANNEL	850515	850515	900	1800	29	0	23	0	1	6	3	1	0	0	0
CIRCULAR SIDE CHANNEL	850521	850522	1200	1200	227	26	76	1	126	295	8	21	1	5	0
CIRCULAR SIDE CHANNEL	850522	850522	1200	1800	25	6	25	0	0	0	0	0	0	0	0
CIRCULAR SIDE CHANNEL	850523	850524	1800	930	14	4	11	0	4	0	0	0	0	0	0
TOTAL					310	36	143	1	131	304	11	26	1	5	0
BIRCH CREEK SIDE CHANNEL	850430	850502	1400	900	2	0	2	1	1	0	0	0	0	2	3
TOTAL					2	0	2	1	1	0	0	0.	0	2	3

[1] Missing dates at Trapper Side Channel represent days the net was not set.

[2] Three juvenile sockeye salmon with coded wire tags were caught.

[3] An additional 250+ sockeye was released due to length of time in sample bucket.

[4] Missing dates at Sunset Side Channel represent days the net was set but no fish were caught (April 16 to April 23).

[5] Missing dates at Circular Side Channel from April 16 to April 29 are days the net was set but no fish were caught. Data gaps from April 30 to May 27 are due to ice jams causing net problems.

The Circular net was installed on April 6 and monitored through May 25. A summary of the total catch is as follows: King salmon, 310; sockeye, 36; coho, 143; pink, 1; chum, 131.

CONCLUSIONS

Preliminary lower river salmon spawning habitat assessments were begun in the fall of 1984 following observations made by ADF&G personnel of significant chum salmon spawning within side channel habitats of the lower Susitna River. The preliminary habitat assessments conducted indicate that several of the physical variables evaluated may be critical to availability of spawning habitat and to the viability of incubating chum salmon embryos deposited in these habitats.

Habitat Data

Groundwater flow appeared to be a critical factor affecting the overwintering success of embryos at study sites. From field observations the quantity of groundwater flow appeared to be a function of mainstem stage. Groundwater flow was observed to decrease as the mainstem stage decreased threatening exposure of redds until an ice cover formed on the mainstem. Within a short period of time following the mainstem ice cover in the vicinity of the three side channels (Trapper, Sunset, and Circular), the influence of groundwater flow increased to provide sufficient side channel flow for redd survival. However, lack of groundwater flow within the side channels prior to ice cover formation appeared to pose a threat to the survival of the chum salmon embryos at all three major side channel spawning sites evaluated. The upper portion of Sunset Side Channel froze about one week prior to the formation of mainstem ice cover, resulting in a mortality of chum salmon embryos in some redds at this site. Following formation of mainstem ice cover stage data was obtained and indicates that ground water within each study site remained stable and at levels sufficient for redd survival throughout the remaining winter months.

The six lower river study sites had areas of upwelling during the open water season, however, five of these sites had an ice cover during the winter. Upwelling was observed at these five sites by drilling through the ice cover.

Water temperature did not seem to pose a threat to incubating embryos at any of the study sites as long as sufficient groundwater upwelling was present. In general, water temperatures were found to be similar between the lower and upper monitoring stations within each of the side channels with intragravel water temperatures consistently warmer than surface water. Circular Side Channel was found to have the greatest range of surface and intragravel water temperatures (-0.2 to 4.0 and -0.1 to 3.8, respectively) and the coldest water temperatures, although the Upper Sunset Side Channel surface water temperature probe indicated frozen conditions from November 16-20. Overall, these baseline data indicate that the intragravel water temperatures were sufficient to provide adequate incubation and embryo development. However, prior to installation at temperature stations some freeze out occurred at Upper Sunset Side Channel prior to ice staging due to insufficient groundwater upwelling.

Substrate did not appear to be limiting to incubating embryos at any of the redds evaluated. Substrate samples obtained from chum salmon redds indicate that larger particle sizes (.8 - 3.0 inches) are predominant in the top 4 inches and particle sizes gradually decrease as depth increases.

Biological Data

Chum salmon spawning activity was observed within four side channels modeled using the IFG-4 method. For each of these side channels projections of gross surface area and weighted usable area of chum salmon spawning habitat were made using the calibrated IFG-4 hydraulic simulation models developed in support of the lower river rearing habitat investigations.

Gross surface area projections at each of these study sites increased with increasing mainstem discharge and site flow. Projections of WUA of chum salmon spawning habitat peaked when or just after the site flow was controlled by mainstem discharge, then declined with increasing mainstem discharge and site flow.

Overall, the sites with higher controlling discharges provided more WUA for chum salmon spawning over time (e.g. Trapper Creek Side Channel, Circular Side Channel, and Sunset Side Channel) than did the site with a lower controlling discharge (e.g. Mainstem West Bank Side Channel).

Suitability criteria developed for the middle Susitna River indicate that upwelling is an important variable for spawning chum salmon (Vincent-Lang et al. 1984). When hydraulic models lacking upwelling are linked with middle river suitability criteria in the HABTAT model the result is WUAs of zero. Simulating upwelling in these models produced similar trends in WUAs as in models where upwelling was observed.

Embryo incubation studies showed that embryos generally developed to alevin stage at sites where spawning occurred with the exception of those in Upper Sunset which were frozen due to a lack of upwelling groundwater prior to mainstem ice-staging. Development analysis of embryos collected at Trapper, Sunset, Circular, and mainstem at Birch Creek in late January showed that embryos were developed to the caudal bud free stage to pigmentation.

Outmigrant studies at Trapper Side Channel, Sunset Side Channel, and Circular Side Channel confirmed the survival of embryos through emergence. In addition, it became apparent that a significant number of chinook, coho, and sockeye salmon utilize these same habitats for overwintering.

RECOMMENDATIONS FOR FUTURE STUDIES

Results of the FY85 studies indicate that a significant population of spawning chum salmon has been observed to utilize mainstem and side channel habitats of the lower Susitna River (Yentna River to the three rivers confluence). This, coupled with supplemental reconnaissance field data collected in association with the rearing habitat studies presented in this memorandum, indicate that further studies are necessary to better understand and define how mainstem discharge affect habitats used by chum salmon for spawning and incubation. The following recommendations therefore are made for future studies:

1. Conduct foot and aerial surveys of lower river side channel and mainstem habitats to further determine the location and numbers of salmon utilizing these areas for spawning.

2. Evaluate the effects that natural flow variations of the mainstem have on passage into spawning areas documented in this memorandum and those discovered during future spawning surveys.

3. Determine the relationship that mainstem ice-staging has on ground water upwelling in unbreached side channel spawning habitats, specifically during the critical period of mainstem icing in the fall.

4. During this study, it became apparent that a significant number of juvenile salmon utilized the evaluated side channel habitats for overwintering. For this reason, studies should be initiated to determine the magnitude and timing of juvenile salmon inmigration into side channel habitats and to evaluate the potential impact that post project flow regimes may have on the overwintering rearing habitat potential of these sites.

5. Chum salmon embryos should be sampled during their incubation phase to determine redd survival over the critical time period when ground water flow is reduced prior to winter staging. Sampling should continue until side channel flow has stabilized.

6. Substrate and upwelling conditions should be documented for those areas where spawning is found. Surface and intragravel temperatures should also be monitored throughout the incubation period.

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