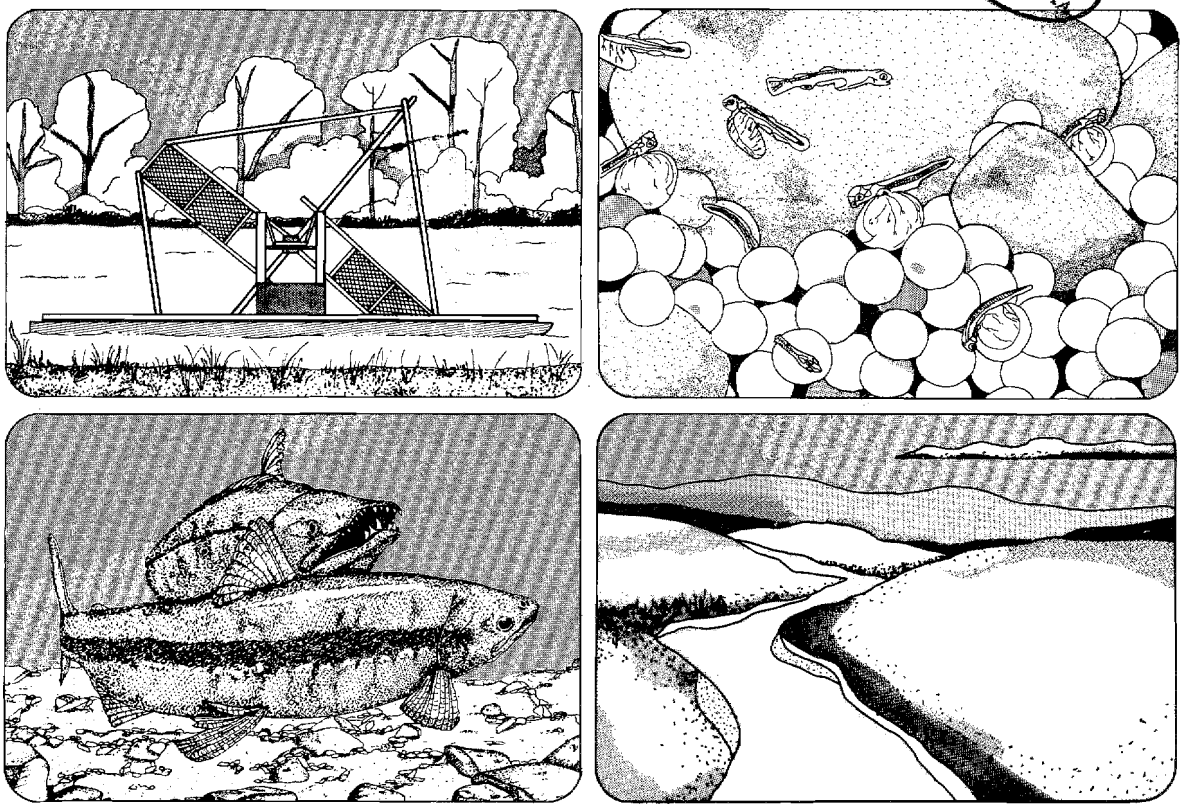

ALASKA DEPARTMENT OF FISH AND GAME
SUSITNA HYDRO AQUATIC STUDIES REPORT SERIES

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ALASKA DEPARTMENT OF FISH AND GAME
SUSITNA HYDRO AQUATIC STUDIES

REPORT NO. 3

AQUATIC HABITAT AND INSTREAM FLOW INVESTIGATIONS (MAY-OCTOBER 1983)

Chapter 5: Eulachon Spawning Habitat in the Lower Susitna River

Edited by:

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NOTICE

ANY QUESTIONS OR COMMENTS CONCERNING THIS REPORT SHOULD BE DIRECTED TO THE ALASKA POWER AUTHORITY SUSITNA PROJECT OFFICE

CONTENTS OF REPORT NO. 3

Part One

Part Two

Questions concerning this and prior reports should be directed to:

Alaska Power Authority
334 W. 5th Avenue
Anchorage, Alaska 99501
Telephone (907) 276-0001

PREFACE

This report is one of a series of reports prepared for the Alaska Power Authority (APA) by the Alaska Department of Fish and Game (ADF&G) to provide information to be used in evaluating the feasibility of the proposed Susitna Hydroelectric Project. The ADF&G Susitna Hydro Aquatic Studies program was initiated in November 1980. The five year study program was divided into three study sections: Adult Anadromous Fish Studies (AA), Resident and Juvenile Anadromous Studies (RJ), and Aquatic Habitat and Instream Flow Studies (AH). Reports prepared by the ADF&G prior to 1983 on this subject are available from the APA.

The information in this report summarizes the findings of the 1983 open water field season investigations. Beginning with the 1983 reports, all reports were sequentially numbered as part of the Alaska Department of Fish and Game Susitna Hydro Aquatic Studies Report Series.

TITLES IN THE 1983 SERIES

Report Number	Title	Publication Date
1	Adult Anadromous Fish Investigations: May - October 1983	April 1984
2	Resident and Juvenile Anadromous Fish Investigations: May - October 1983	July 1984
3	Aquatic Habitat and Instream Flow Investigations: May - October 1983	1984
4	Access and Transmission Corridor Aquatic Investigations: May - October 1983	1984

This report, "Aquatic Habitat and Instream Flow Investigations" is divided into two parts. Part I, the "Hydrologic and Water Quality Investigations", is a compilation of the physical and chemical data collected by th ADF&G Su Hydro Aquatic Studies team during 1983. These data are arranged by individual variables and geographic location for ease of access to user agencies. The combined data set represents the available physical habitat of the study area within the Cook Inlet to Oshetna River reach of the Susitna River. Part II, the "Adult Anadromous Fish Habitat Investigations", describes the subset of available habitat compiled in Part 1 that is utilized by adult anadromous fish studied in the middle and lower Susitna River (Cook Inlet to Devil Canyon) study area. The studies primarily emphasize the utilization of side slough and side channel habitats of the middle reach of the Susitna River for spawning (Figure A). It represents the first stage of development for an instream flow relationships analysis report which will be prepared by E.W. Trihey and Associates.

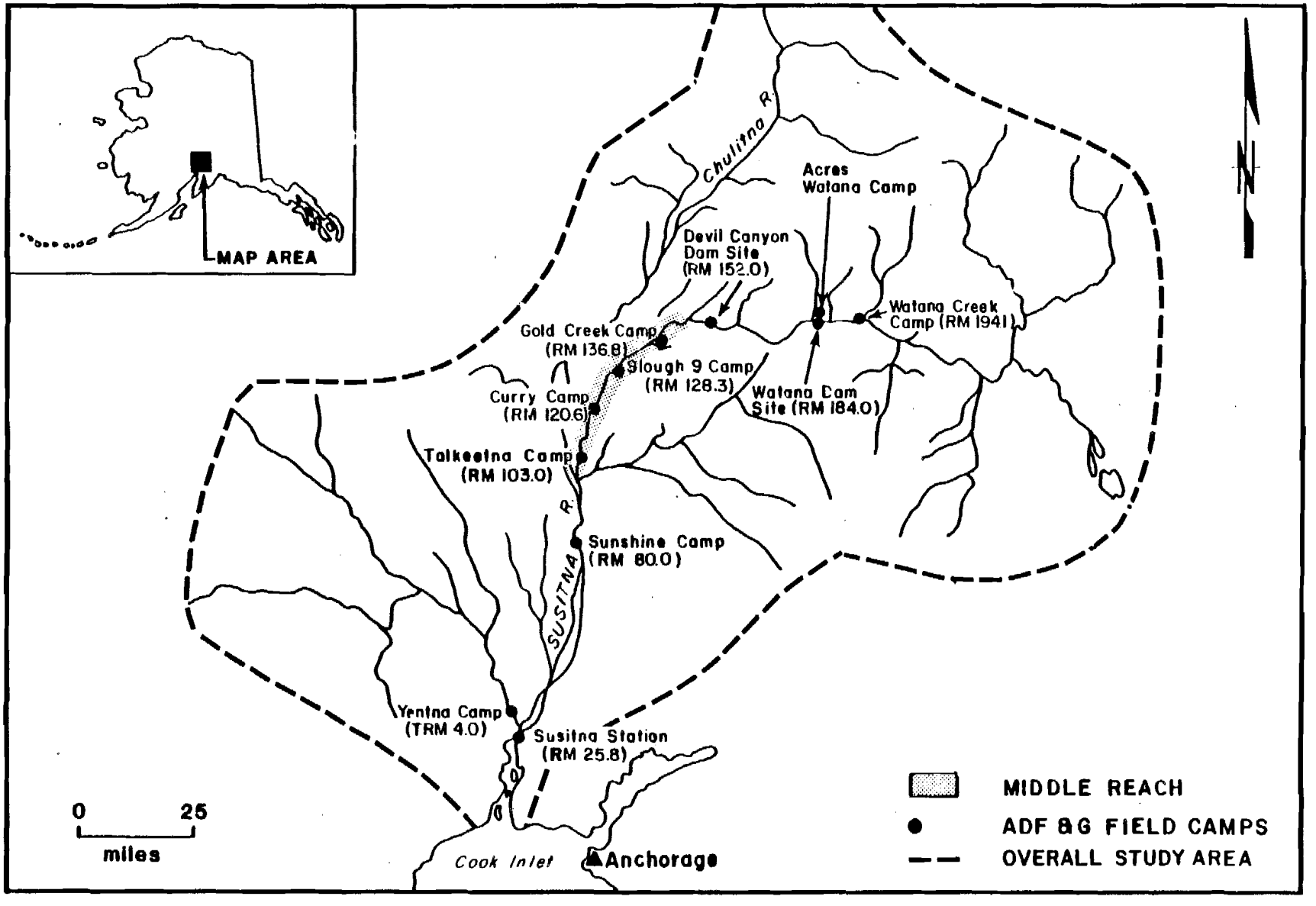

Figure A. Susitna River drainage basin.

EULACHON SPAWNING HABITAT IN THE LOWER SUSITNA RIVER.

1984 Report No. 3, Chapter 5

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ABSTRACT

Eulachon [Thaleichthys pacificus (Richardson)] are an anadromous member of the smelt family. Studies to determine naturally occurring hydraulic and temperature relationships to eulachon immigration and spawning were initiated by the Alaska Department of Fish and Game (ADF&G) in 1982 and continued into 1983. These surveys indicated that eulachon are probably the most abundant species of fish in the Susitna River. Based on 1982 and 1983 catch data, eulachon being their upstream spawning migration during early to mid-May. Two distinct spawning runs of eulachon enter the Susitna River with no apparent definite correlation with either mainstem discharge or temperature. Spawning was found to occur over a broad range of hydraulic and substrate conditions along the margins of mainstem habitats from the mouth of the Susitna River (RM 0) upstream to RM 50.3. Based on a representative number of spawning sites selected for further evaluation, it appears that similar physical habitat condition will be present under both decreased and increased mainstem discharge conditions.

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1.0 INTRODUCTION

This chapter reports the habitat characteristics associated with eulachon [Thaleichthys pacificus (Richardson)] spawning in the lower Susitna River. Eulachon are an anadromous member of the smelt family. With-project changes associated with the development and operation of the Susitna Hydroelectric Project may have impacts on eulachon immigration and spawning in the lower Susitna River. Two of the major impacts expected include decreased discharge and increased water temperatures during the period of the eulachon spawning run (May-June). Studies to determine naturally occurring hydraulic and temperature relationships to inmigration and spawning were initiated by the Alaska Department of Fish and Game (ADF&G) in 1982 and continued into 1983. The results of these studies will enable project participants to evaluate with-project effects on eulachon immigration and spawning.

The 1982 surveys (ADF&G 1983a, 1983b) confirmed previous reports (Morrow 1980, Lee et. al., 1980) that eulachon utilize the lower Susitna River basin for spawning. These surveys (May-June, 1982) included preliminary investigations of the extent and timing of the eulachon run in the Susitna River and of the various habitat and environmental parameters associated with the eulachon spawning run. Results of the 1982 surveys indicated that two runs of eulachon utilize the Susitna River for spawning and that eulachon are probably the most abundant species of fish in the Susitna River drainage. It was also determined that eulachon spawn over a broad range of hydraulic and substrate conditions along the margins of mainstem habitats. Specific findings of the 1982

surveys are summarized in the ADF&G Phase II Basic Data Report, Volumes 2 and 4 (ADF&G 1983a, 1983b).

The objectives of the 1983 studies were to further:

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

2. Identify habitats utilized by eulachon for spawning;

3. Determine the habitat and environmental parameters associated with eulachon spawning;

4. Monitor mainstem discharge and surface water temperatures associated with the timing, movement, and spawning of eulachon; and

5. Determine whether similar physical habitat conditions might exist under varied mainstem flow regimes to support impact and mitigation assessments by other project personnel.

The first objective was addressed by the Adult Anadromous Fish Studies with results presented in Barrett, Thompson, and Wick (1984). The last four objectives were addressed by the Aquatic Habitat and Instream Flow Studies Group with results presented in this chapter.

2.0 METHODS

Methods used in the 1983 studies are presented below by objective.

Objective 1

Objective 1 was addressed by the Adult Anadromous Fish Studies. Methods used in assessing this objective are presented in Barrett, Thompson, and Wick (1984).

Objective 2

Dip nets and boat mounted electrofishing gear were used to identify habitats utilized by eulachon for spawning. Capture sites were not assumed to be spawning sites unless the following criteria were met[1]:

1. A single sampling effort at the catch site produced at least 25 eulachon;

2. At least one male eulachon, one pre-spawning condition female, and either one spawning or post-spawning condition female were captured in a single sampling effort at a catch site; and,

3. All eulachon captured at the catch site were in a vigorous free-swimming condition.

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[1] These criteria were modified from those used in the 1982 ADF&G study (ADF&G 1983b). The basis for implementing these criteria can be found in the ADF&G FY84 Basic Data Report, Volume 2 (ADF&G 1983a).

Twenty representative spawning sites were selected for evaluation from the total population of utilized spawning sites surveyed. Field studies to obtain data on the habitat attributes of these 20 spawning sites were scheduled to coincide with the second eulachon run because our 1982 investigations and field experience indicated this was a more advantageous period for sampling than during the first eulachon run.

Objective 3

Habitat surveys were conducted at the 20 eulachon spawning sites selected for evaluation to determine habitat and environmental parameters associated with eulachon spawning. The procedures followed in each habitat survey consisted of:

1. The spawning site was assigned a sample number and the river mile (RM), geographic code (GC), time of day, and date of sampling were determined and recorded;

2. A field sketch of the site was drawn depicting the general habitat characteristics of the site and areas of sampling and measurements;

3. A general description of the habitat characteristics of the site and the sampling methods and gear used were recorded;

4. The typical substrate composition of the site was visually determined and recorded using methods described in the Phase II Procedures Manual (ADF&G 1982);

5. Representative measurements of air and surface water temperature, pH, dissolved oxygen, and specific conductance were collected at each site using procedures described in the FY84 Procedures Manual (ADF&G 1982);

6. Water depth and velocity was measured at points on a sampling grid developed for the collection of water depth and velocity data based on procedures described in the FY84 Procedures Manual (ADF&G 1982).

7. Representative photographs of the site were taken. (A complete set of photographs are on file at the ADF&G Su Hydro office, 2207 Spenard Road, Anchorage, Alaska 99503).

Objective 4

Surface water temperatures associated with eulachon spawning runs were determined with a Peabody-Ryan model J-90 thermograph was placed along the east bank of the Susitna River at RM 4.5. This type of thermograph can continuously monitor and record surface water temperatures. Strip charts from this recorder were reduced to obtain daily mean temperatures calculated as the mean of four, instantaneous, point temperature readings at 6-hour intervals.

Mainstem Susitna River discharges associated with eulachon spawning runs were obtained as provisional discharge data for the Susitna River at Susitna Station was obtained from the U.S. Geological Survey (USGS, 1983

provisional data). These data were in the form of mean daily discharge readings.

Objective 5

A representative sub-sample of the surveyed spawning sites was chosen for further study to determine whether similar suitable physical habitat conditions that were present at the time of spawning might exist at different mainstem discharges. At each of the five study sites selected for further study, two representative transects were selected at the time of the spawning run for streambank/streambed surveys. Headpins were established on each transect at a point sufficiently above the high water marks. These headpins were then referenced to a benchmark (BM) with an assigned elevation of 100.00 feet. Streambank/streambed profiles were then surveyed from the headpin into the river to a depth of approximately five feet using the basic techniques of differential leveling. The substrate composition along each transect was visually determined and recorded. Water surface elevation and distance to water's edge from headpin at the time of spawning were determined at each transect and recorded. Representative measurements of water depth and velocity were also obtained along each transect and recorded. The date of the field work was noted so that the mainstem discharge associated with these measurements could later be obtained and recorded with the field data. During subsequent visits to the sites, additional measurements of water surface elevation, distance to water's edge from headpin, water depth, and velocity were obtained along each transect at different mainstem discharges.

3.0 RESULTS

Spawning habitat surveys were conducted at 20 sites (Table 5-1) between RM 10 and RM 20 during the second eulachon run (Barrett, Thompson, and Wick 1984). Field sketches of each surveyed spawning site depicting the general habitat characteristics of the site and areas of measurement and sampling are presented in Appendix Figures 5-A-1 and 5-A-2.

Representative measurements of water quality (surface water temperature, pH, specific conductance, and dissolved oxygen) obtained at the time of spawning collected at each spawning site are summarized in Table 5-2 and Figures 5-1 and 5-2. The means and ranges of instantaneous water depths and velocities measured at the time of eulachon spawning at each site are summarized in Table 5-3 and Figure 5-3. The general substrate composition observed at each site during the period of spawning is presented in Figure 5-4.

Average daily surface water temperature of the mainstem Susitna River at RM 4.5 and mean daily discharge of the mainstem Susitna River at Susitna Station (USGS 1983 provisional data) were plotted with catch per unit effort (Barrett, Thompson, and Wick 1984) for the gill net sets at high tides May 10 through June 8, 1983 to compare the mainstem surface water temperatures and discharges associated with the movement patterns and timing of spawning of eulachon (Figure 5-5). These data indicate there appears to be no definite correlation between the timing of the eulachon spawning run entering the Susitna River with either mainstem discharge or surface water temperature.

Table 5-1. Sites and survey dates at which 1983 eulachon spawning habitat surveys were conducted: May 23-26, 1983.

Site	River Mile	Geographic Code	Date	Time
1	20.0	S16N07W09DDB	830523	1445
2	12.8	S15N07W12BCB	830524	0930
3	13.8	S15N07W02DAC	830524	1100
4	15.0	S16N07W35LDA	830524	1135
5	15.0	S16N07W35BDA	830524	1215
6	16.2	S16N07W26BDB	830524	1300
7	18.1	S16N07W15CCB	830524	1430
8	19.5	S16N07W16AAA	830524	1530
9	21.5	S16N07W04DBB	830524	1630
10	23.0	S17N07W33DBB	830524	1700
11	20.5	S16N07W08DCA	830525	1030
12	22.8	S17N07W32DDA	830525	1130
13	23.1	S17N07W33BCD	830525	1230
14	24.9	S17N07W27BBD	830525	1530
15	26.2	S17N07W22ADA	830525	1600
16	26.5	S17N07W23BDD	830525	1700
17	28.0	S17N07W13BAD	830526	1000
18	30.1	S17N06W08CBD	830526	1100
19	33.4	S18N06W33ABD	830526	1130
20	36.5	S18N06W15BBA	830526	1230

Table 5-2. Instantaneous measurements of water quality variables collected at sites at which eulachon spawning habitat surveys were conducted on dates field surveys were performed: May 23-26, 1983.

Site	Date	Water Temp. (°C)	pH	Specific Conductance (umhos)	Dissolved Oxygen (mg/l)	Mainstem[1] Discharge (cfs)
1	830523	8.1	6.6	95	10.2	66,000
2	830524	6.5	6.8	93	6.4	62,000
3	830524	6.7	6.9	93	8.1	64,000
4	830524	6.5	6.9	93	8.6	64,000
5	830524	7.5	6.8	94	8.7	64,000
6	830524	7.8	6.9	94	8.3	64,000
7	830524	7.2	6.9	94	7.3	64,000
8	830524	8.6	6.9	96	6.1	64,000
9	830524	9.3	6.9	99	6.1	64,000
10	830524	8.1	6.8	95	8.9	64,000
11	830525	10.8	7.2	98	10.6	62,000
12	830525	9.3	7.0	99	10.3	62,000
13	830525	7.8	7.0	98	10.3	62,000
14	830525	9.8	7.0	101	9.4	62,000
15	830525	8.0	6.7	102	5.9	62,000
16	830525	9.5	6.8	102	6.5	62,000
17	830526	8.6	7.2	103	11.3	64,000
18	830526	8.6	7.2	103	10.8	64,000
19	830526	9.1	6.8	108	6.2	64,000
20	830526	8.8	7.1	103	10.1	64,000
	mean:	8.3	6.9	98	8.5	
	range:	6.5-10.8	6.7-7.2	93-108	5.9-11.3	

[1] Mean daily mainstem discharge at the USGS Susitna Station gaging station (USGS, provisional data).

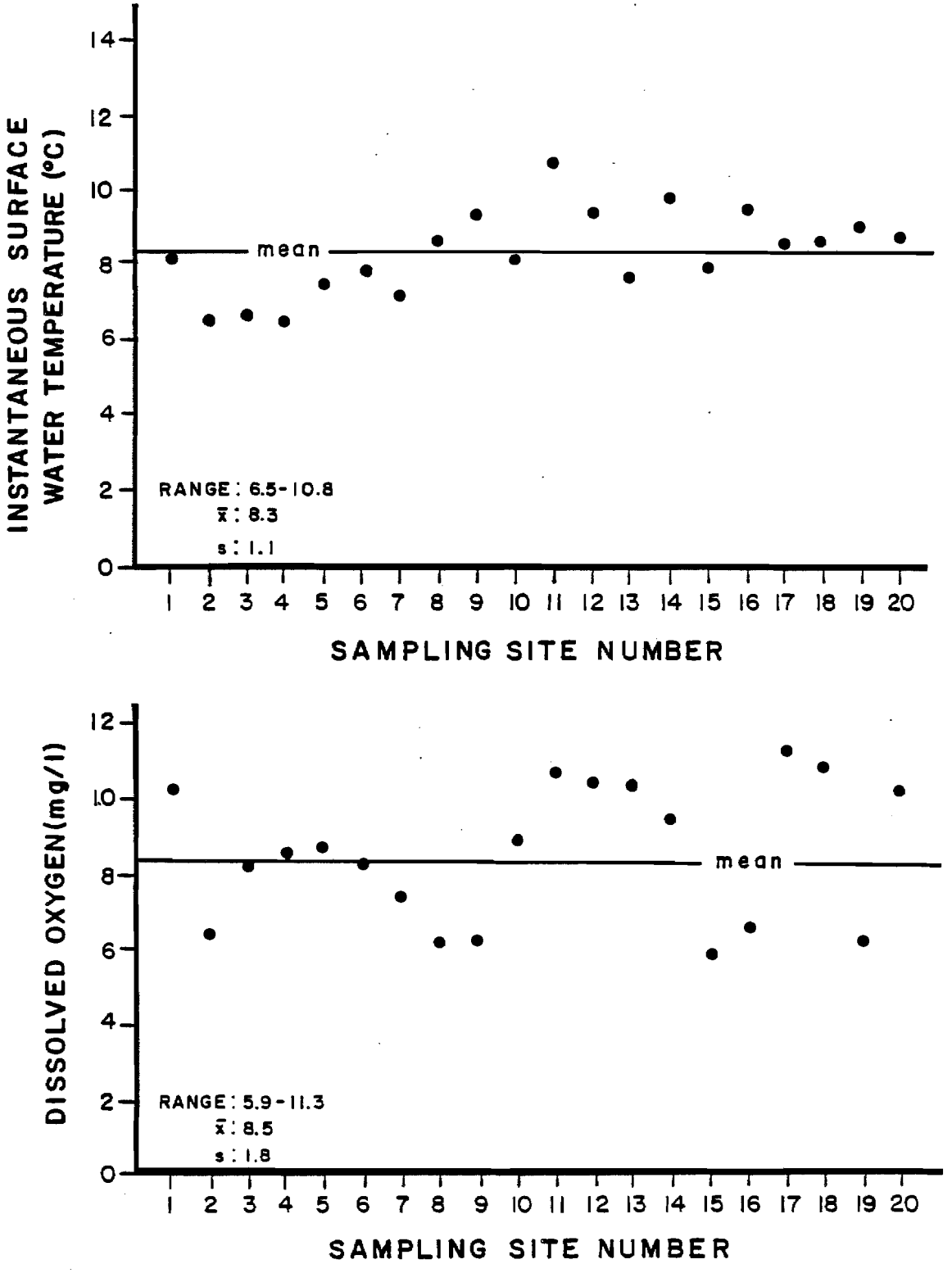


Figure 5-1. Instantaneous measurements of surface water temperature and dissolved oxygen collected at sites at which eulachon spawning habitat surveys were conducted on dates field surveys were performed: May 23-26, 1983.

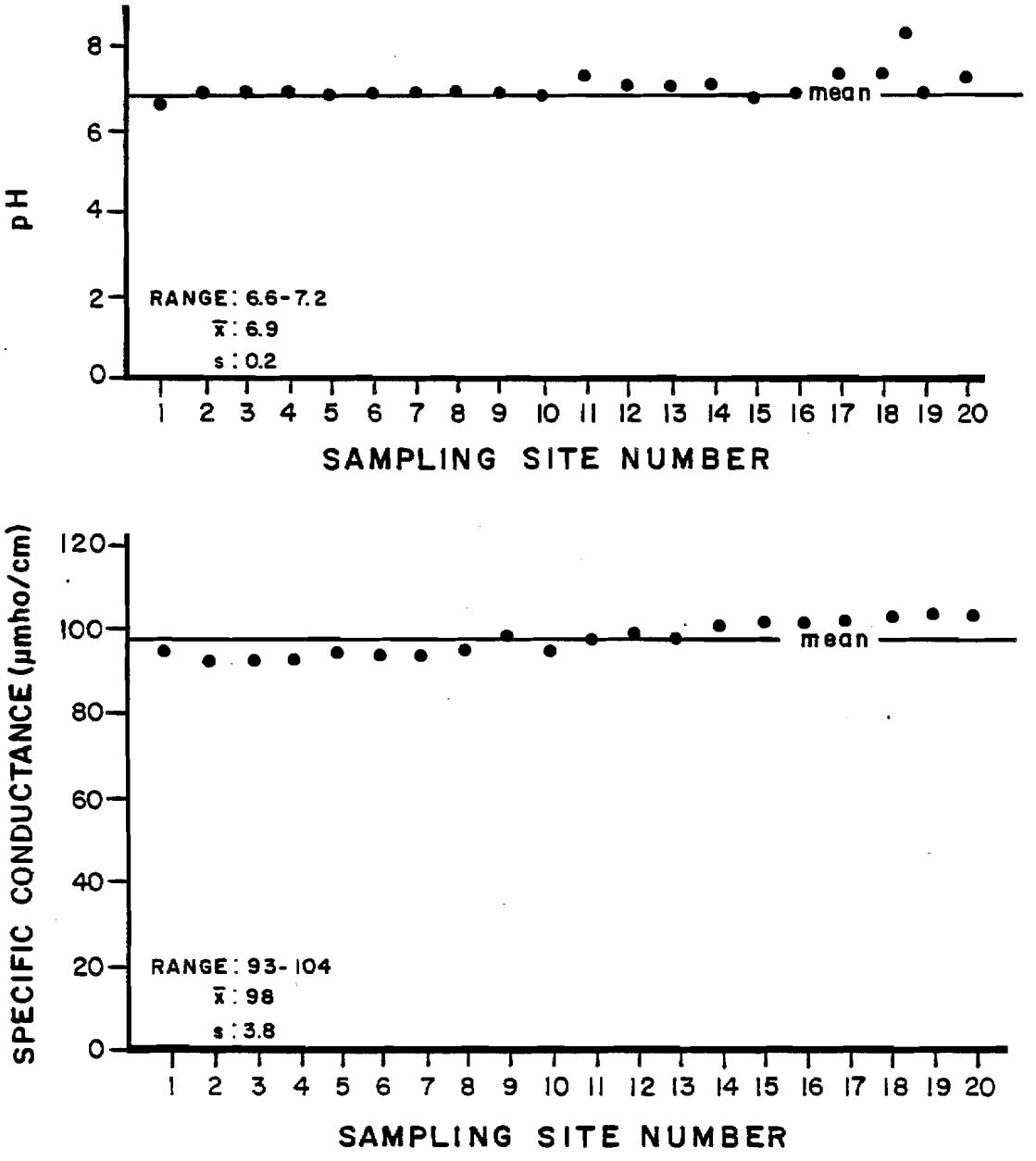


Figure 5-2. Instantaneous measurements of pH and specific conductance collected at sites at which eulachon spawning habitat surveys were conducted on dates field surveys were performed: May 23-26, 1983.

Table 5-3. Ranges, means (x), and standard deviations (s) of instantaneous water depths and velocities at sites at which spawning at habitat surveys were conducted on dates field surveys were performed: May 23-26, 1983.

Site	Date	Mainstem[1] Discharge (cfs)	Depth			Velocity		
			Range	x	s	Range	x	s
1	830523	66,000	0.5-2.3	1.3	0.6	0.8-2.5	1.6	0.5
2	830525	62,000	0.8-3.8	2.5	0.9	0.1-1.1	0.7	0.3
3	830524	64,000	1.1-4.0	2.3	1.0	0.1-1.9	1.0	0.5
4	830524	64,000	0.7-3.9	2.3	1.1	0.8-2.0	1.4	0.5
5	830524	64,000	0.6-3.8	2.2	1.1	0.2-2.0	1.2	0.6
6	830524	64,000	0.8-3.4	2.1	0.9	0.2-2.1	1.2	0.6
7	830524	64,000	1.1-3.8	2.6	0.8	0.8-2.2	1.4	0.3
8	830524	64,000	0.4-3.6	1.7	0.9	0.0-2-3	1.2	0.7
9	830524	64,000	0.6-2.9	1.5	0.7	0.4-2.3	1.4	0.6
10	830524	64,000	0.5-4.5	1.8	1.0	0.5-2.6	1.3	0.8
11	830525	62,000	0.7-2.9	1.7	0.6	0.6-1.5	1.1	0.2
12	830525	62,000	0.3-1.9	1.0	0.4	0.1-3.5	1.6	1.0
12	830525	62,000	0.6-3.9	2.3	1.1	0.1-2.9	2.0	0.8
14	830525	62,000	0.5-2.7	1.6	0.7	0.6-3.2	2.1	0.9
15	830525	62,000	0.6-4.4	2.1	1.2	0.0-2.5	1.7	0.6
16	830525	62,000	1.1-4.1	2.7	1.1	0.4-1.7	1.1	0.4
17	830526	64,000	0.5-2.8	1.5	0.6	0.1-2.7	1.5	0.7
18	830526	64,000	1.3-4.0	2.6	0.9	0.1-2.3	0.8	0.6
19	830526	64,000	0.6-3.0	1.7	0.8	0.4-2.6	1.4	0.6
20	830526	64,000	0.5-3.9	2.3	1.2	0.4-3.4	2.4	0.9
	Overall range:		0.3-4.5	1.0-2.7		0.0-3.4	0.7-2.4	

[1] Mean daily mainstem discharge at the USGS Susitna Station gaging station (USGS, provisional data)

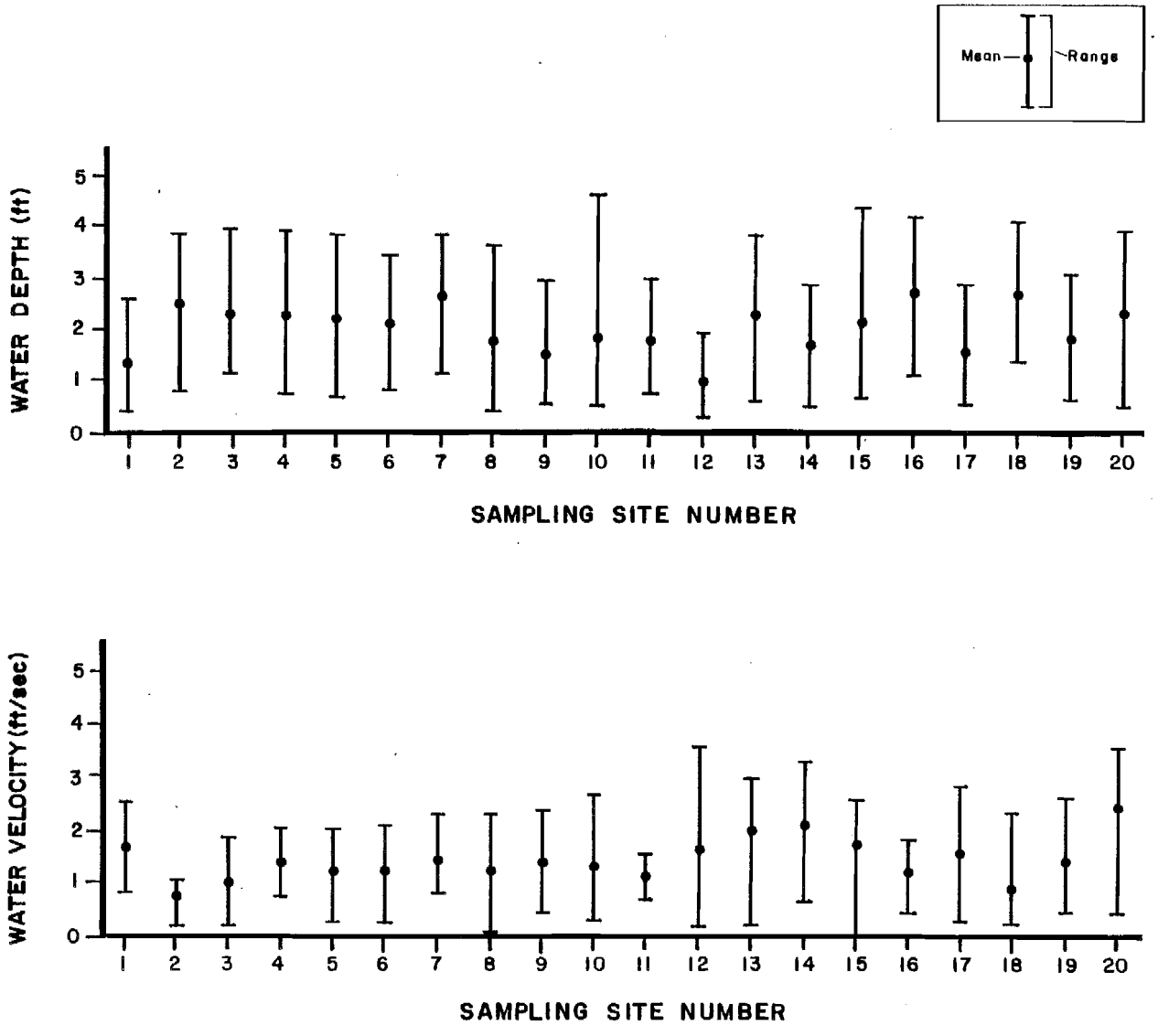


Figure 5-3. Means and ranges of water depths and velocities at sites at which eulachon spawning habitat surveys were conducted on dates field surveys were performed: May 23-26, 1983.

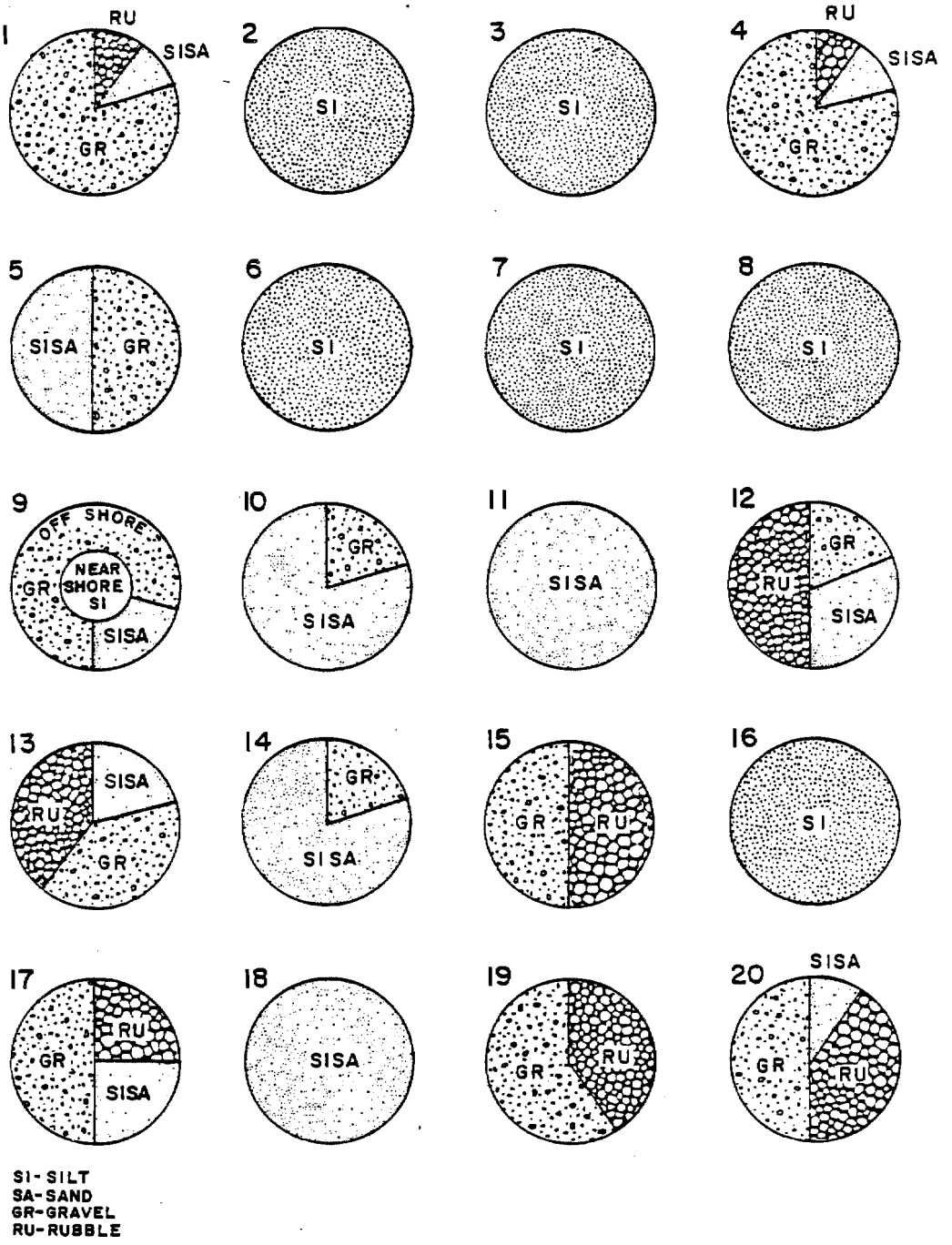


Figure 5-4. Compositions of substrates at sites at which eulachon spawning habitat surveys were conducted on dates field surveys were performed: May 23-26, 1983.

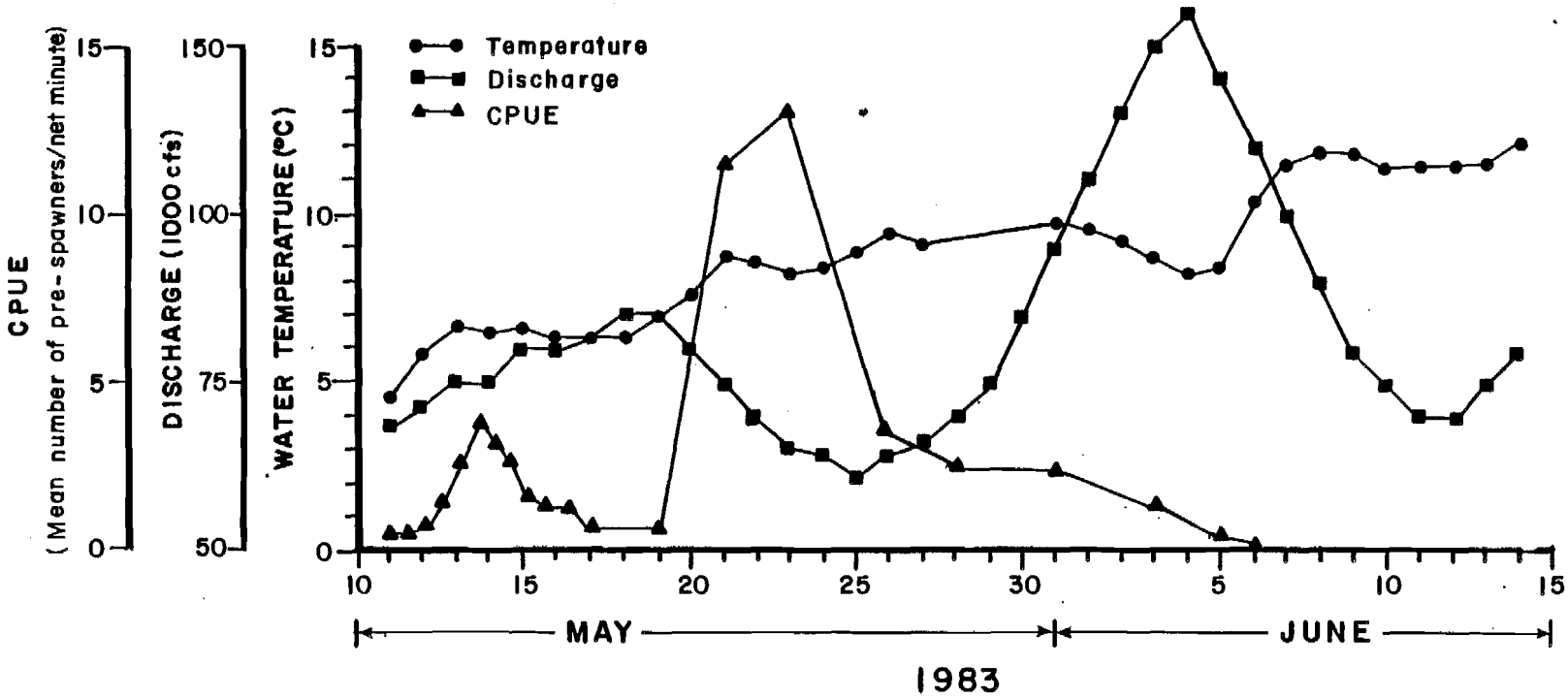


Figure 5-5. Provisional mainstem discharge of the Susitna River (USGS provisional data) at Susitna Station and daily mean surface water temperature of the Susitna River at RM 4.5 compared at catch per unit effort for the gill net set at RM 5.0: (see Report #1 of this report series) May 11-June 14, 1983.

Frequency distributions of measured instantaneous water depths and velocities were constructed to determine water depths and velocities most often utilized for spawning. Frequency distributions of instantaneous water depths measured at sites at which spawning habitat surveys were conducted during 1983 are compared to those developed from 1982 data (ADF&G 1983b) (Figures 5-6a and 5-6b). The 1982 and 1983 data were pooled to form a composite data base for the two year study period (Figure 5-6c). Frequency distributions of instantaneous water velocities measured at sites at which spawning habitat surveys were conducted during 1983 are compared to those developed from 1982 data (ADF&G 1983b) (Figure 5-7a and 5-7b). The 1982 and 1983 data were also pooled to form a composite data base for the two year study period (Figure 5-7c).

Mean water depths measured at surveyed spawning sites during 1983 ranged from 1.1 to 2.7 feet with the range of depths at all survey sites varying from 0.3 to 4.5 feet over a range of mainstem discharges from 62,000 to 64,000 cfs as measured at the USGS Susitna Station monitoring station. These values compare with values obtained during the 1982 study of 1.1 to 3.1 feet and 0.3 to 4.3 feet, respectively (ADF&G 1983b) over a range of mainstem discharges from 65,000 to 110,000 cfs as measured at the USGS Susitna Station monitoring station.

The mean water velocity measured at surveyed spawning sites during 1983 ranged from 0.7 to 2.4 feet/second with the range of velocities varying at all survey sites from 0.0 to 3.4 feet/second over a range of mainstem discharges from 62,000 to 64,000 cfs as measured at the USGS Susitna Station monitoring station. These values compare with values obtained during the

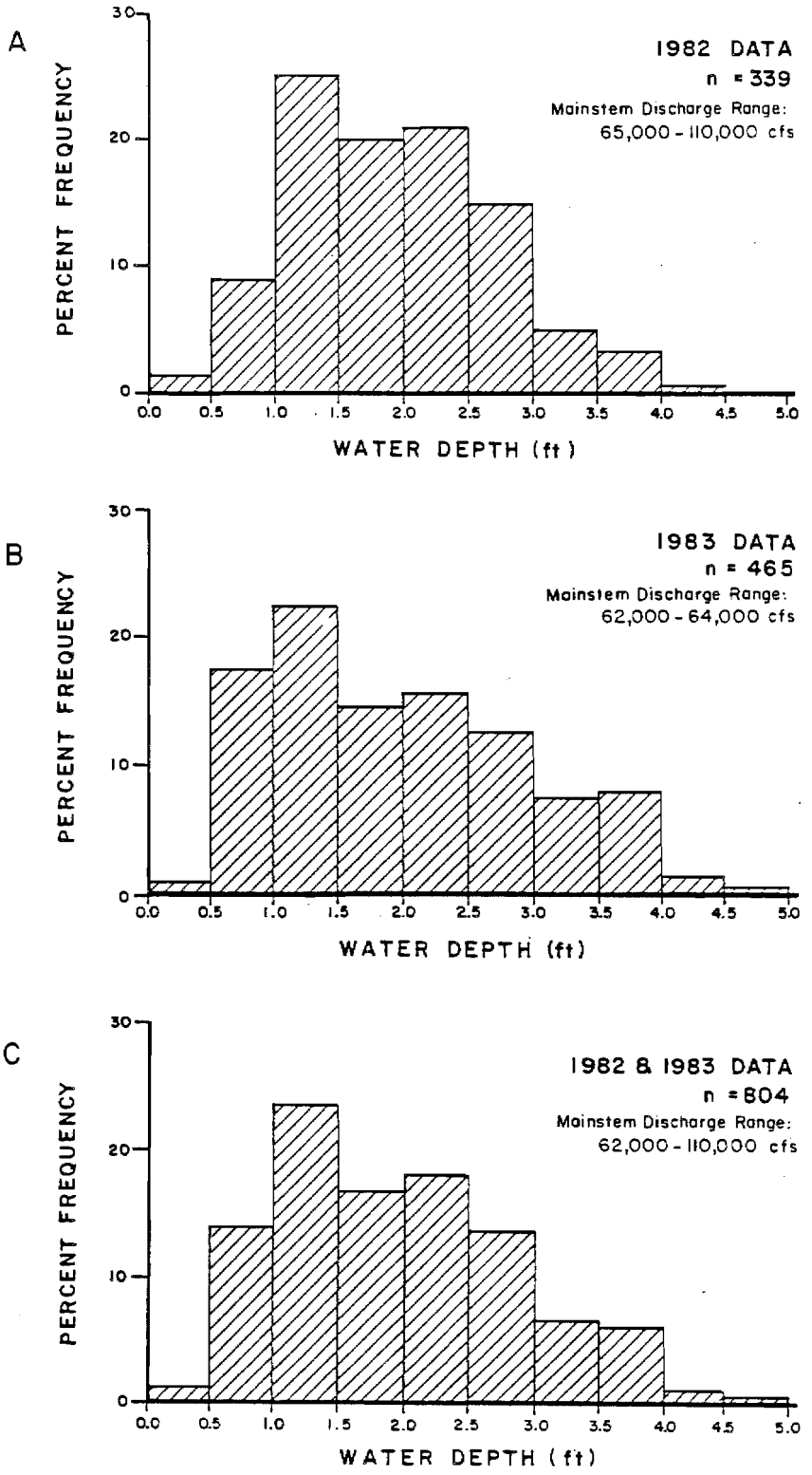


Figure 5-6. Frequency distributions of instantaneous water depths measured at sites at which eulachon spawning habitat surveys were conducted during 1982(A) and 1983(B). These data have been combined to form a frequency distribution for the 1982 and 1983 data bases (C).

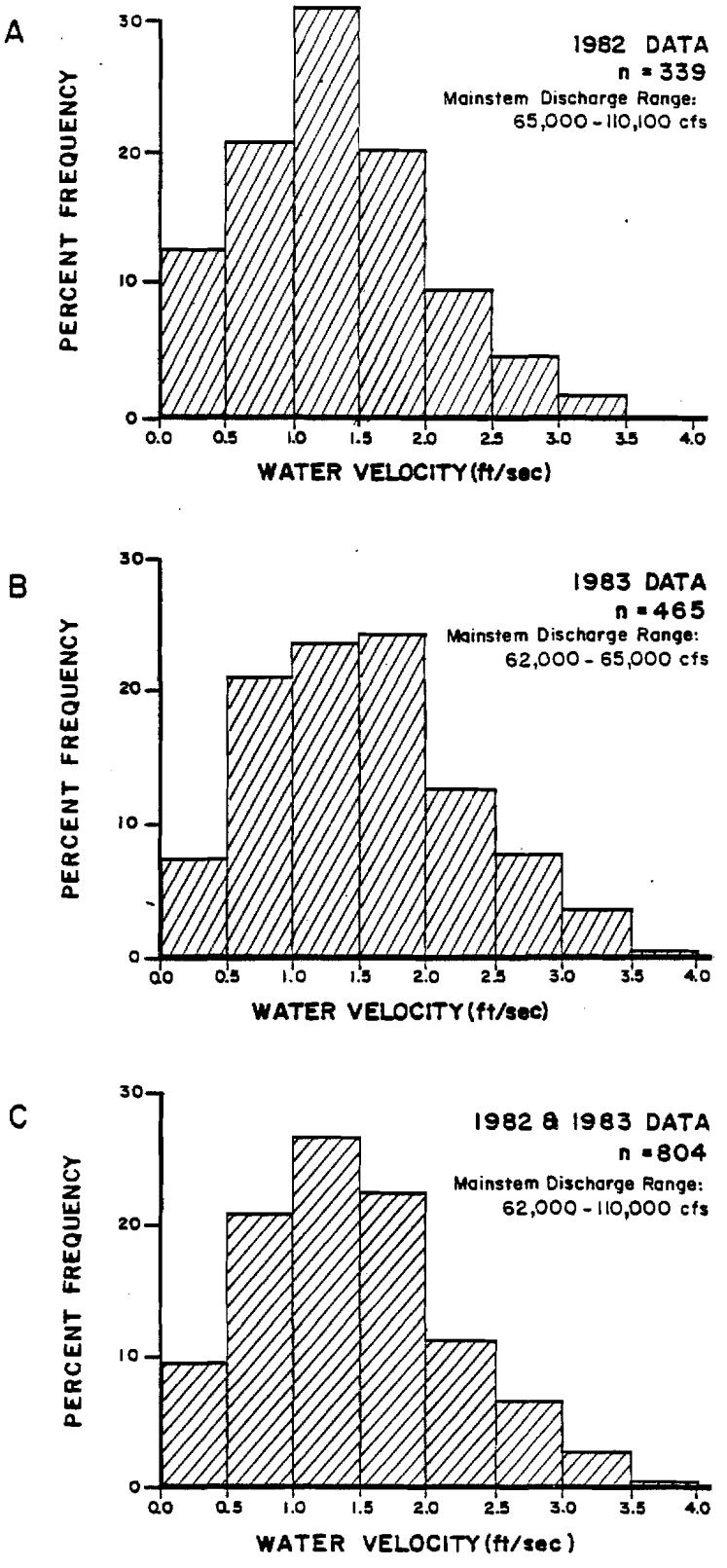


Figure 5-7. Frequency distributions of instantaneous water velocities measured at sites at which eulachon spawning habitat surveys were conducted during 1982(A) and 1983(B). These data were combined to form a frequency distribution for the 1982 and 1983 data bases (C).

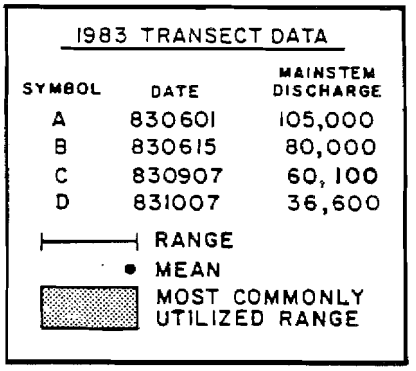
1982 study of 0.6 to 1.9 feet/second and 0.0 to 3.2 feet/second, respectively (ADF&G 1983) over a range of mainstem discharges from 65,000 to 110,000 cfs as measured at the USGS Susitna Station monitoring station.

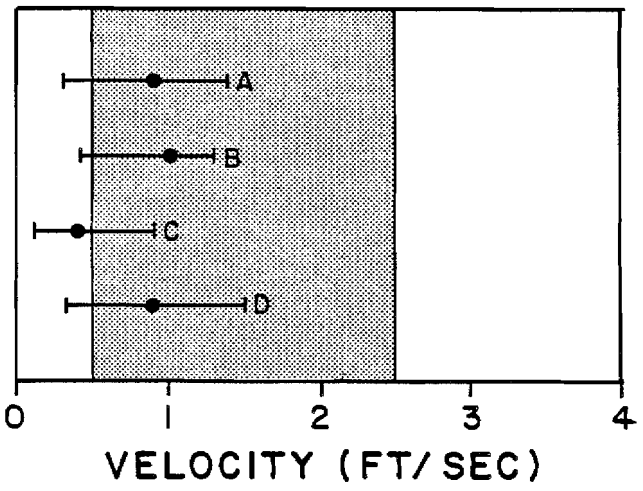
A representative sub-sample of the eulachon spawning sites surveyed in 1983 were chosen for further study (Table 5-4) to determine whether hydraulic conditions similar to those that were present at the time of eulachon spawning might also exist under different mainstem flow conditions. At each site within the representative subsample, streambank/streambed profiles were surveyed along two study transects from the streambank into the river. These partial cross sectional profiles are presented in Appendix Figures 5-A-21 through 5-A-25. Water surface elevations were also surveyed on each transect when spawning occurred and at four different mainstem discharge levels during subsequent visits. These data are provided as an insert on each respective appendix figure. Point measurements of depths and velocities occurring at these sites were also obtained at the time of eulachon spawning and during the subsequent visits. Frequency distributions of the depths and velocities measured at each site during the time of spawning as compared with the ranges and means of a representative sample of instantaneous water depths and velocities obtained at the sites during subsequent sampling are shown in Appendix Figures 5-A-6 through 5-A-30. Comparisons of the ranges and means of measured depths and velocities at these study sites for four mainstem discharges to the range of depths and velocities most commonly utilized by spawning eulachon are presented in Figures 5-8 through 5-12. Results of these comparisons indicate that the depths of flow and mean water column velocities measured at the five representative spawning locations for mainstem discharges between 36,000 and 105,000 cfs (as recorded at Susitna

Station) generally fall within the range of depths and velocities most commonly utilized by spawning eulachon (refer to Figures 5-6 and 5-7).

Table 5-4. Eulachon spawning study sites selected for further study.

Site	River Mile	Geographic Code
2	12.8	S15NO7W12BCB
6	16.2	S16NO7W26BDB
10	23.0	S17NO7W33DBB
13	23.1	S17NO7W33BCD
20	36.5	S18NO6W15BBA





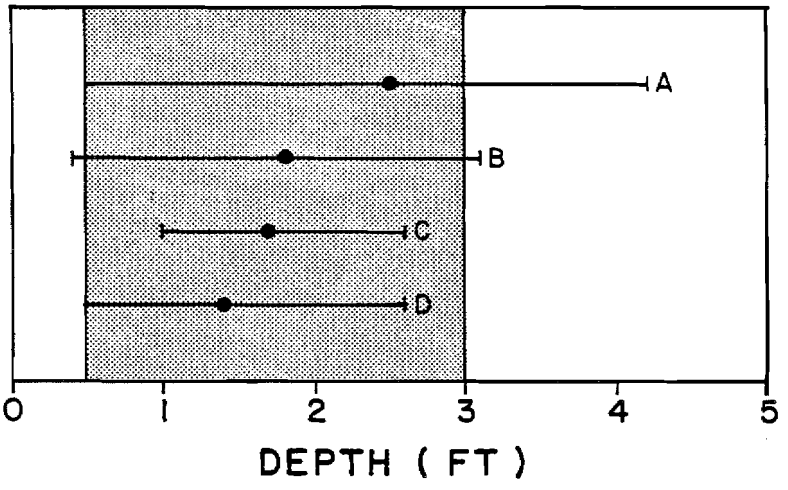
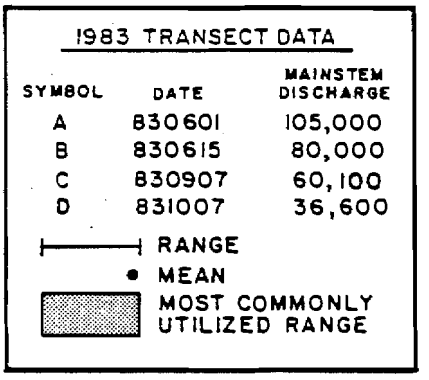
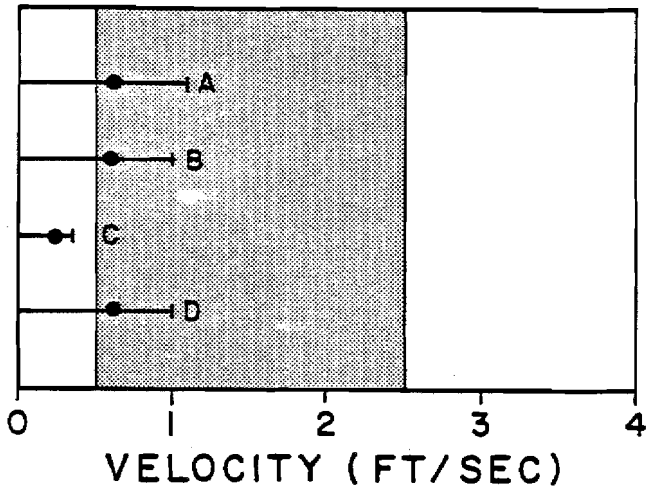


Figure 5-8. Comparison of the ranges and means of measured depths and velocities at the eulachon spawning study site at RM 12.8 (Site No. 2) to the range of depths and velocities most commonly utilized for eulachon spawning.





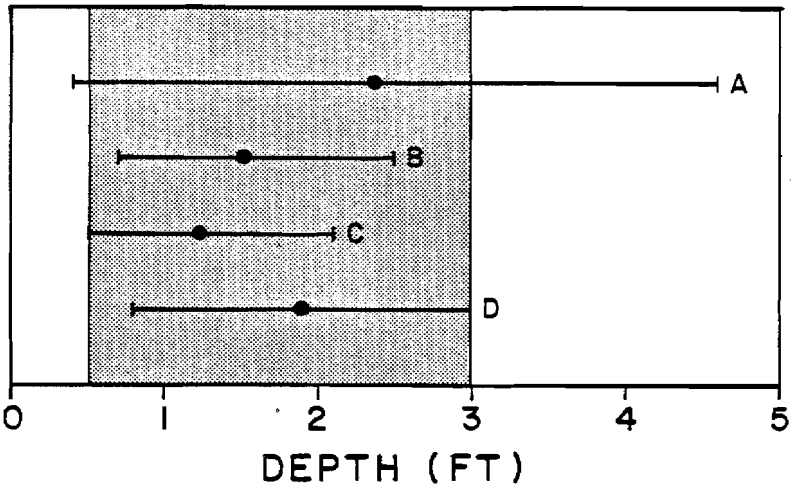


Figure 5-9. Comparison of the ranges and means of measured depths and velocities at the eulachon spawning study site at RM 16.2 (Site No. 6) to the range of depths and velocities most commonly utilized for eulachon spawning.

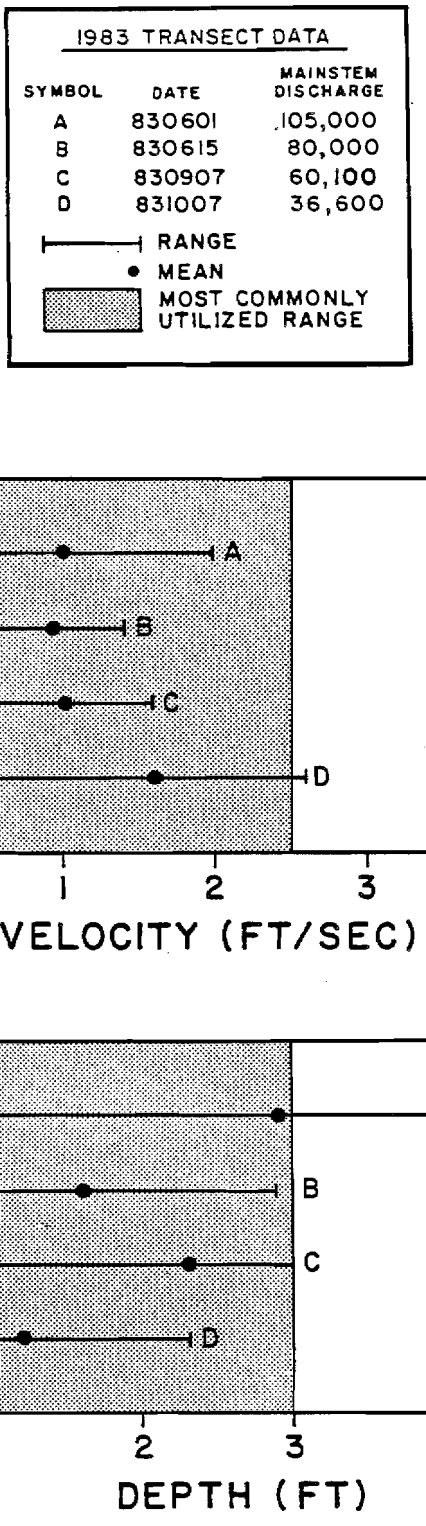


Figure 5-10. Comparison of the ranges and means of measured depths and velocities at the eulachon spawning study site at RM 23.0 (Site No. 10) to the range of depths and velocities most commonly utilized for eulachon spawning.

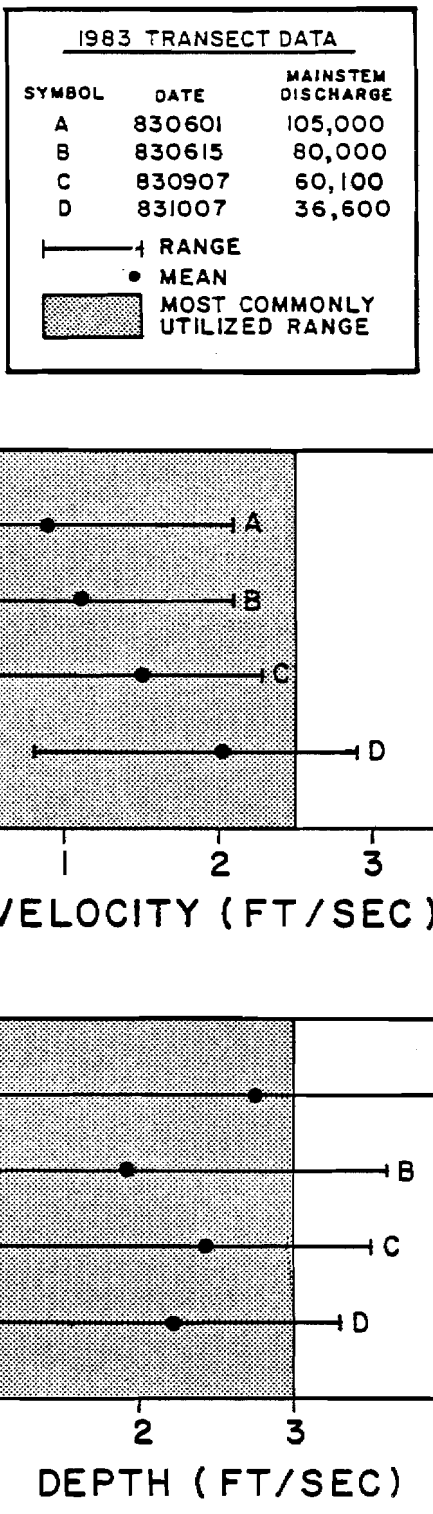


Figure 5-11. Comparison of the ranges and means of measured depths and velocities at the eulachon spawning study site at RM 23.1 (Site No. 13) to the range of depths and velocities most commonly utilized for eulachon spawning.

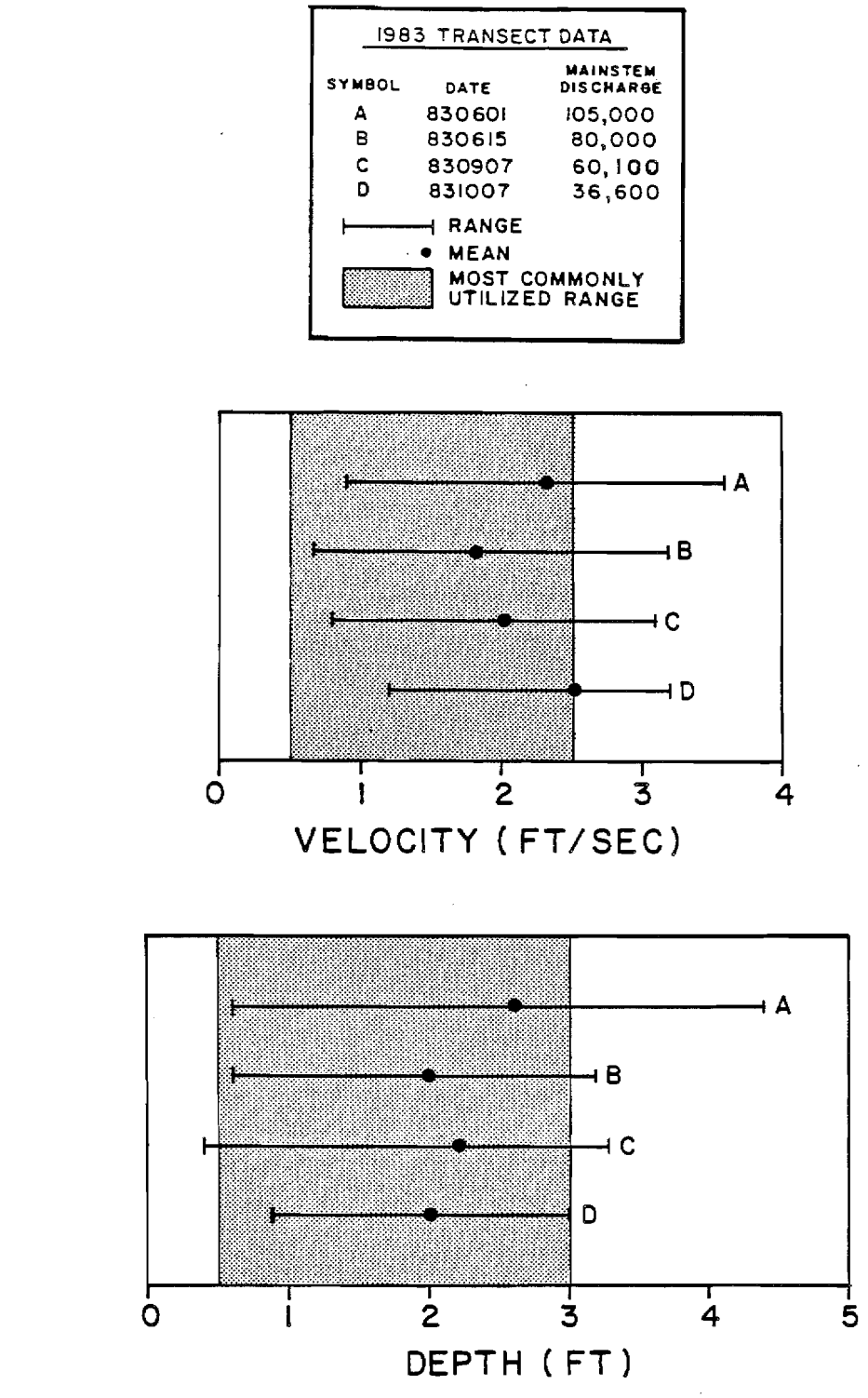


Figure 5-12. Comparison of the ranges and means of measured depths and velocities at the eulachon spawning study site at RM 36.5 (Site No. 20) to the range of depths and velocities most commonly utilized for eulachon spawning.

4.0 DISCUSSION

Based on 1982 (ADF&G 1983a) and 1983 (Barrett, Thompson, Wick 1984) catch data at gillnet sets in the tidally influenced zone of the Susitna River at RM 4.5, eulachon begin their upstream spawning migration during early to mid-May. The earliest captures of eulachon during 1982 and 1983 occurred on May 16 and May 11, respectively. Because both these dates correspond to the first day sampling was initiated each year, the actual dates of the beginning of the spawning migration actually precede these dates. Earlier sampling both years was precluded due to river ice conditions.

The 1982 and 1983 catch data also show that two runs of eulachon use the Susitna River for spawning. During both years, more fish were associated with the second run than the first run. During 1982, the first run occurred from approximately May 16 to May 30 with the second run occurring from June 1 to June 8. This compares with 1983 data which show the two runs occurring earlier, with the first run lasting from approximately May 10 to May 18 and the second from May 19 to June 6.

The reason for the differences in the timing of the runs between 1982 and 1983 may be linked to the surface water temperature of the mainstem Susitna River. During 1983, the surface water temperature of the mainstem warmed faster than it did during 1982. However, there appears to be no definite correlation between the timing of the eulachon spawning runs entering the Susitna River with either mainstem discharge or surface water temperature.

During 1983, eulachon were observed from the mouth of the Susitna River (RM 0) to RM 50.3 in the east channel. This compares to 1982 observations which identified RM 49.5 as the upstream limit of migration (ADF&G 1983a).

Eulachon utilized shoreline margins of the mainstem Susitna River and its associated side channels for passage and spawning during both 1982 and 1983. As in 1982, however, eulachon did not utilize the clear water tributaries upstream of their confluence zones for either passage of spawning. The reasons for this are presently unknown, however, differences in turbidity and temperature may be partially responsible.

It appears that eulachon key on water velocity for upstream orientation during their spawning migration run. During both 1982 and 1983, eulachon were seldom observed in areas of low water velocity (less than 0.3 feet/second) or backwater. The majority of the upstream migration occurred along the banks of the river where water velocities generally exceeded 0.3 feet/second.

Eulachon have been reported to spawn over coarse sand and pea-sized gravel in water up to 7.6 feet deep (Morrow 1980). As a result of our 1982 and 1983 studies we conclude that eulachon spawn over a broad range of hydraulic and substrate conditions throughout the mainstem Susitna River and its associated side channels below RM 45.0. Bar and riffle habitats along the margins of the river were most commonly utilized. No spawning was observed in clear water tributaries or sloughs. Substrates used for spawning during 1982 and 1983 ranged from 100% silt to

gravel/rubble with substrates most commonly used for spawning ranging from silt to silty sand intermixed with gravel and rubble. Water temperatures at spawning sites surveyed during 1982 and 1983 ranged from 6.2 to 11.2°C with means of 8.5°C and 8.3°C, respectively. These water temperatures are somewhat higher than preferred spawning temperatures of 4.7 to 7.8°C previously reported by Morrow (1980). Frequency distributions (Figure 5-6) of water depths measured at 40 surveyed spawning sites in the lower Susitna River during 1982 and 1983 indicate that depths ranging from 0.5 to 3.0 feet are most commonly utilized for spawning. Frequency distributions (Figure 5-7) of water velocities measured at 40 surveyed spawning sites in the lower Susitna River during 1982 and 1983 indicate that water velocities ranging from 0.5 to 2.5 feet/second are most commonly utilized for spawning.

Comparisons between the range of depths and velocities that occur at known spawning areas over a wide range of mainstem discharges to the range of depths and velocities that occurred at these sites at the time of spawning (Appendix Figures 5-A-26 through 5-A-70) and to the range of depths and velocities most commonly utilized for eulachon spawning in the lower Susitna River (Figures 5-8 through 5-12) indicate that variations in mainstem discharge have relatively little effect on the availability of acceptable depths and velocities at eulachon spawning sites. This is likely attributable to both specific spawning habits of eulachon and stream channel geometry of the lower Susitna River.

Eulachon have most commonly been observed spawning along the shoreline margins of the lower mainstem Susitna River over silt to silty-sand

substrates intermixed with gravels and rubbles where depths are most commonly between 0.5 and 3.0 feet and velocities most commonly range from 0.5 to 2.5 feet per second. Field observations of 40 spawning sites and analysis of data collected at five intensively sampled sites indicate that acceptable substrates and hydraulic conditions persist along these shoreline margins for mainstem discharges between 35,000 and 105,000 cfs. That is, although the depth of flow and velocity at discrete points within spawning areas change in response to variations in mainstem discharge, streambank geometry is sufficiently uniform and stable to allow the zone of acceptable depths and velocities to migrate in and out along the shoreline in response to mainstem discharge.

Although results of this study have indicated that variations in mainstem discharge between 35,000 and 105,000 cfs have little effect on the availability of suitable spawning areas, other factors such as water temperature and shoreline stability should also be considered when making interpretations or applications of our results.

5.0 CONTRIBUTORS

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6.0 ACKNOWLEDGEMENTS

Funding for this study was provided by the State of Alaska, Alaska Power Authority. Assistance with study design and editorial review of text was provided by E.W. Trihey & Associates.

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8.0 APPENDIX A

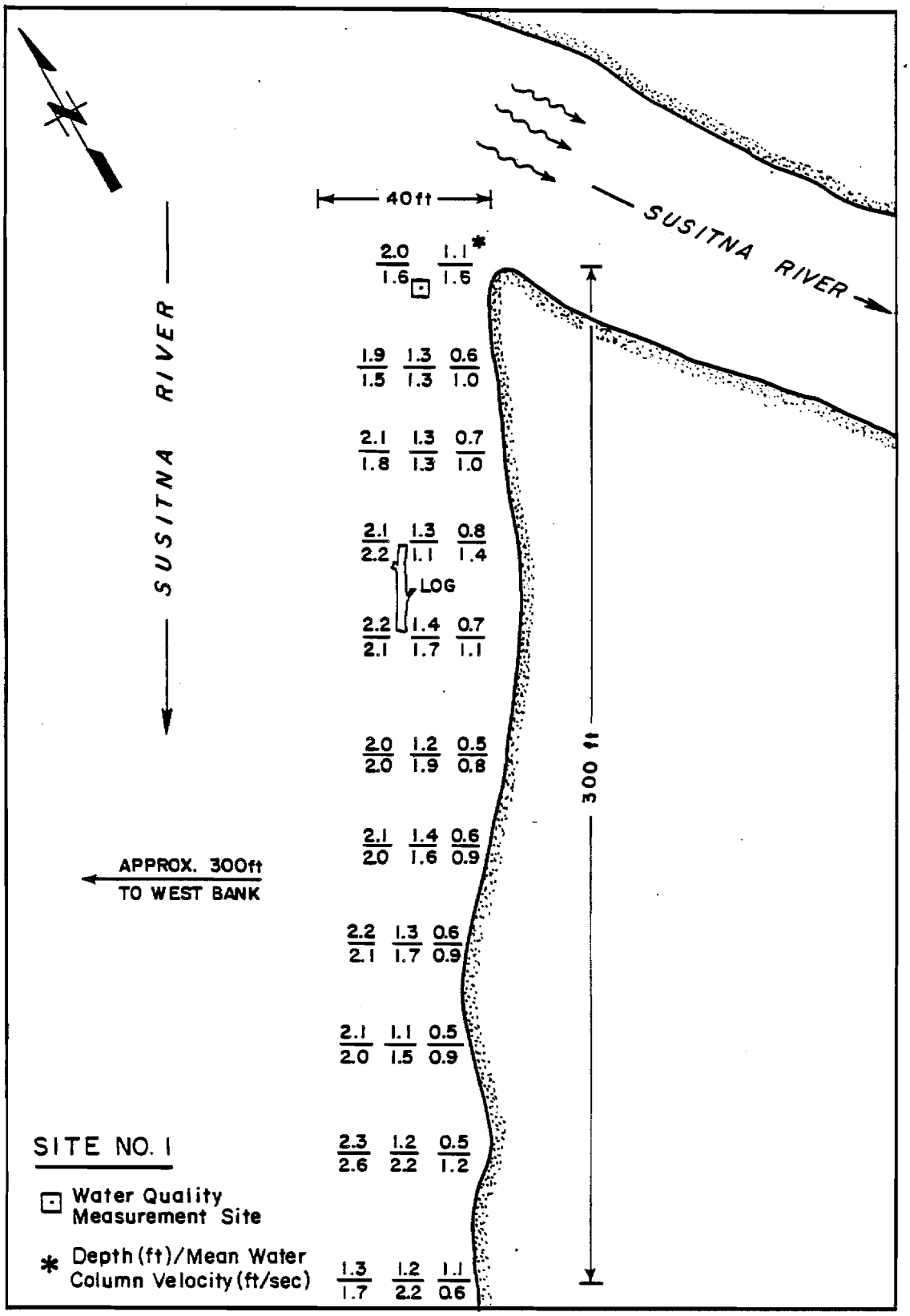


Figure 5-A-1. Eulachon spawning area (Site No. 1) on the Susitna River at RM 21.0 (GC S16N07W09DDB): May 23, 1983.

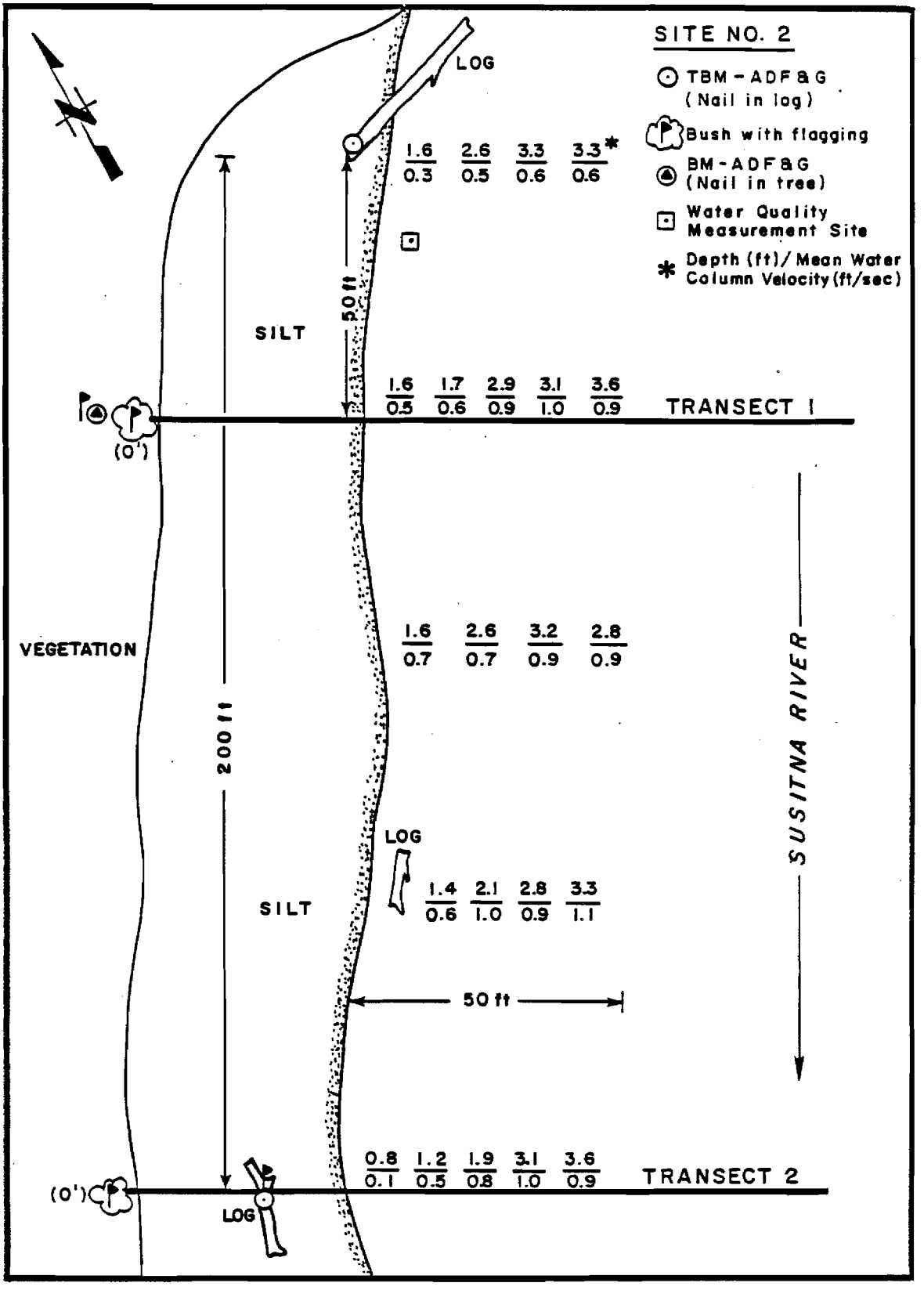


Figure 5-A-2. Eulachon spawning area (Site No. 2) on the Susitna River at RM 12.8 (GC S15N07W12BCB): May 24, 1983.

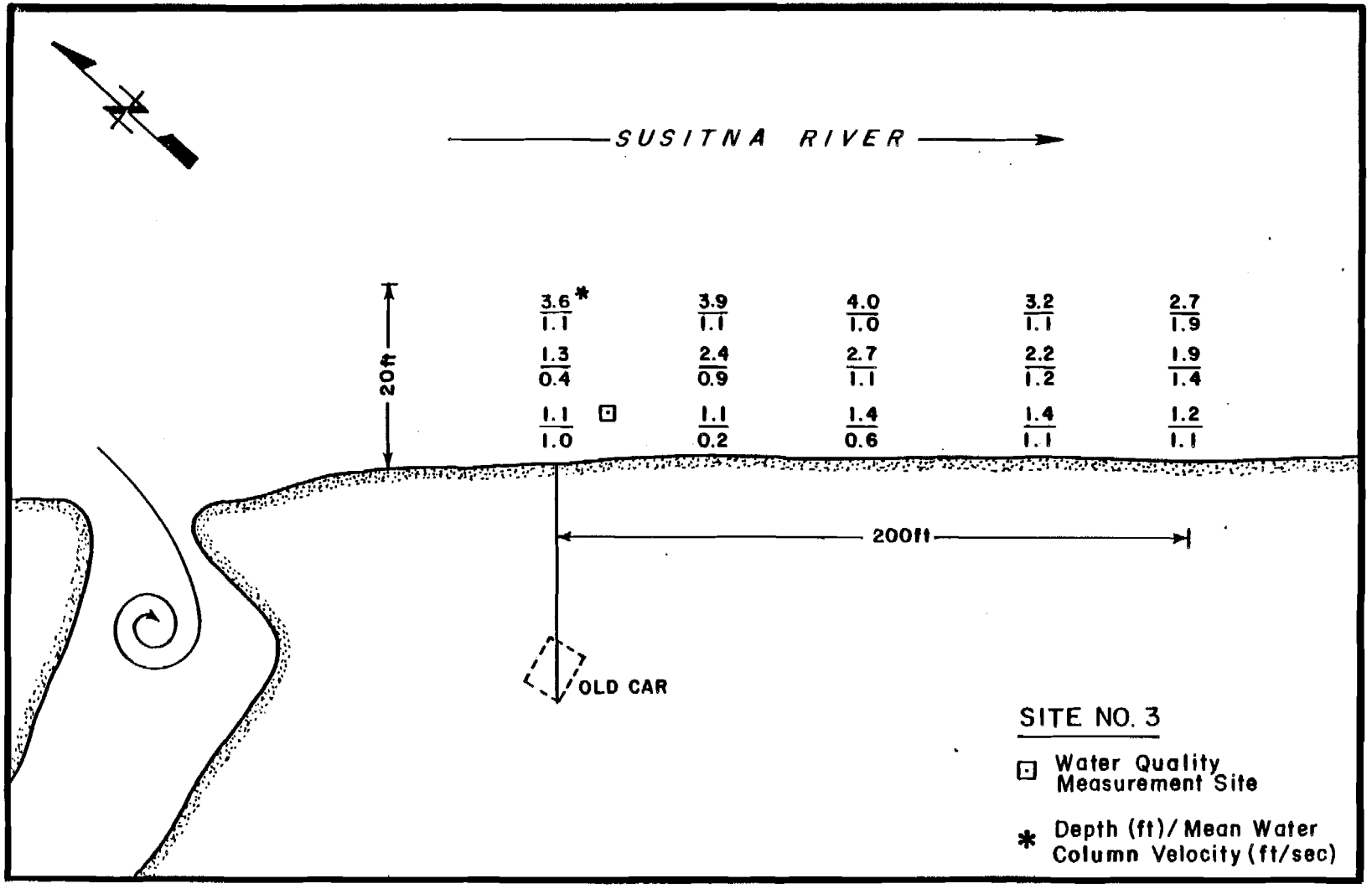


Figure 5-A-3. Eulachon spawning area (Site No. 3) on the Susitna River at RM 13.8 (GC S15N07W02DAC): May 24, 1983.

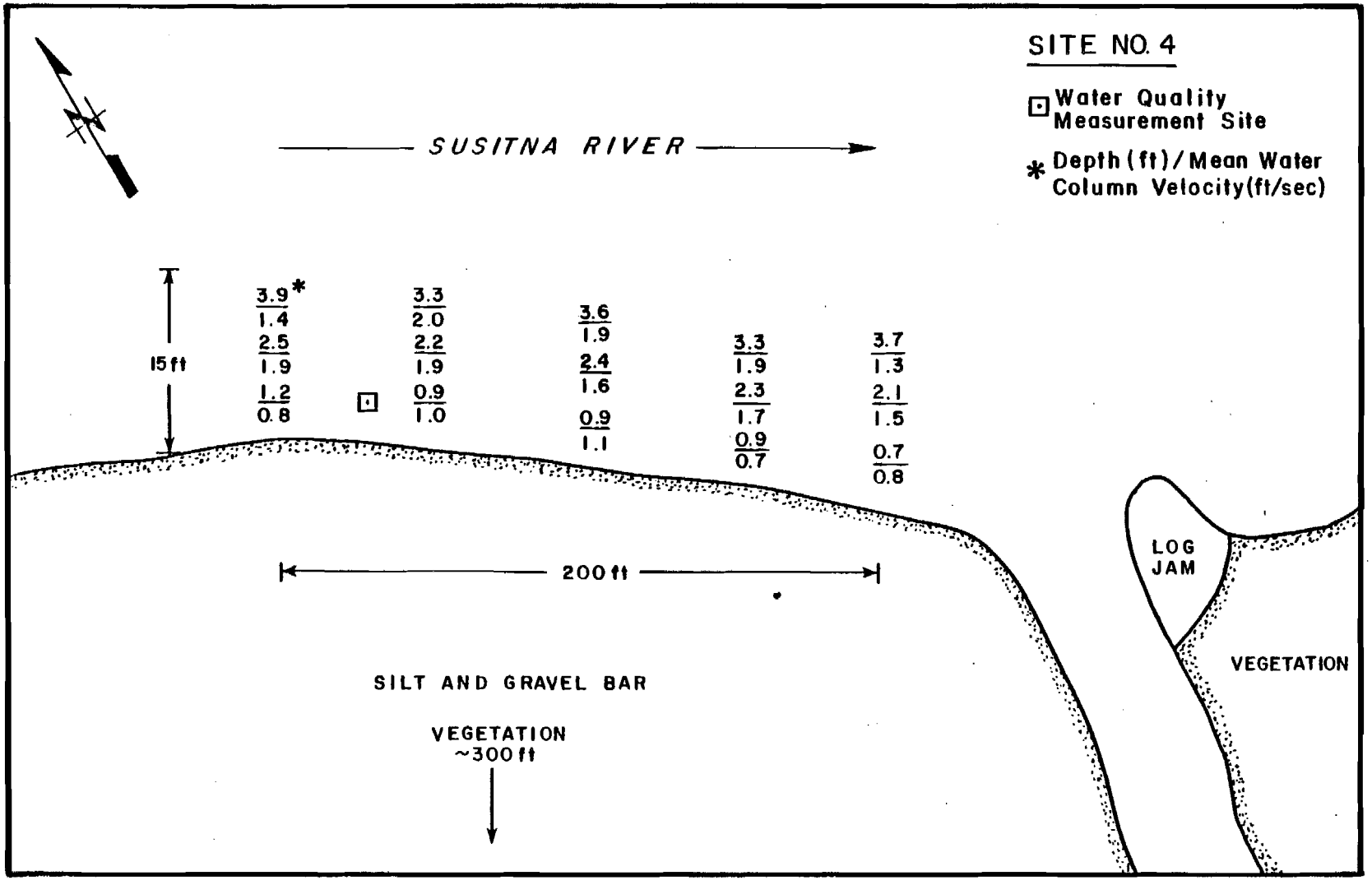


Figure 5-A-4. Eulachon spawning area (Site No. 4) on the Susitna River at RM 15.0 (GC S16N07W35CDA): May 24, 1983.

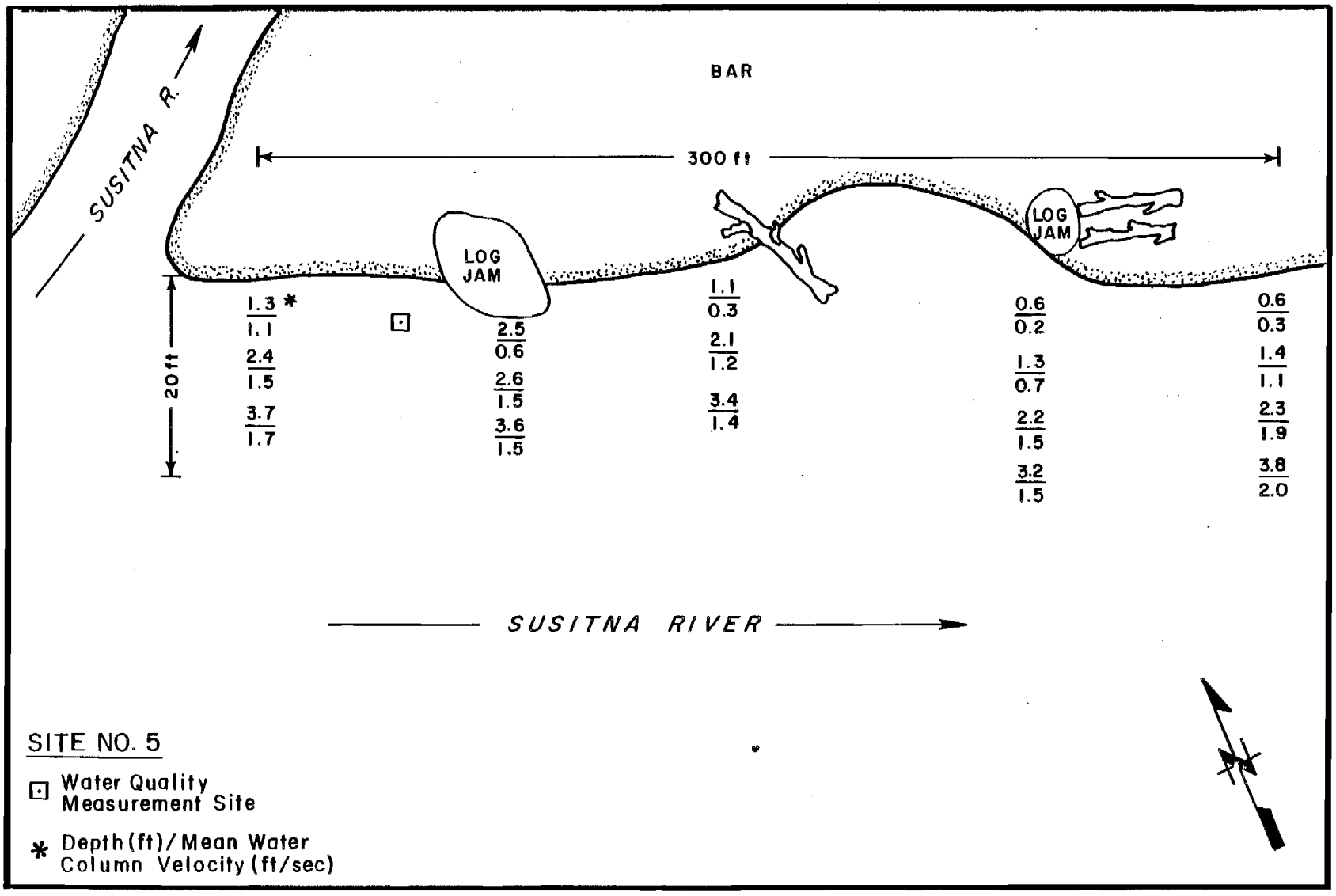


Figure 5-A-5. Eulachon spawning area (Site No. 5) on the Susitna River at RM 15.0 (GC S16N07W35BDA): May 24, 1983.

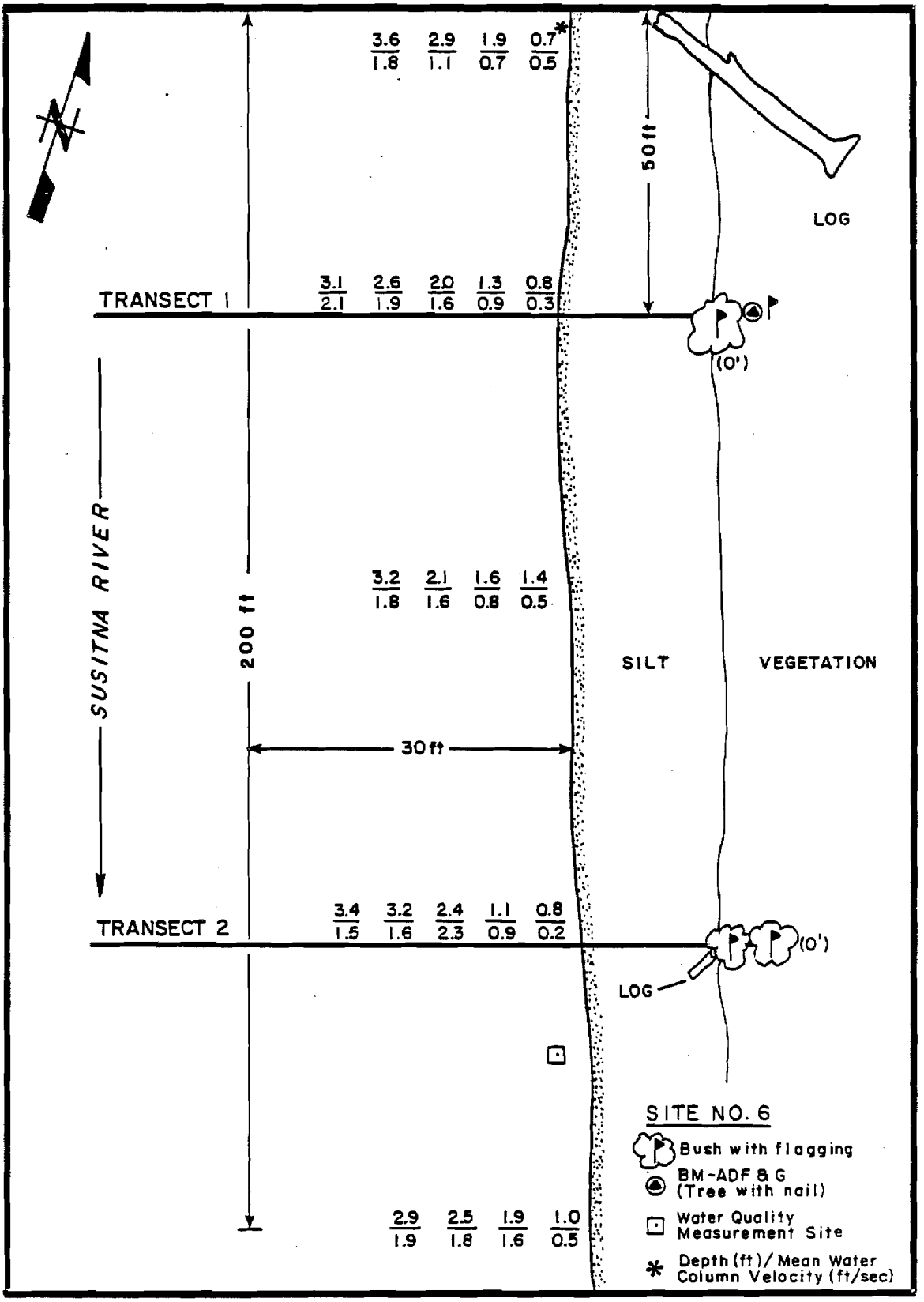


Figure 5-A-6. Eulachon spawning area (Site No. 6) on the Susitna River at RM 16.2 (GC S16N07W26BDB): May 24, 1983.

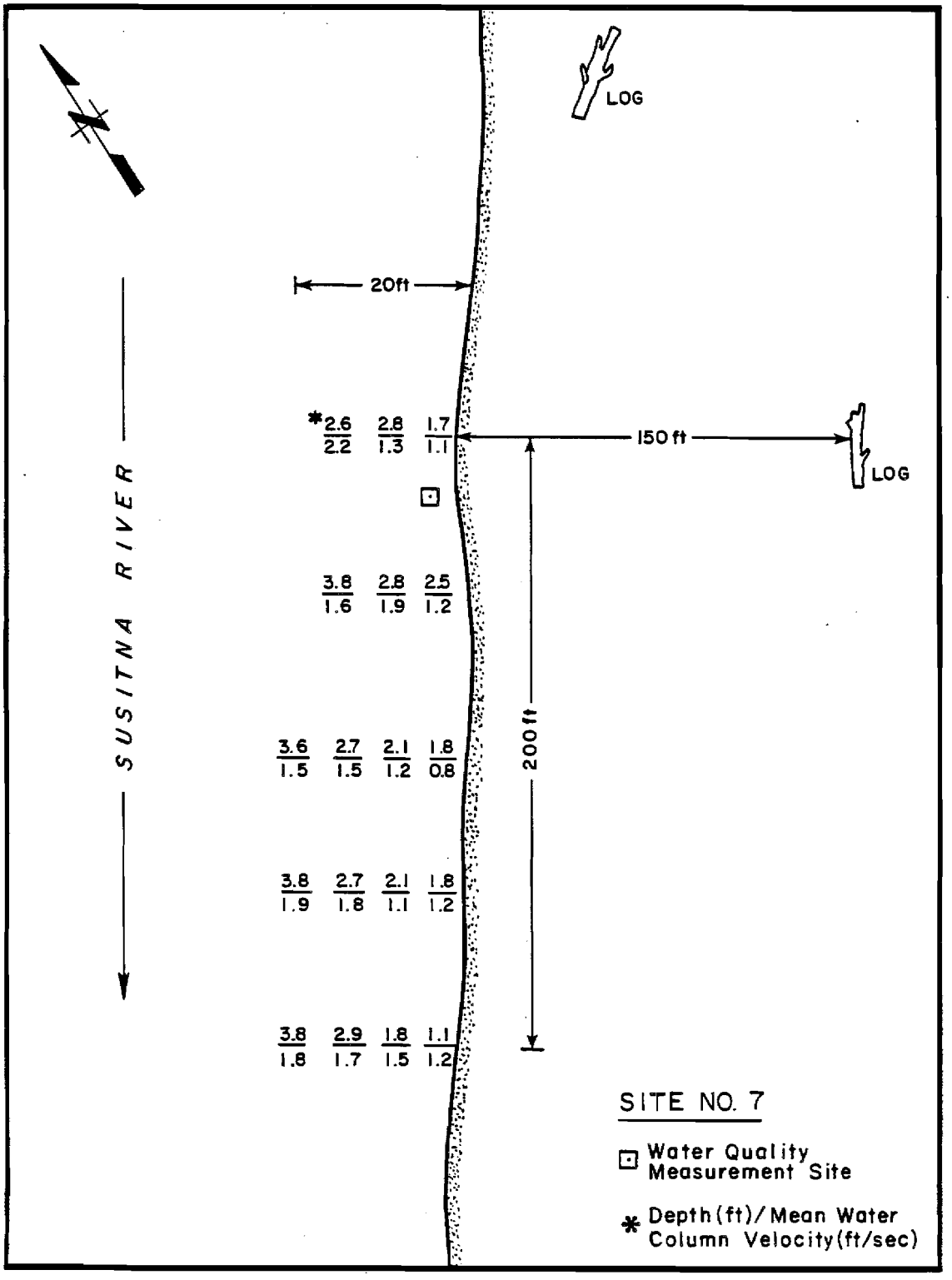


Figure 5-A-7. Eulachon spawning area (Site No. 7) on the Susitna River at RM 18.1 (GC S16N07W15CCB): May 24, 1983.

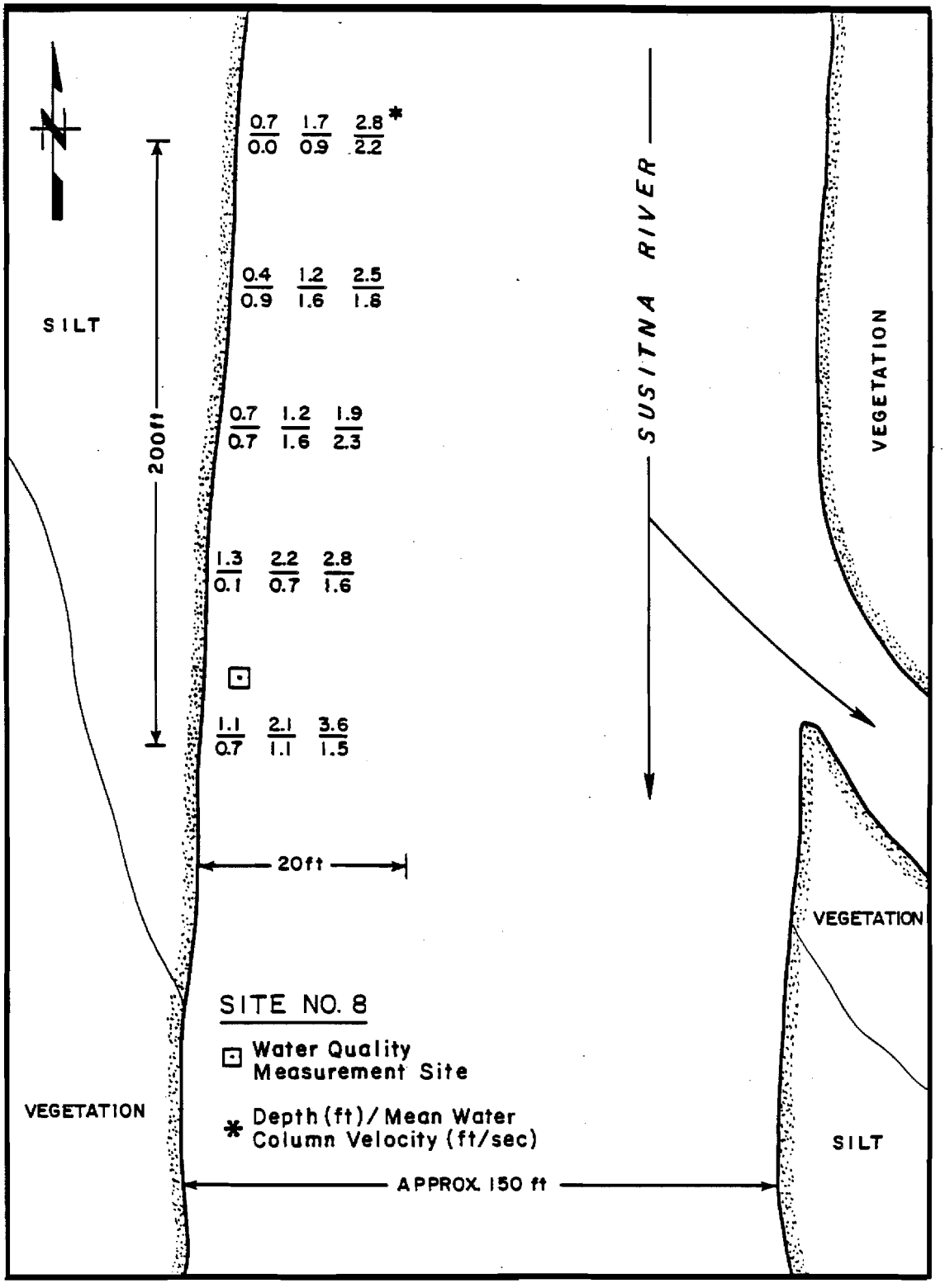


Figure 5-A-8. Eulachon spawning area (Site No. 8) on the Susitna River at RM 19.5 (GC S16N07W16AAA): May 24, 1983.

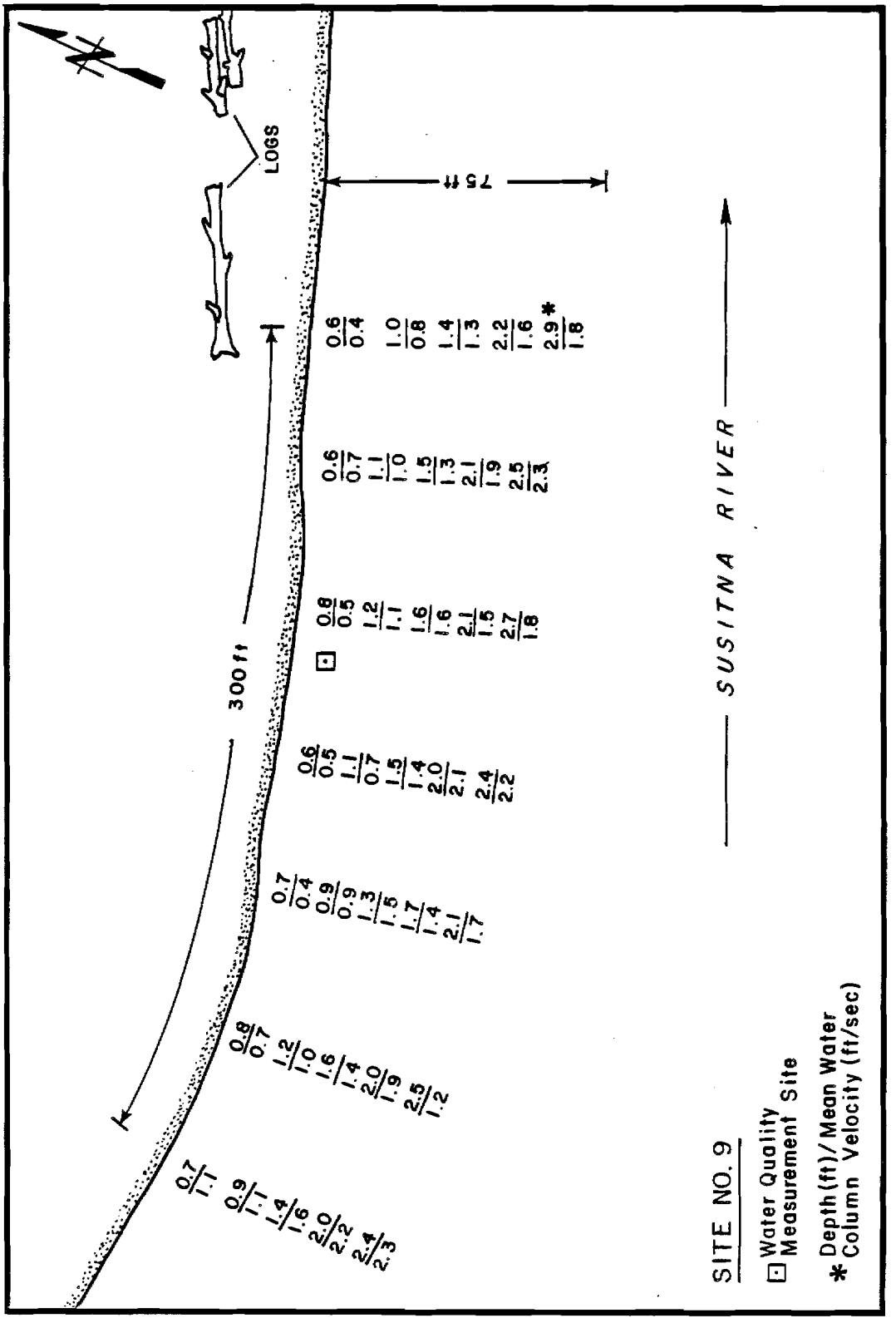


Figure 5-A-9. Eulachon spawning area (Site No. 9) on the Susitna River at RM 21.5 (GC S16N07W04DBB): May 24, 1983.

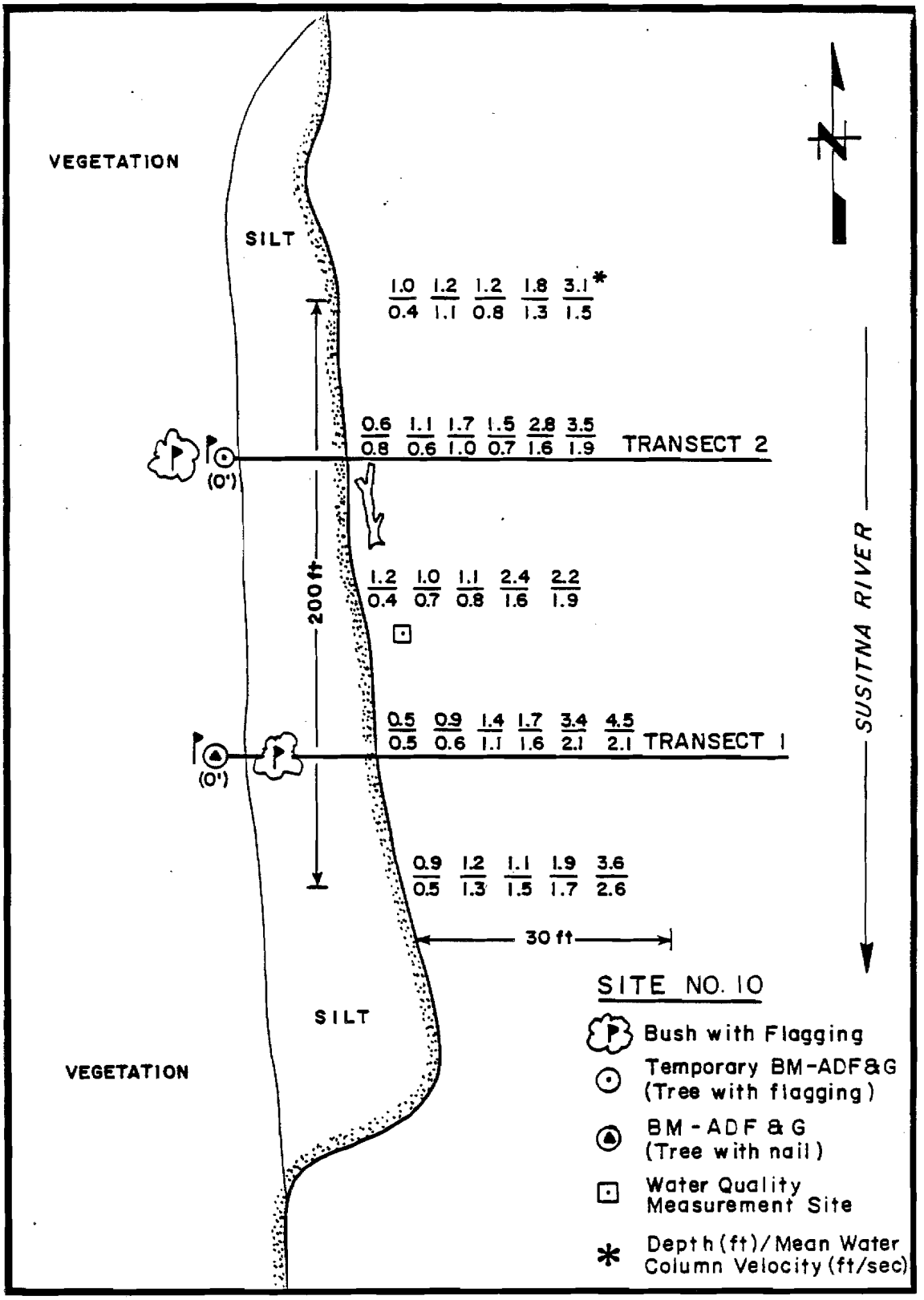


Figure 5-A-10. Eulachon spawning area (Site No. 10) on the Susitna River at RM 23.0 (GC S17N07W33DBB): May 24, 1983.

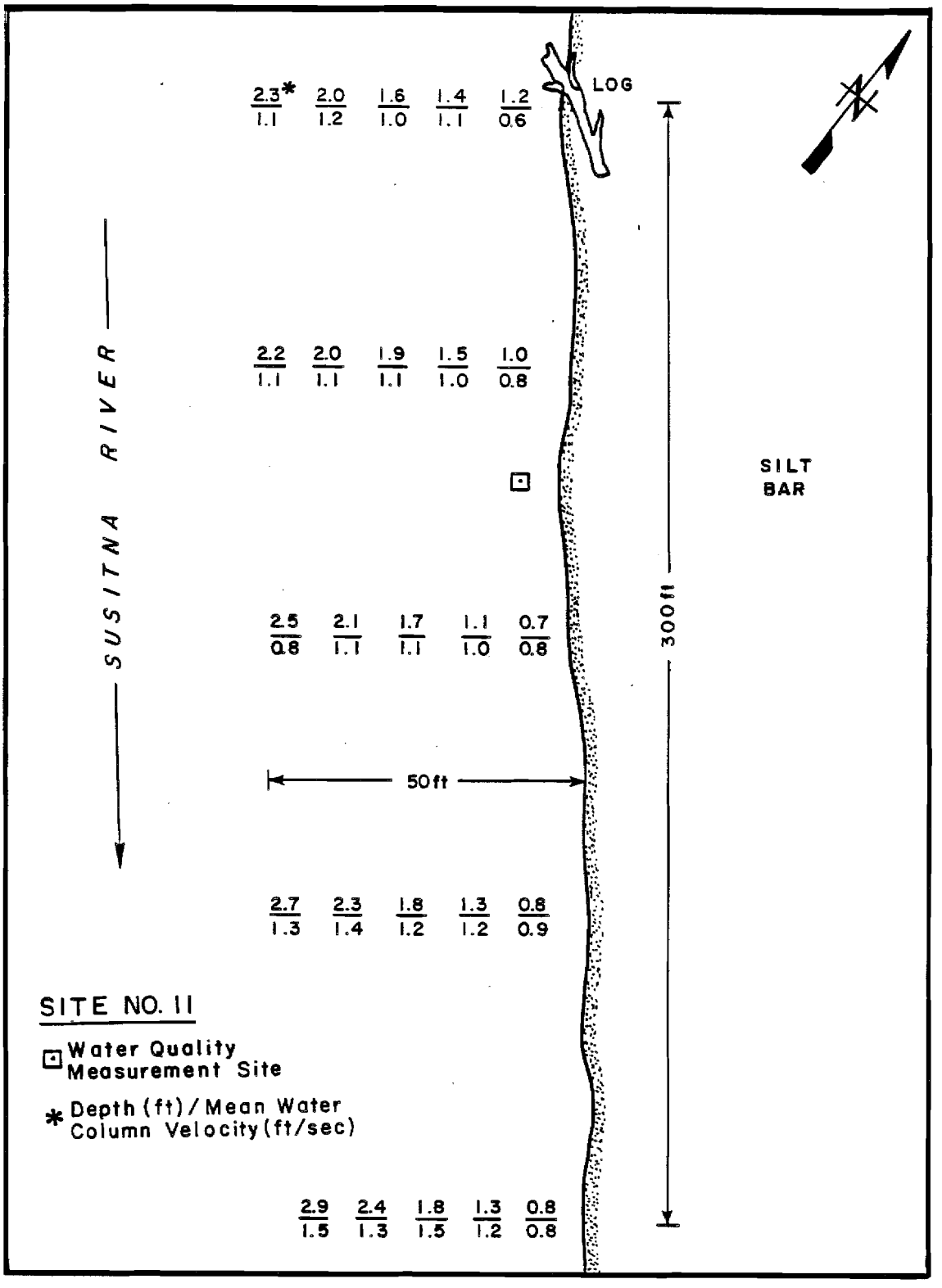


Figure 5-A-11. Eulachon spawning area (Site No. 11) on the Susitna River at RM 20.5 (GC S16N07W08DCA): May 25, 1983.

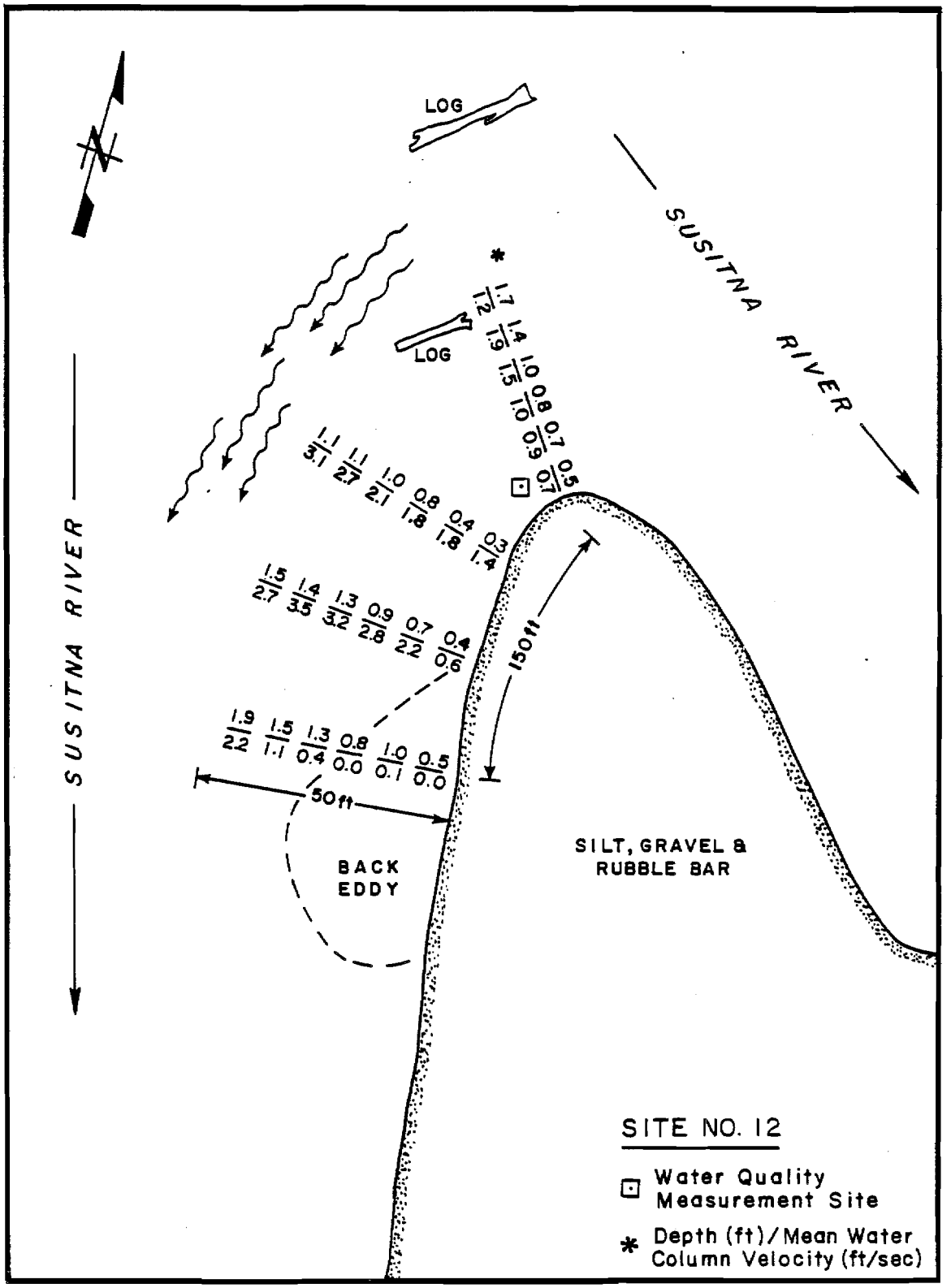


Figure 5-A-12. Eulachon spawning area (Site No. 12) on the Susitna River at RM 22.8 (GC S17N07W32DDA): May 25, 1983.

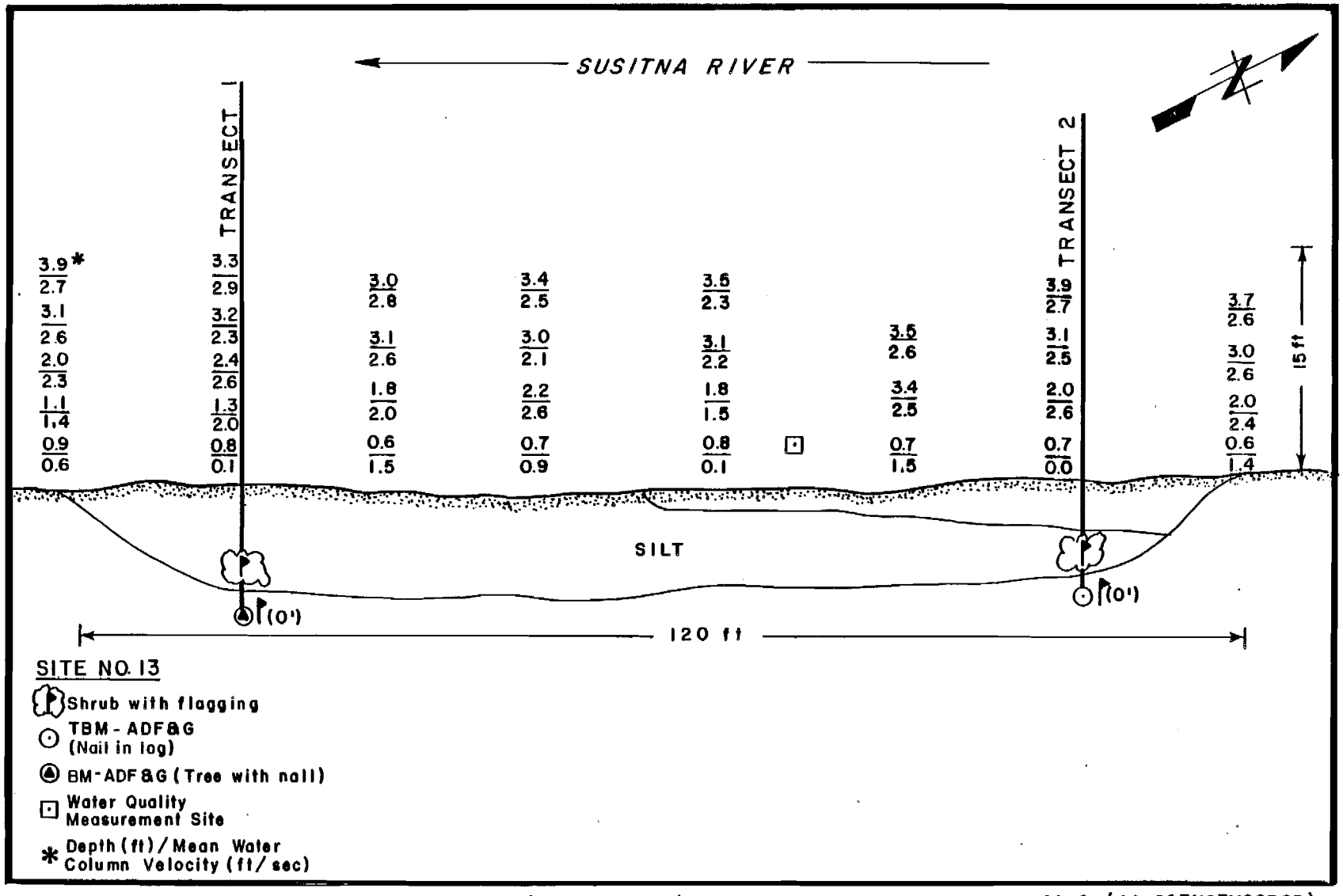


Figure 5-A-13. Eulachon spawning area (Site No. 13) on the Susitna River at RM 23.1 (GC S17N07W33BCD): May 25, 1983.

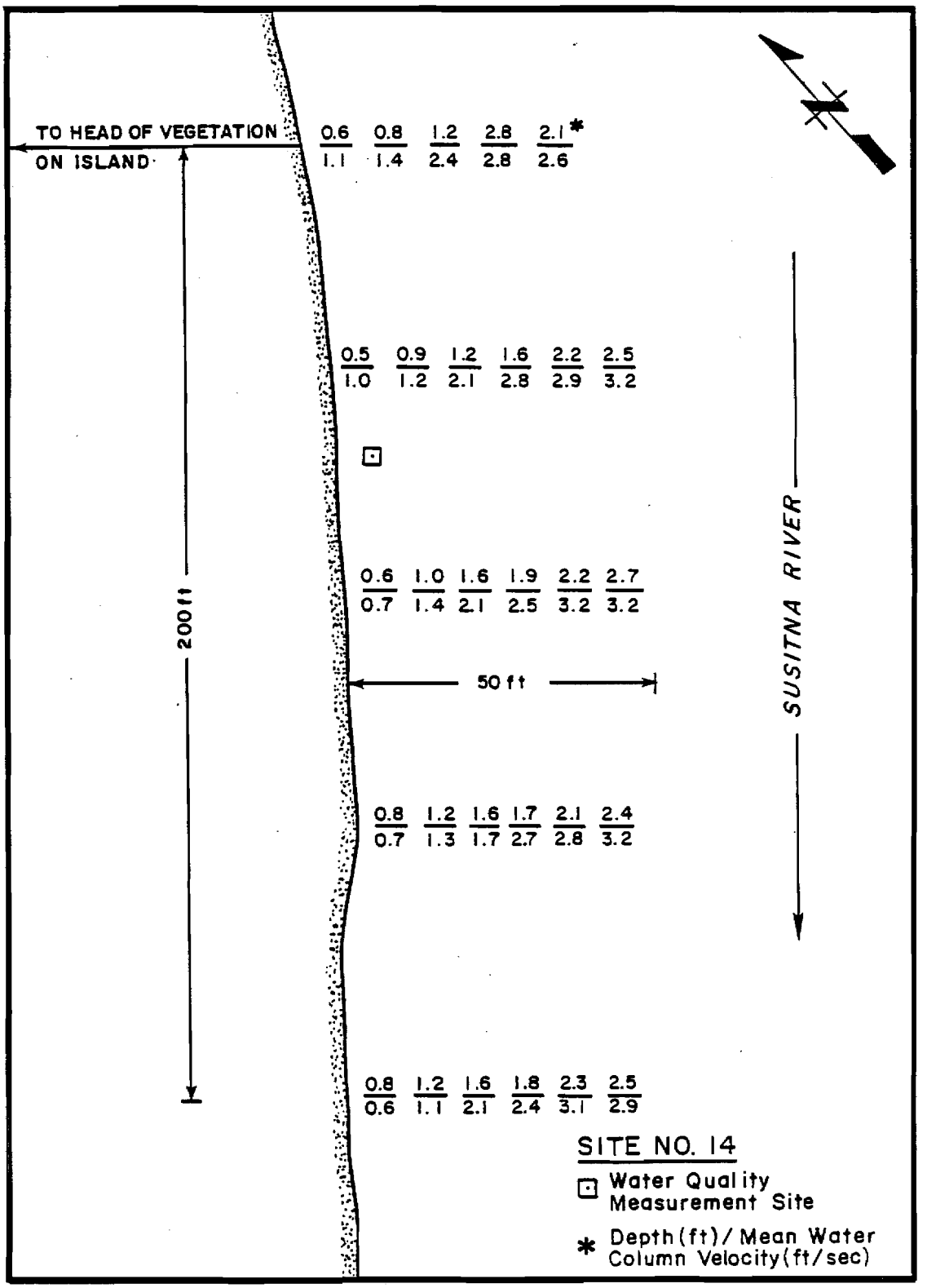


Figure 5-A-14. Eulachon spawning area (Site No. 14) on the Susitna River at RM 24.9 (GC S17N07W27BBD): May 25, 1983.

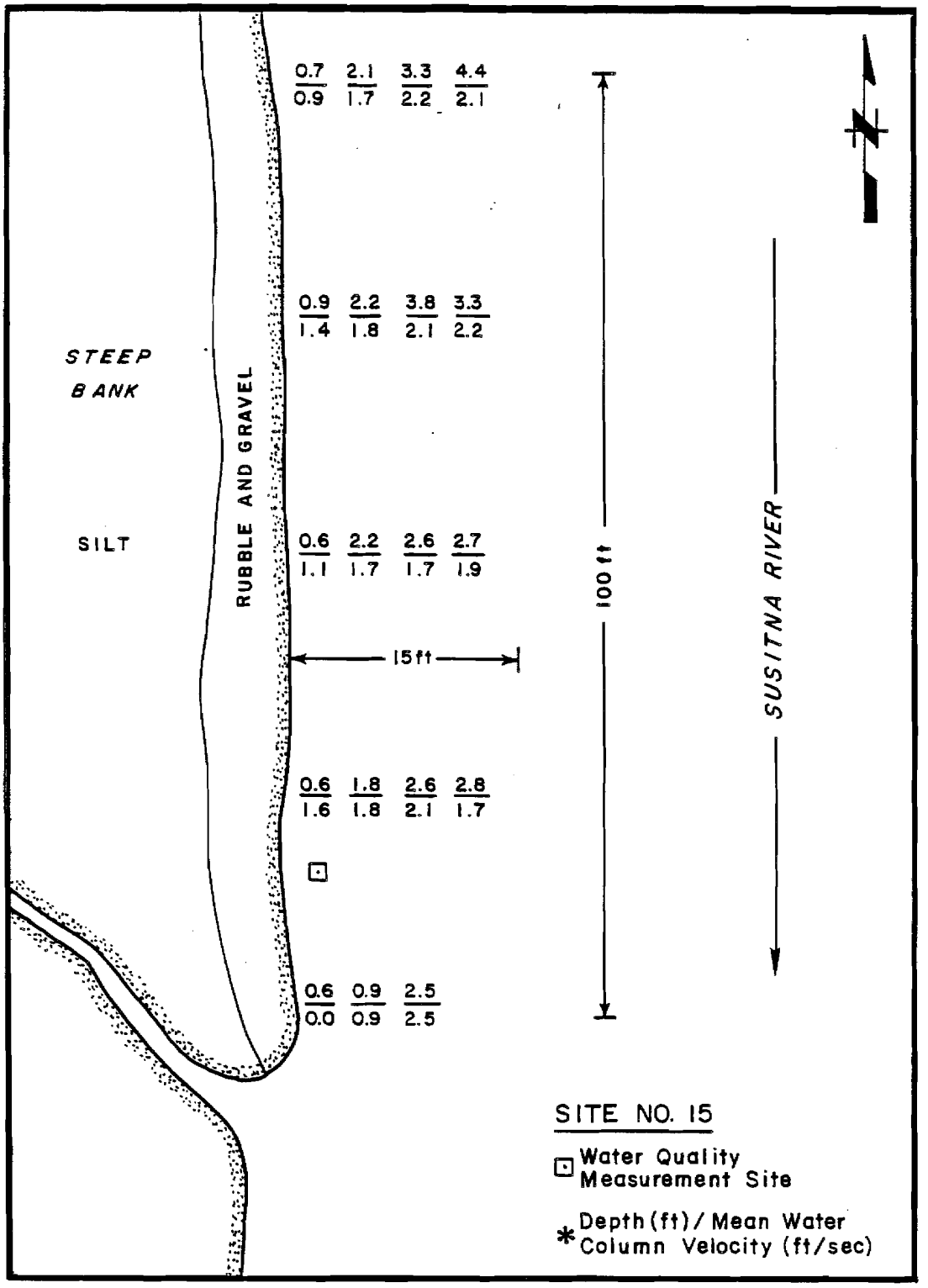


Figure 5-A-15. Eulachon spawning area (Site No. 15) on the Susitna River at RM 26.2 (GC S17N07W22ADA): May 25, 1983.

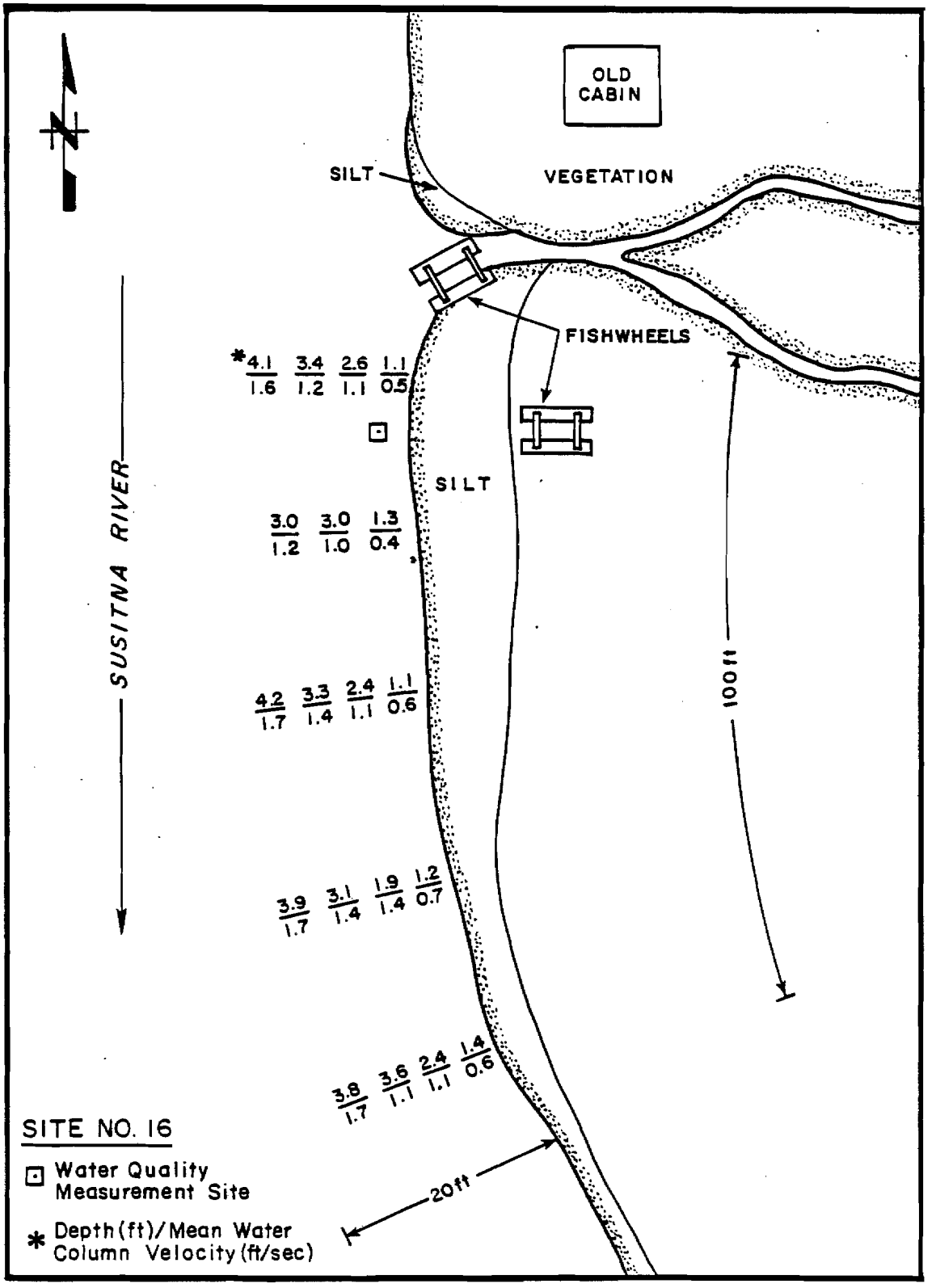


Figure 5-A-16. Eulachon spawning area (Site No. 16) on the Susitna River at RM 26.5 (GC S17N07W23BDD): May 25, 1983.

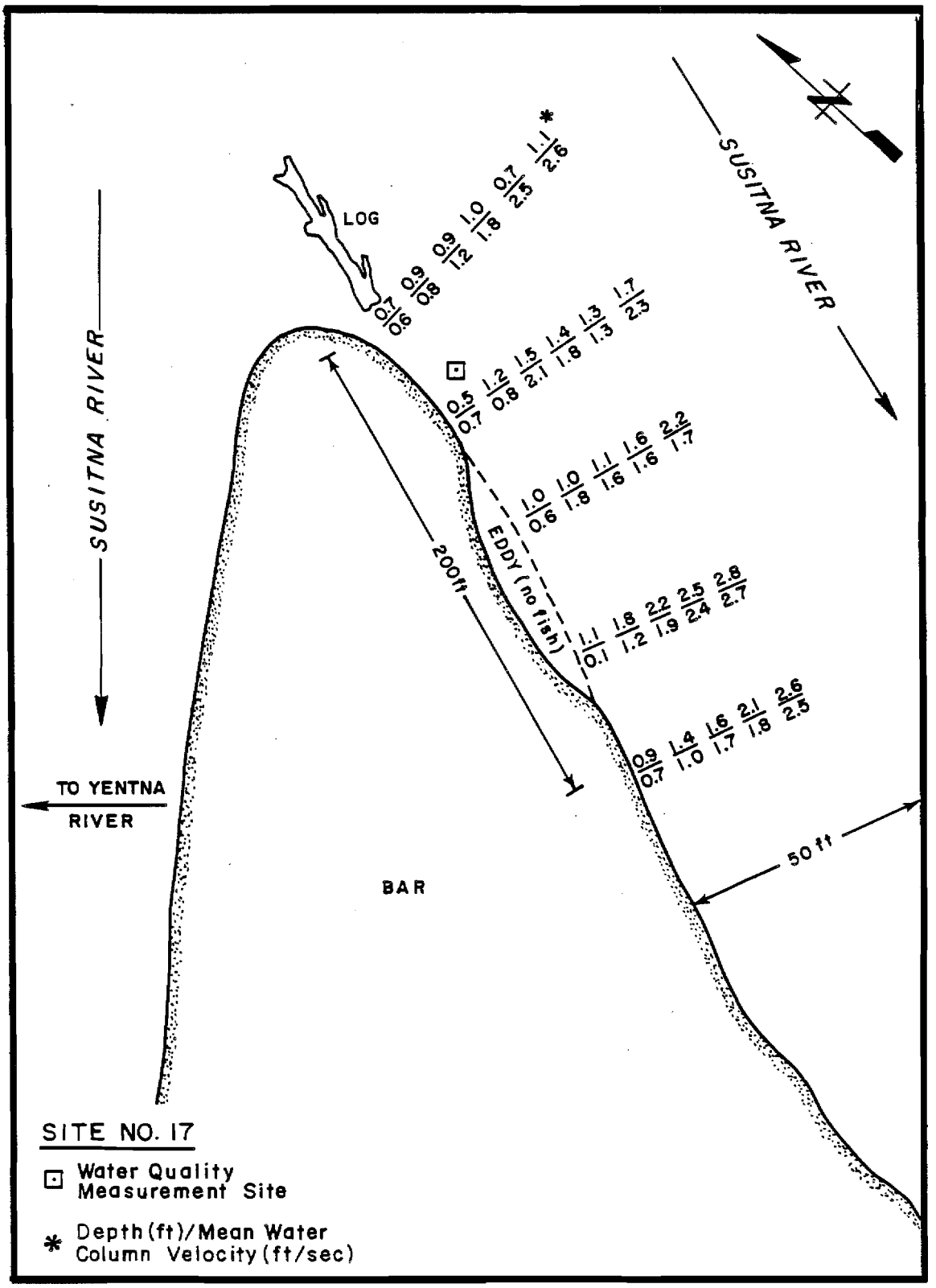


Figure 5-A-17. Eulachon spawning area (Site No. 17) on the Susitna River at RM 28.0 (GC S17N07W13BAD): May 26, 1983.

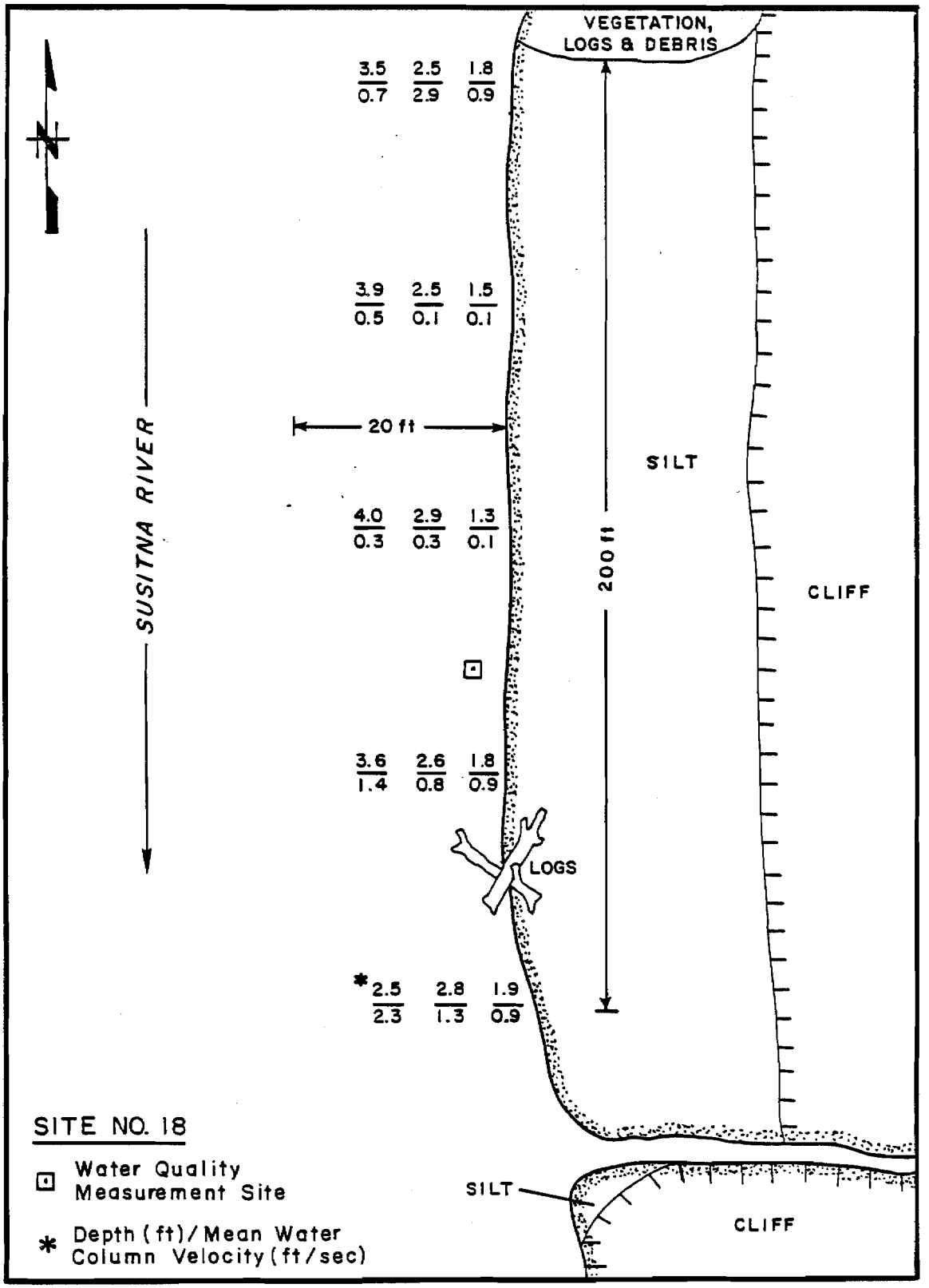


Figure 5-A-18. Eulachon spawning area (Site No. 18) on the Susitna River at RM 30.1 (GC S17N06W08CBD): May 26, 1983.

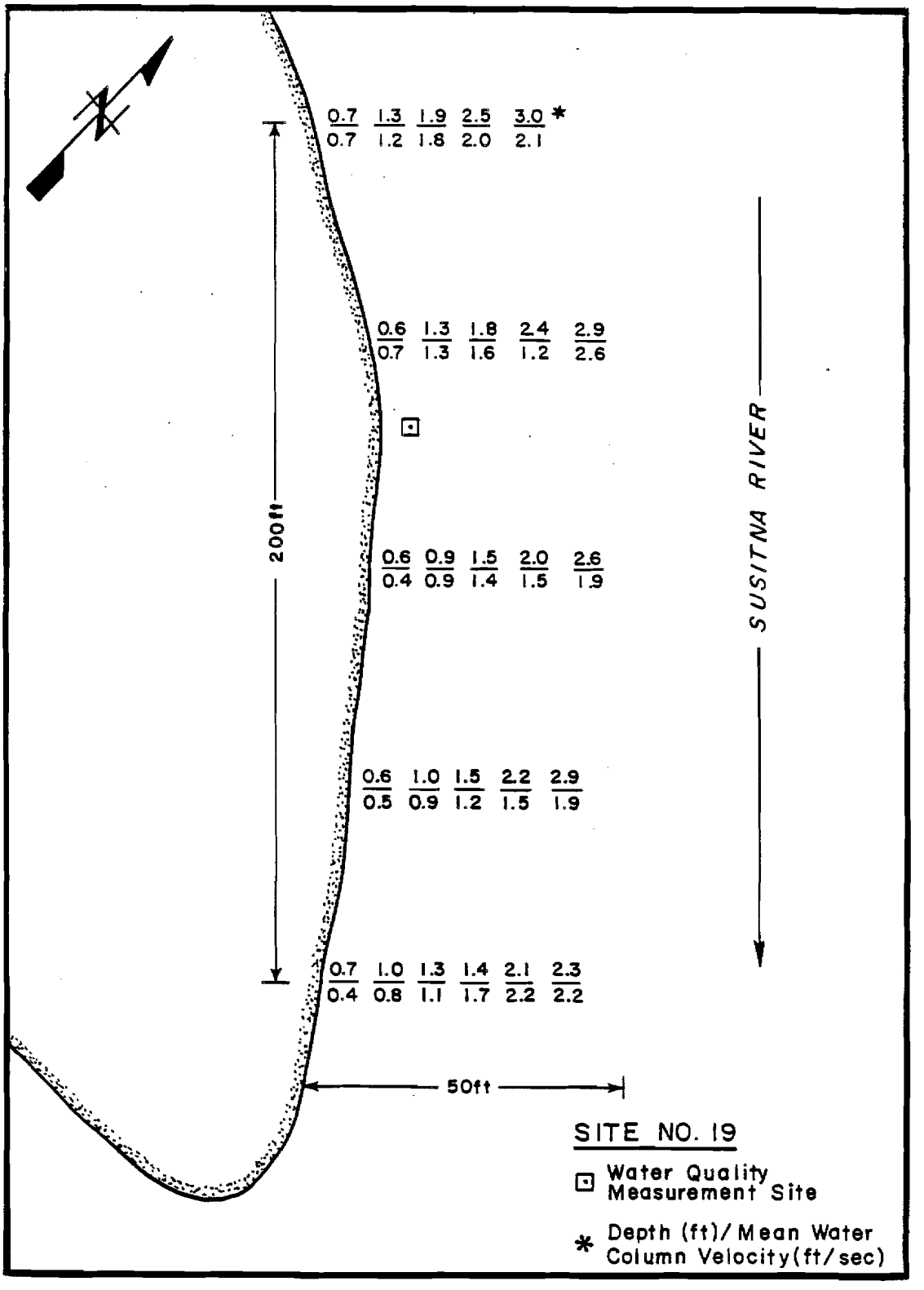


Figure 5-A-19. Eulachon spawning area (Site No. 19) on the Susitna River at RM 33.4 (GC S18N06W33ABD): May 26, 1983.

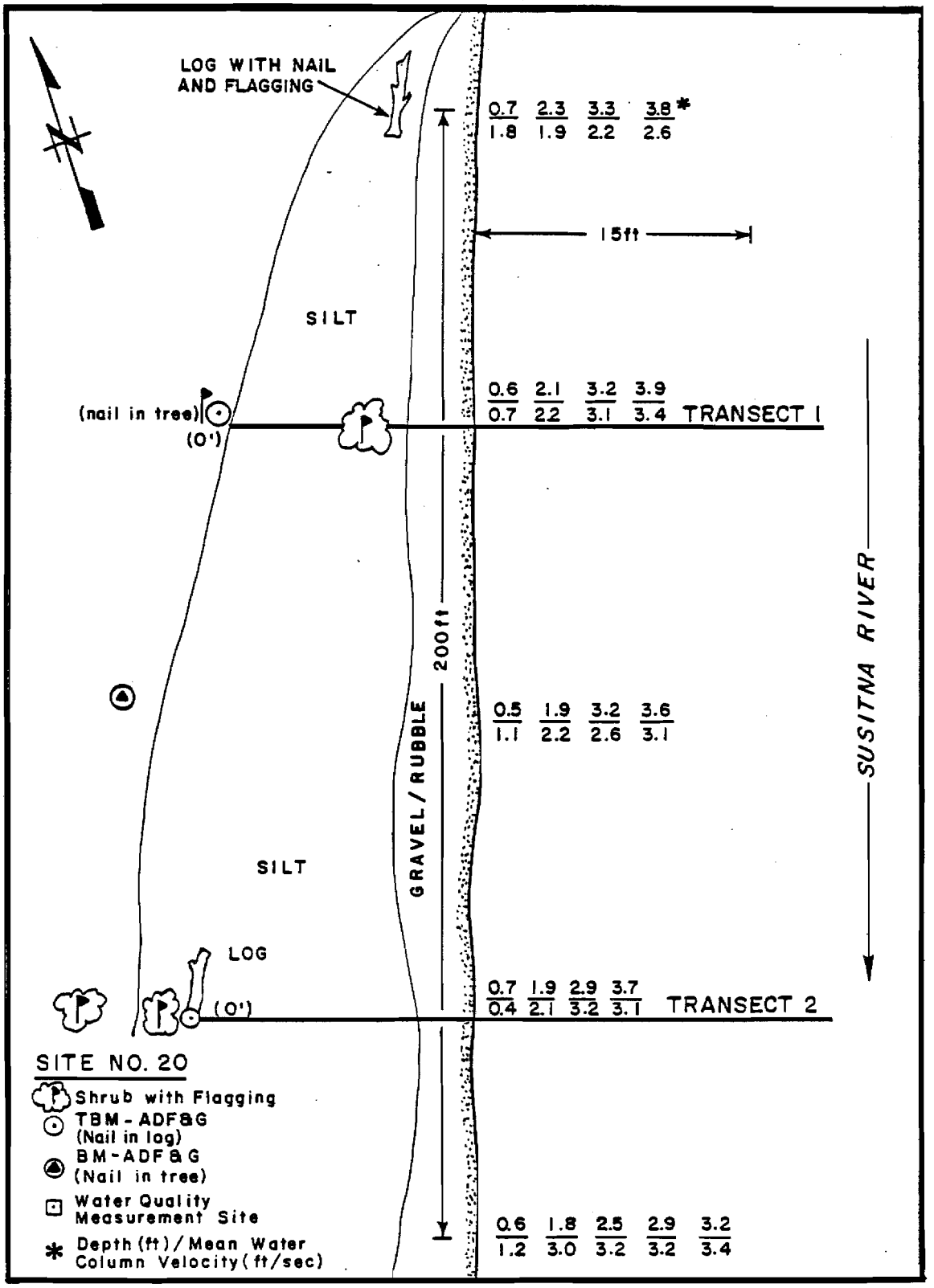


Figure 5-A-20. Eulachon spawning area (Site No. 20) on the Susitna River at PM 36.5 (GC S18N06W15BBA): May 26, 1983.

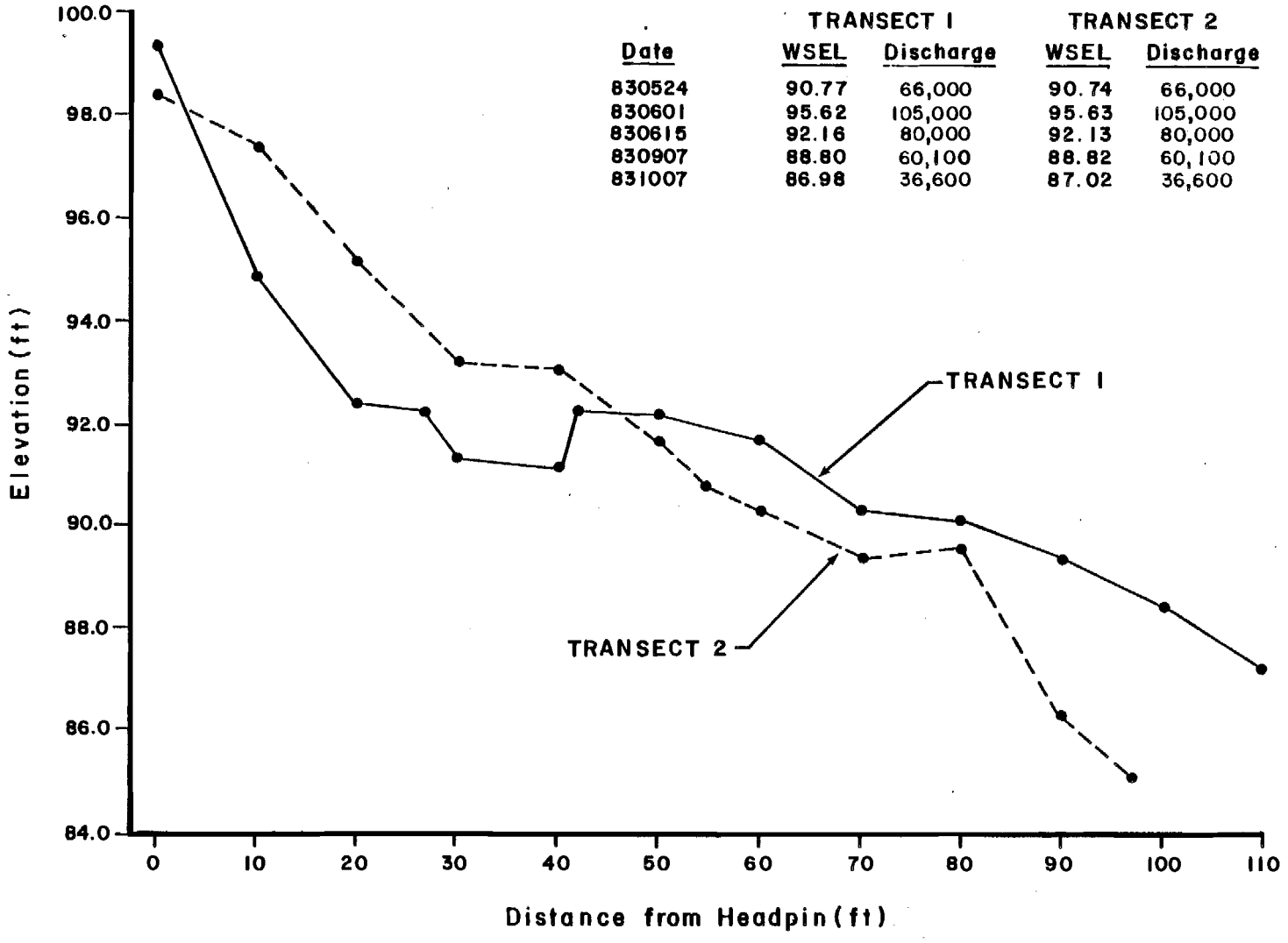


Figure 5-A-21. Streambank/streambed profiles obtained at two transects at the eulachon spawning study site located at RM 23.0 (Site No. 10). Water surface elevations (WSEL) obtained on each transect at the time of measurement and during subsequent visits along with corresponding mainstem discharges at Susitna Station (provisional USGS data) are presented in the insert table.

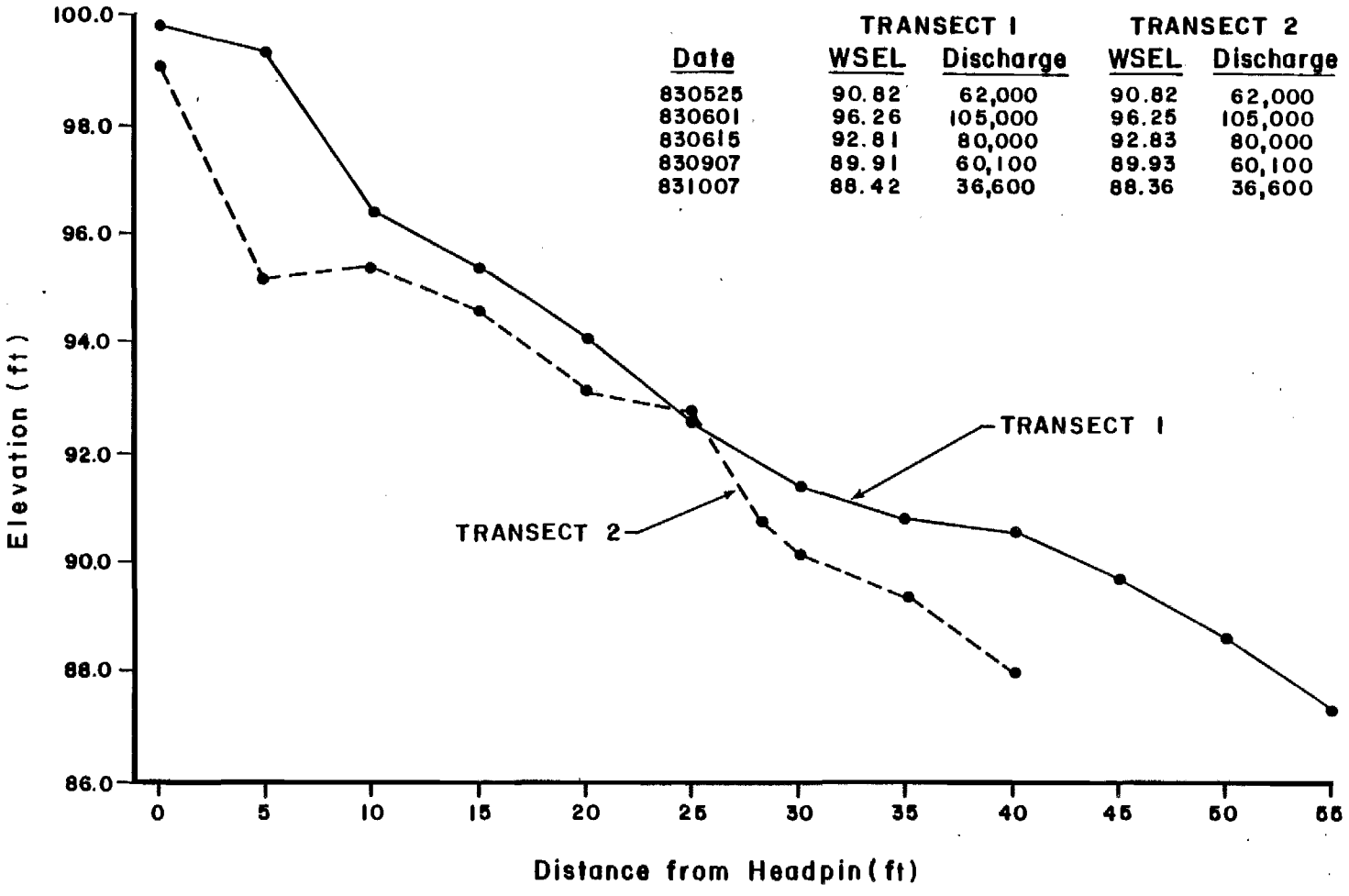
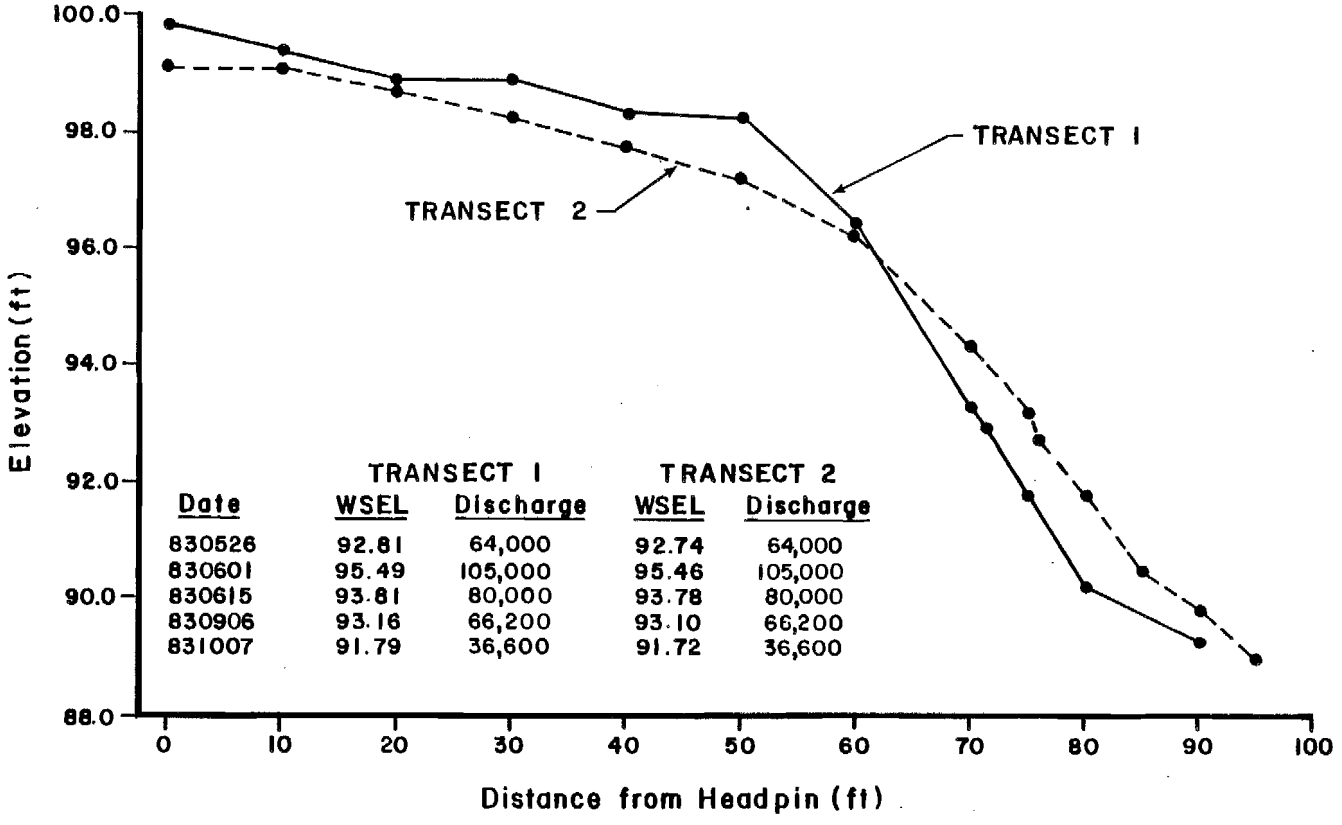


Figure 5-A-22. Streambank/streambed profiles obtained at two transects at the eulachon spawning study site located at RM 23.1 (Site No. 13). Water surface elevations (WSEL) obtained on each transect at the time of measurement and during subsequent visits along with corresponding mainstem discharges at Susitna Station (provisional USGS data) are presented in the insert table.



Date	TRANSECT 1 WSEL	TRANSECT 1 Discharge	TRANSECT 2 WSEL	TRANSECT 2 Discharge
830526	92.81	64,000	92.74	64,000
830601	95.49	105,000	95.46	105,000
830615	93.81	80,000	93.78	80,000
830906	93.16	66,200	93.10	66,200
831007	91.79	36,600	91.72	36,600

Figure 5-A-23. Streambank/streambed profiles obtained at two transects at the eulachon spawning study site located at RM 36.5 (Site No. 20). Water surface elevations (WSEL) obtained on each transect at the time of measurement and during subsequent visits along with corresponding mainstem discharge at Susitna Station (provisional (USGS data) are presented in the insert table.

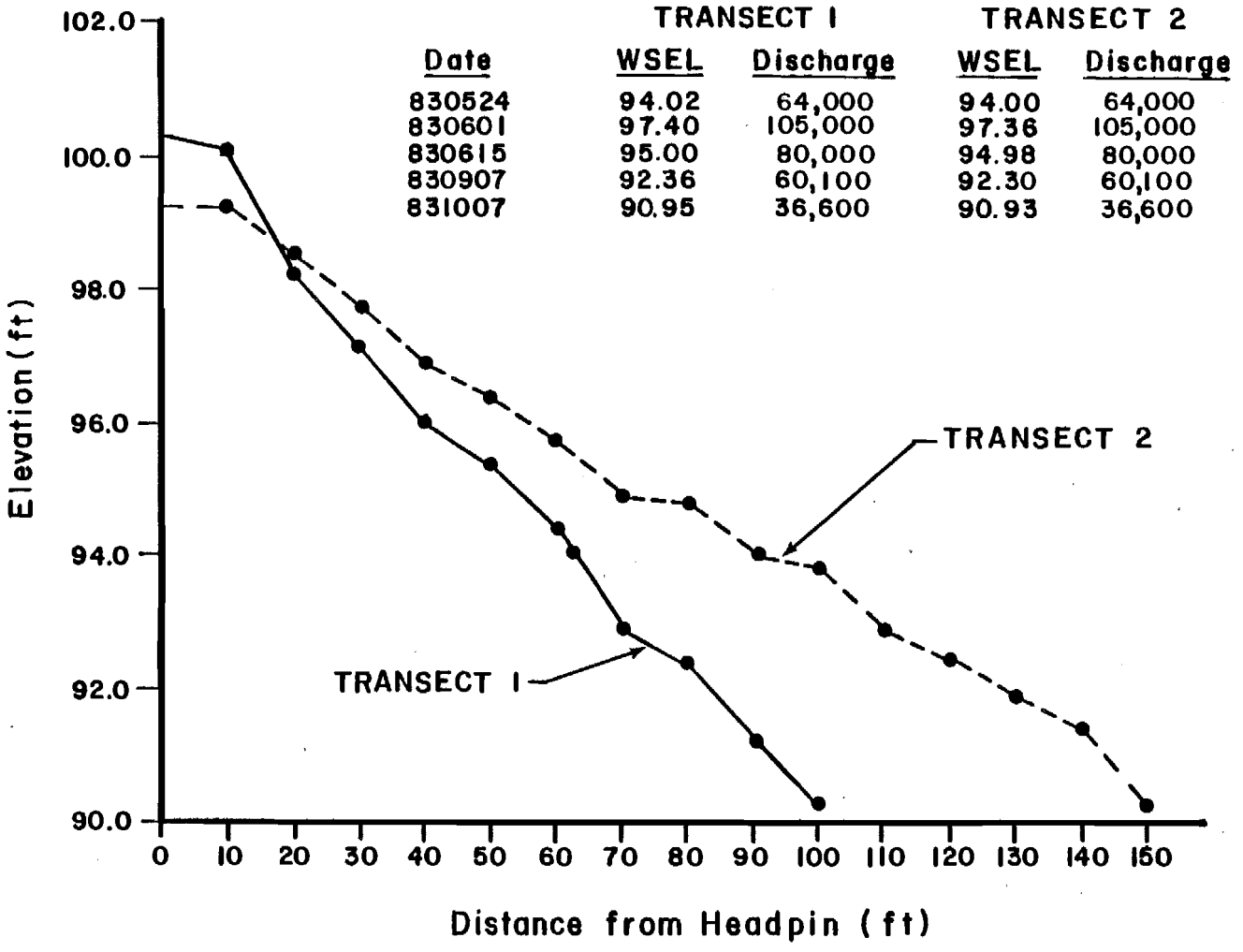


Figure 5-A-24. Streambank/streambed profiles obtained at two transects at the eulachon spawning study site located at RM 12.8 (Site No. 2). Water surface elevations (WSEL) obtained on each transect at the time of measurement and during subsequent visits along with corresponding mainstem discharges at Susitna Station (provisional USGS data) are presented in the insert table.

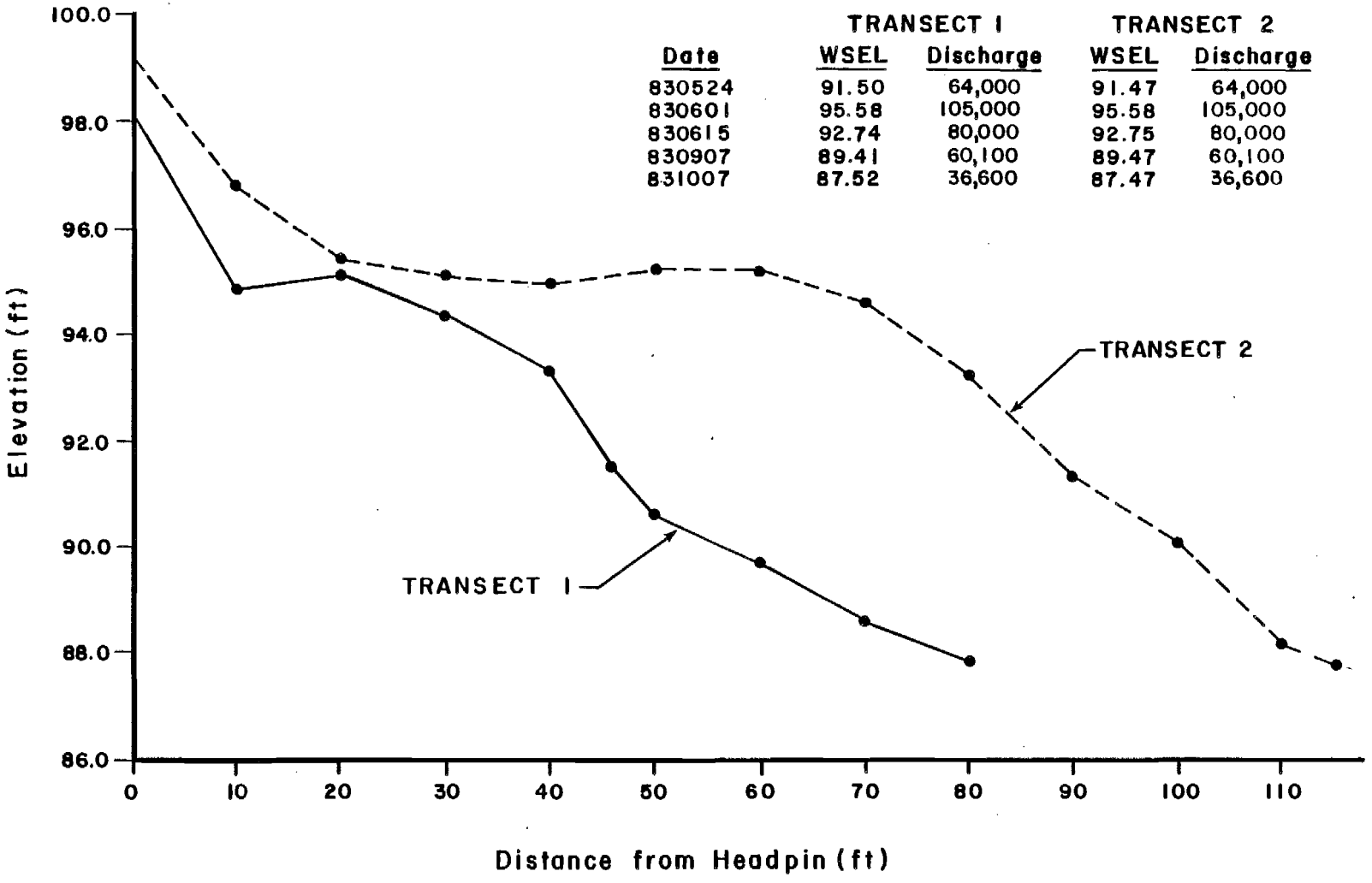


Figure 5-A-25. Streambank/streambed profiles obtained at two transects at the eulachon spawning study site located at RM 16.2 (Site No. 6). Water surface elevations (WSEL) obtained on each transect at the time of measurement and during subsequent visits along with corresponding mainstem discharges at Susitna Station (provisional USGS data) are presented in the insert table.

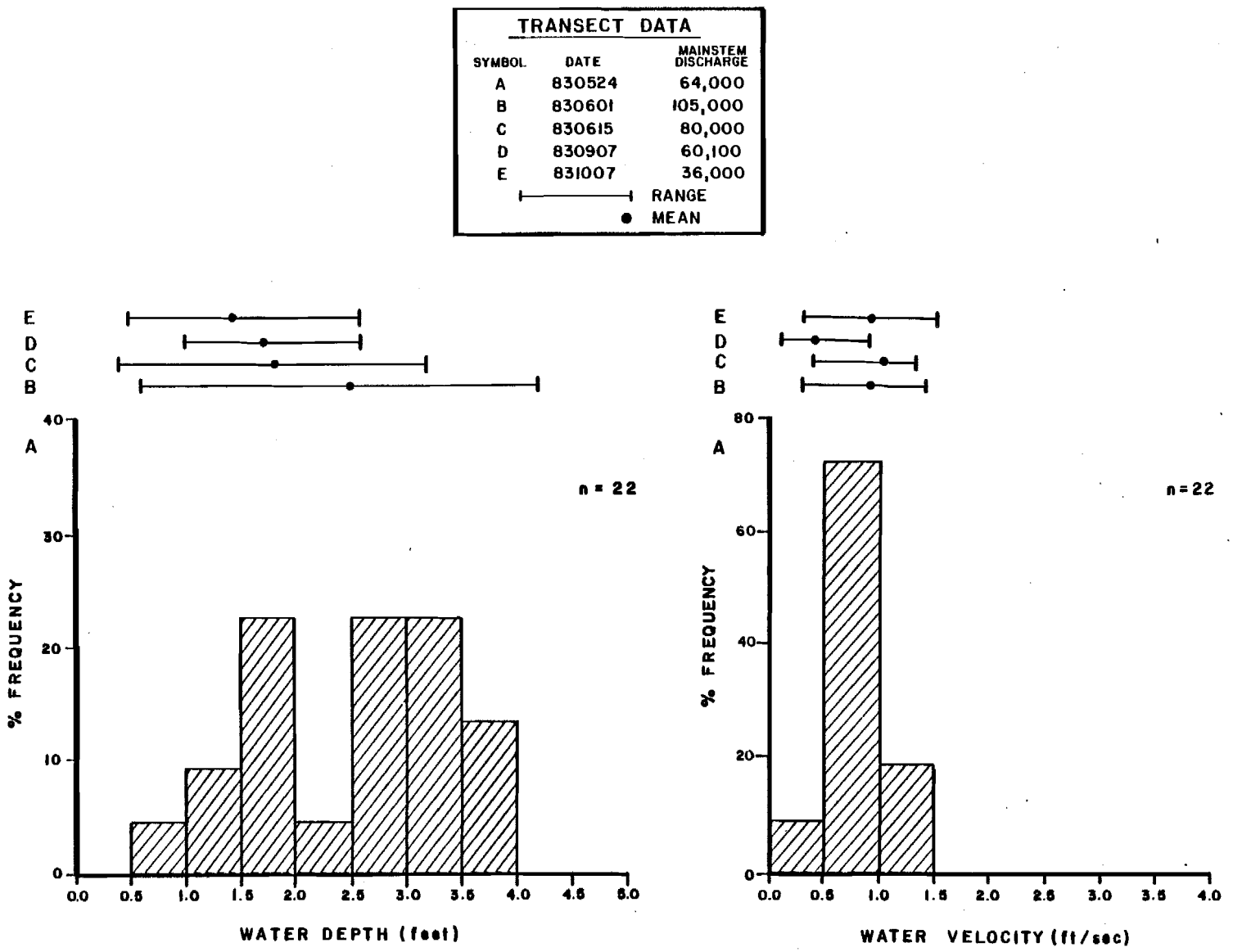


Figure 5-A-26. Frequency distributions of instantaneous water depths (A) and velocities (B) obtained at the time of eulachon spawning at the eulachon spawning study site at RM 12.8 (Site No. 2). Ranges and means of instantaneous water depths and velocities measured along study transects during subsequent visits are also shown.

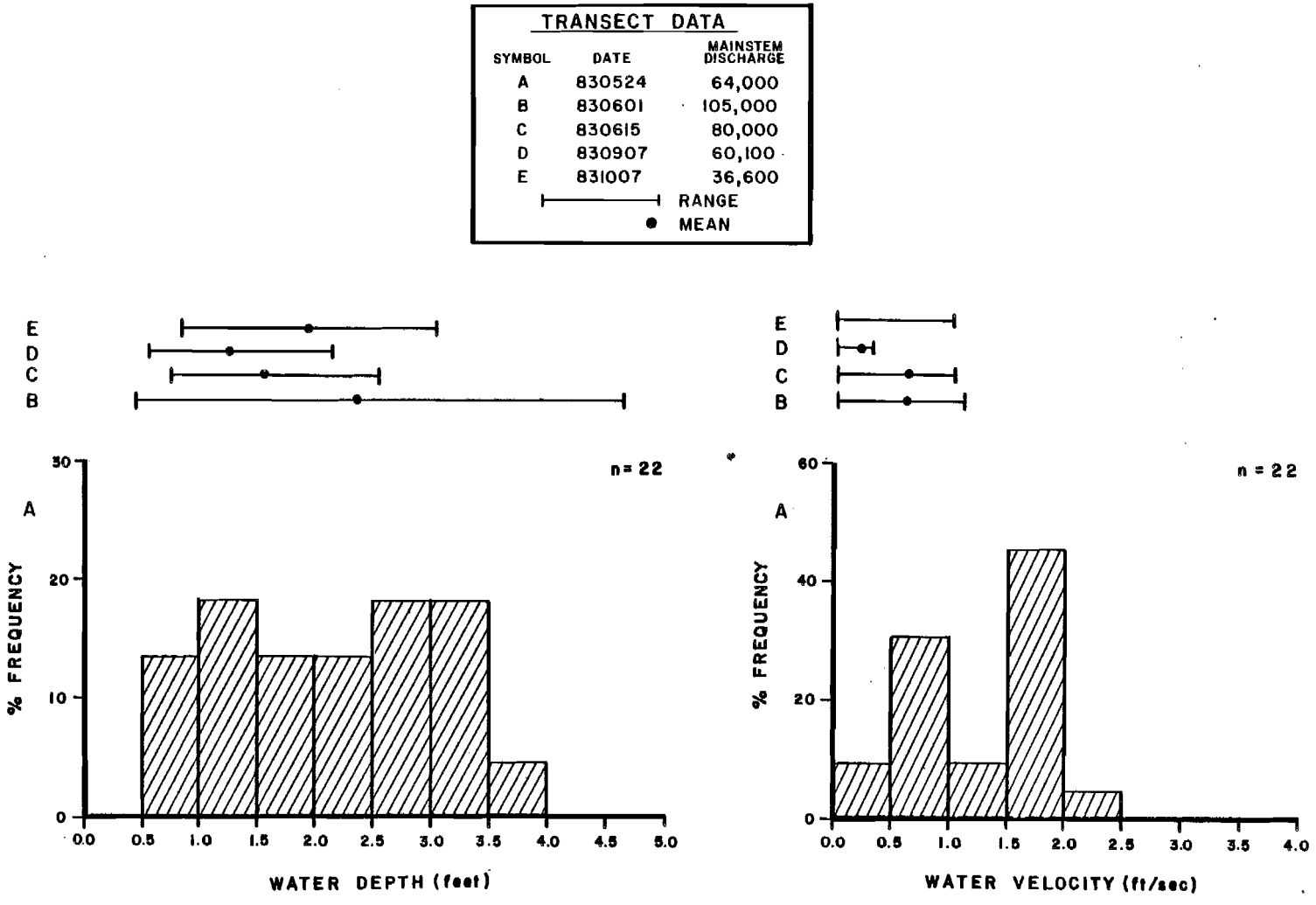


Figure 5-A-27. Frequency distributions of instantaneous water depths (A) and velocities (B) obtained at the time of eulachon spawning at the eulachon spawning at the eulachon spawning study site at RM 16.2 (Site No. 6). Ranges and means of instantaneous water depths and velocities measured along study transects during subsequent visits are also shown.

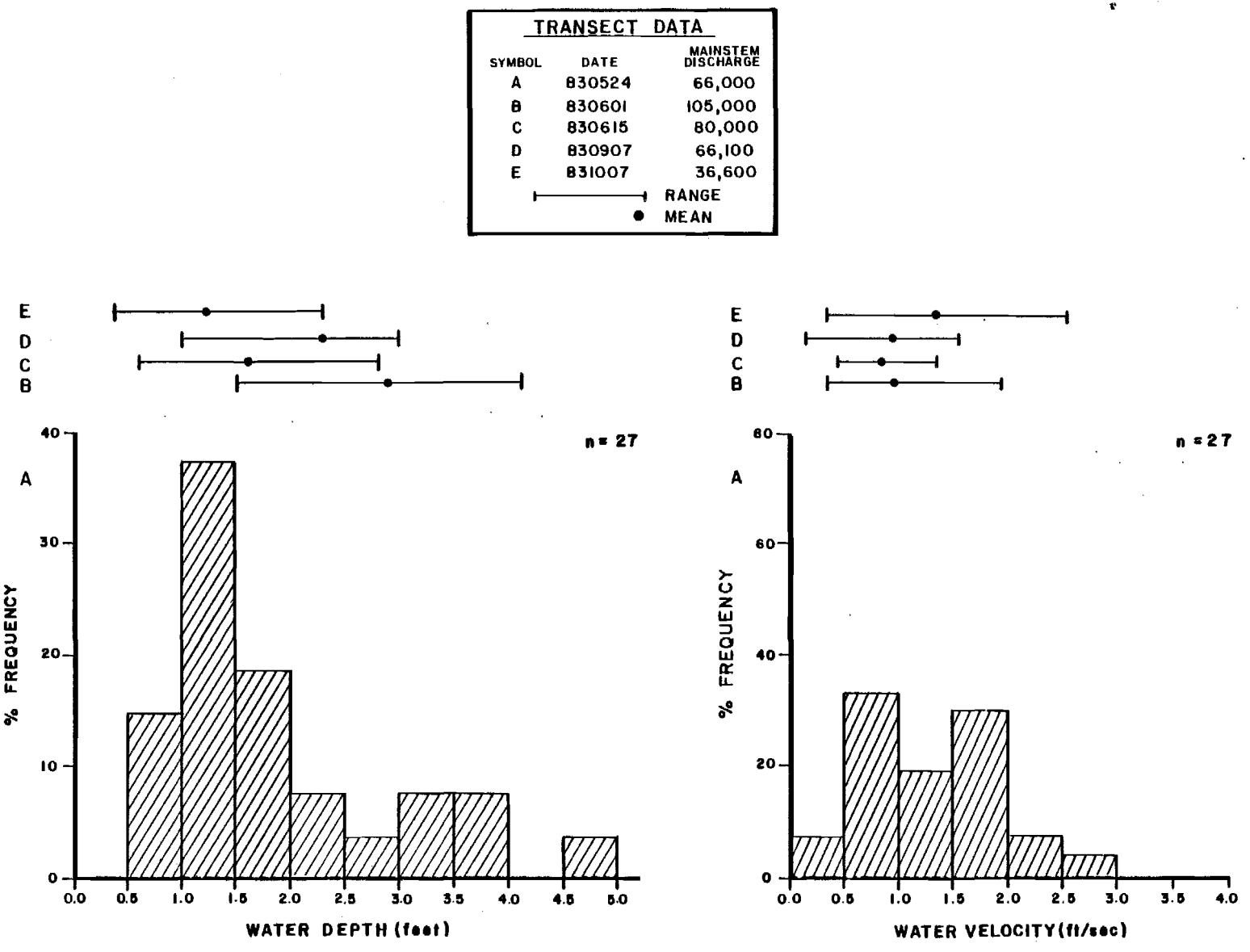


Figure 5-A-28. Frequency distributions of instantaneous water depths (A) and velocities (B) obtained at the time of eulachon spawning at the eulachon spawning study site at RM 23.0 (Site No. 10). Ranges and means of instantaneous water depths and velocities measured along study transects during subsequent visits are also shown.

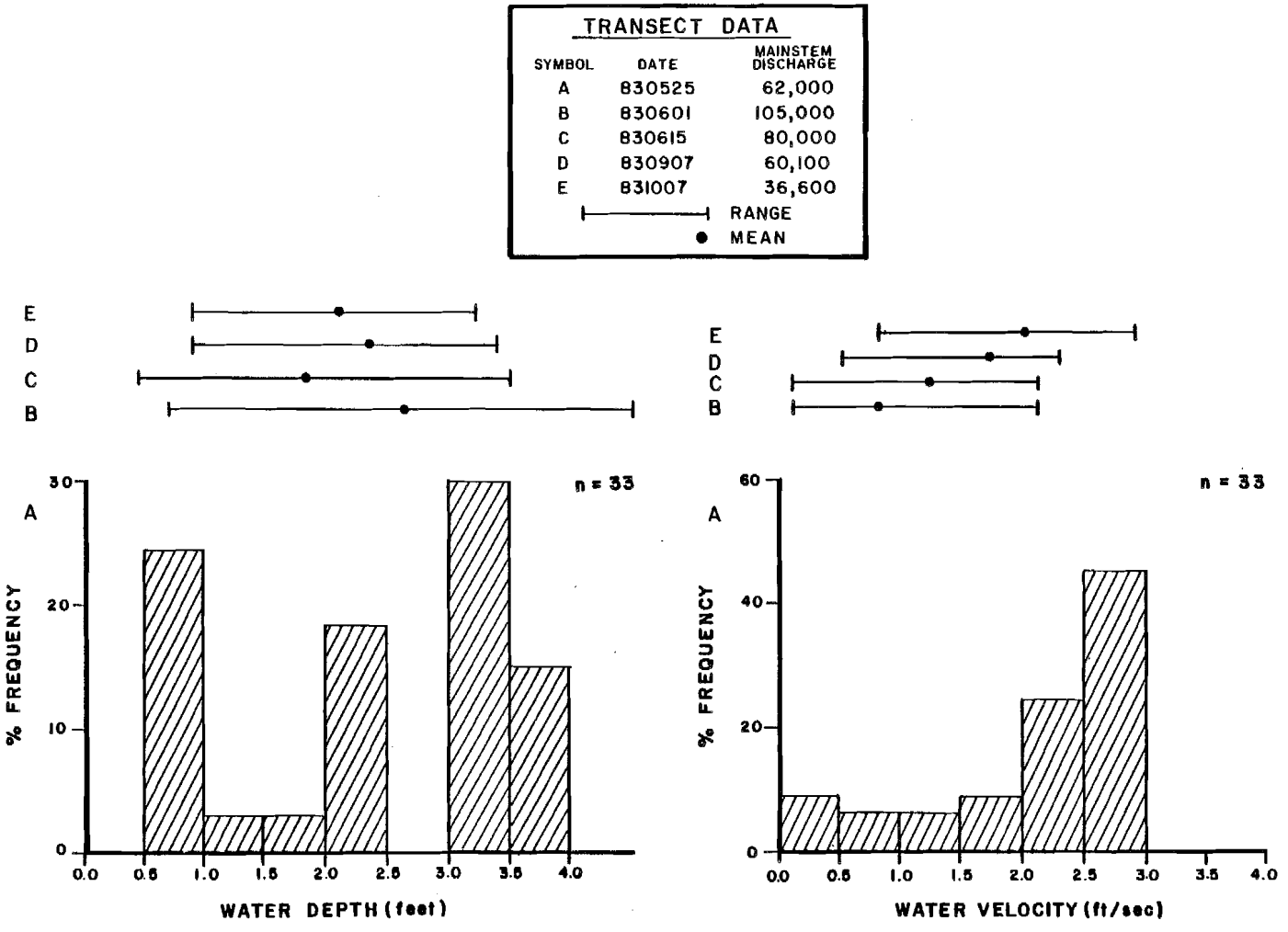


Figure 5-A-29. Frequency distributons of instantaneous water depths (A) and velocities (B) obtained at the time of eulachon spawning at the eulachon spawning study site at RM 23.1 (Site No. 13). Ranges and means of instantaneous water depths and velocities measured along study transects during subsequent visits are also shown.

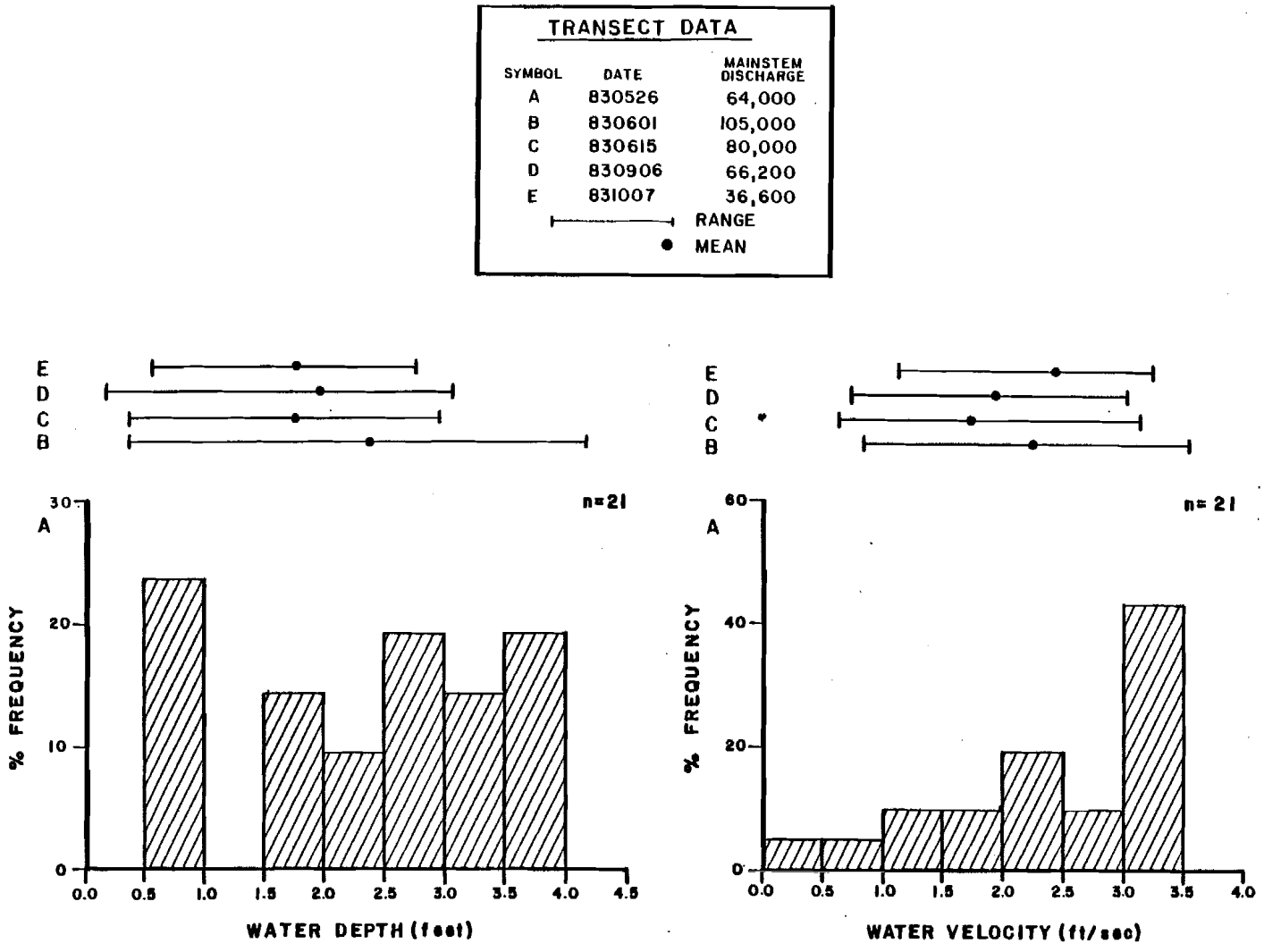


Figure 5-A-30. Frequency distributions of instantaneous water depths (A) and velocities (B) obtained at the time of eulachon spawning at the eulachon spawning study site at RM 36.5 (Site No. 20). Ranges and means of instantaneous water depths and velocities measured along study transects during subsequent visits are also shown.