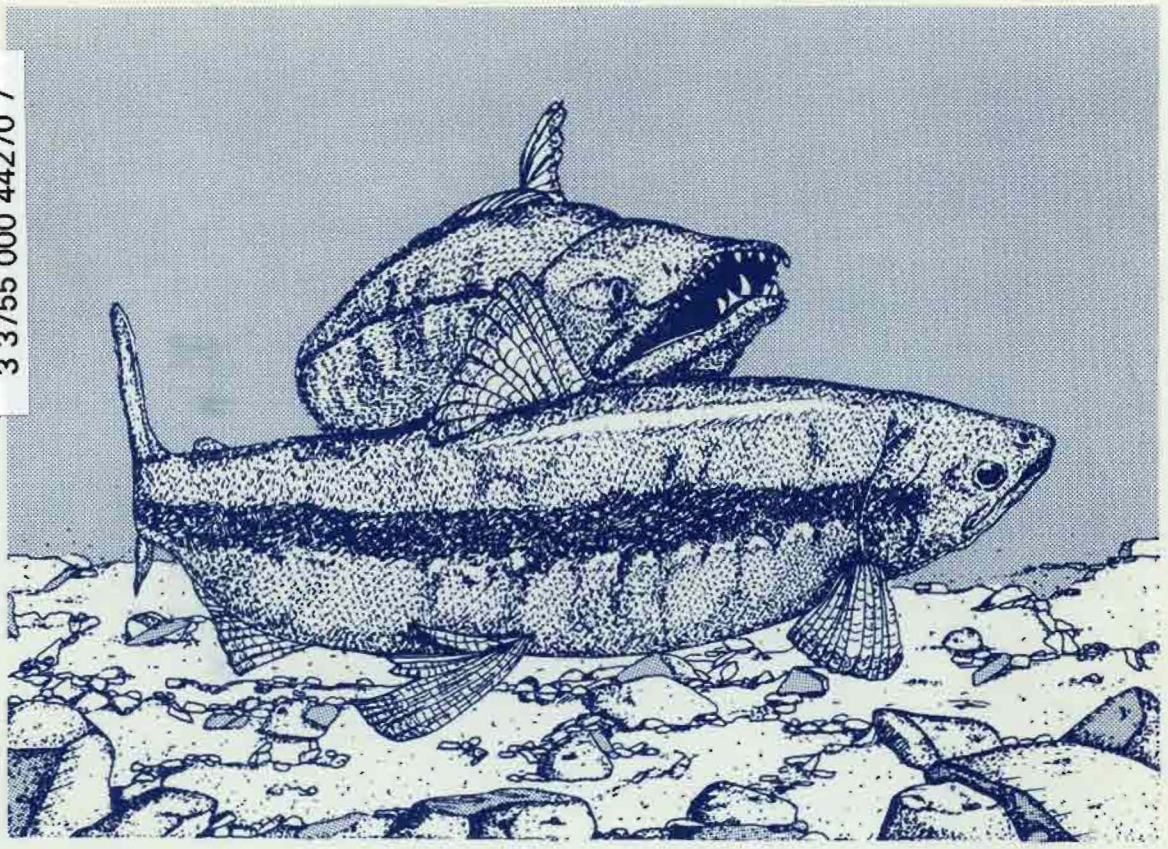

ALASKA DEPARTMENT OF FISH AND GAME
SUSITNA HYDRO AQUATIC STUDIES

REPORT NO. 3 Part II, Chapter 11

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

Edited by:

Christopher C. Estes
and
Douglas S. Vincent-Lang

Prepared for:

ALASKA POWER POWER AUTHORITY
334 W. FIFTH AVE.
ANCHORAGE, ALASKA 99501

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DRAFT April 30, 1984

INVESTIGATIONS OF EULACHON SPAWNING HABITAT IN THE LOWER SUSITNA RIVER.

1984 Report No. 3, Chapter 11

By: Douglas Vincent-Lang

and

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ABSTRACT

(To Be Written)

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1.0 INTRODUCTION

1.1 Background

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. Surveys conducted during 1982 by the Alaska Department of Fish and Game (ADF&G 1983a, 1983b) confirmed previous reports (Morrow 1980, Lee et. al. 1980) that this smelt utilizes the lower Susitna River basin for spawning. These surveys 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 these 1982 surveys indicated that two runs of eulachon utilizing the Susitna River for spawning. It was also determined that eulachon are probably the most abundant species of fish in the Susitna River drainage with spawning occurring over a broad range of conditions in 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).

Post project changes associated with the development and operation of the Susitna Hydroelectric Project may have impacts on the eulachon spawning run entering the Susitna River and on the habitats utilized by eulachon for spawning. Two of the major changes expected include decreased discharge flows and increased water temperatures during the period of the eulachon spawning run (May-June). Studies to determine

the relationship of preproject discharge and temperature relationships to spawning were initiated in 1982 and continued in 1983 to enable other project participants to evaluate post project impacts.

1.2 Objectives

Special objective of the 1983 evaluation of the eulachon spawning run in the lower Susitna River were conducted to further:

1. Determine the extent, timing, and numbers of the spawning runs of eulachon 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 stage 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 and second objectives were addressed by the Adult Anadromous Fish Studies section and results are presented in Report #1 of this

report series (Barrett, Thompson, and Wick 1984). The second through fifth objectives were addressed by the Aquatic Habitat and Instream Flow Studies section and results are presented below.

2.0 METHODS

2.1 Site Selection

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

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.

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 spawning sites, representative of the spawning sites identified, were then selected for evaluation of utilized spawning habitat. Studies were scheduled to coincide with the second run between 1982 investigations indicated this was the most advantageous period for sampling.

2.2 Field Data Collection

To determine habitat and environmental parameters associated with eulachon spawning, habitat surveys were conducted at the 20 eulachon spawning sites selected for study. 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), and time and date of sampling were determined and recorded;

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

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

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

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

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

7. Water depth and velocity data were collected and recorded.

8. 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).

To determine surface water temperatures associated with eulachon spawning runs, a Peabody-Ryan model J-90 thermograph was placed along the east bank of the Susitna River at RM 4.5. Peabody-Ryan thermographs continuously monitor and record surface water temperatures. From these continuous records, daily mean temperatures were calculated as the mean of four, 6-hour, point temperature readings.

To determine mainstem Susitna River discharges associated with eulachon spawning runs, provisional discharge data (U.S. Geological Survey, USGS, 1983 provisional data) for the Susitna River at Susitna Station was obtained from the USGS. These data were converted to mean daily discharge readings.

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 study site selected for further study, two representative transects were selected for streambank/

streambed surveys. Headpins were established at a point sufficiently above the high water marks on each transect. These headpins were then referenced to a benchmark (BM) with an assumed elevation of 100.00 feet. Streambank/streambed profiles were then surveyed using the basic techniques of differential leveling. The substrate composition along each transect was also determined and recorded. Water surface elevation and distance to water's edge from headpin at each transect at the time of spawning were determined and recorded. A representative number of water depth and velocities measurements were then obtained along each transect and recorded. The mainstem discharge associated with these measurements was later obtained and incorporated with these data. Additional measurements of water surface elevation, distance to water's edge from headpin, and water depth and velocity along each transect were later obtained at different levels of mainstem discharge.

3.0 RESULTS

Spawning habitat surveys were conducted at 20 sites between RM 10 and RM 20 during the second (two eulachon runs exist in the Susitna River, see Report #1 this report series 1983 eulachon spawning run (Table 11-1). Maps of each surveyed eulachon spawning site surveyed depicting the general habitat characteristics of the site and areas of measurement and sampling are presented in Appendix Figures 11-A-1 abd 11-A-20.

Representative measurements of water quality (surface water temperature, pH, specific conductance, and dissolved oxygen) collected at each surveyed spawning site at the time of spawning are summarized in Table 2 and Figures 11-1 and 11-2. The means and ranges of instantaneous water depths and velocities measured at the time of eulachon spawning at each site are summarized in Table 11-3 and Figure 11-3. The general substrate composition observed at the time of spawning at each site is presented in Figure 11-4.

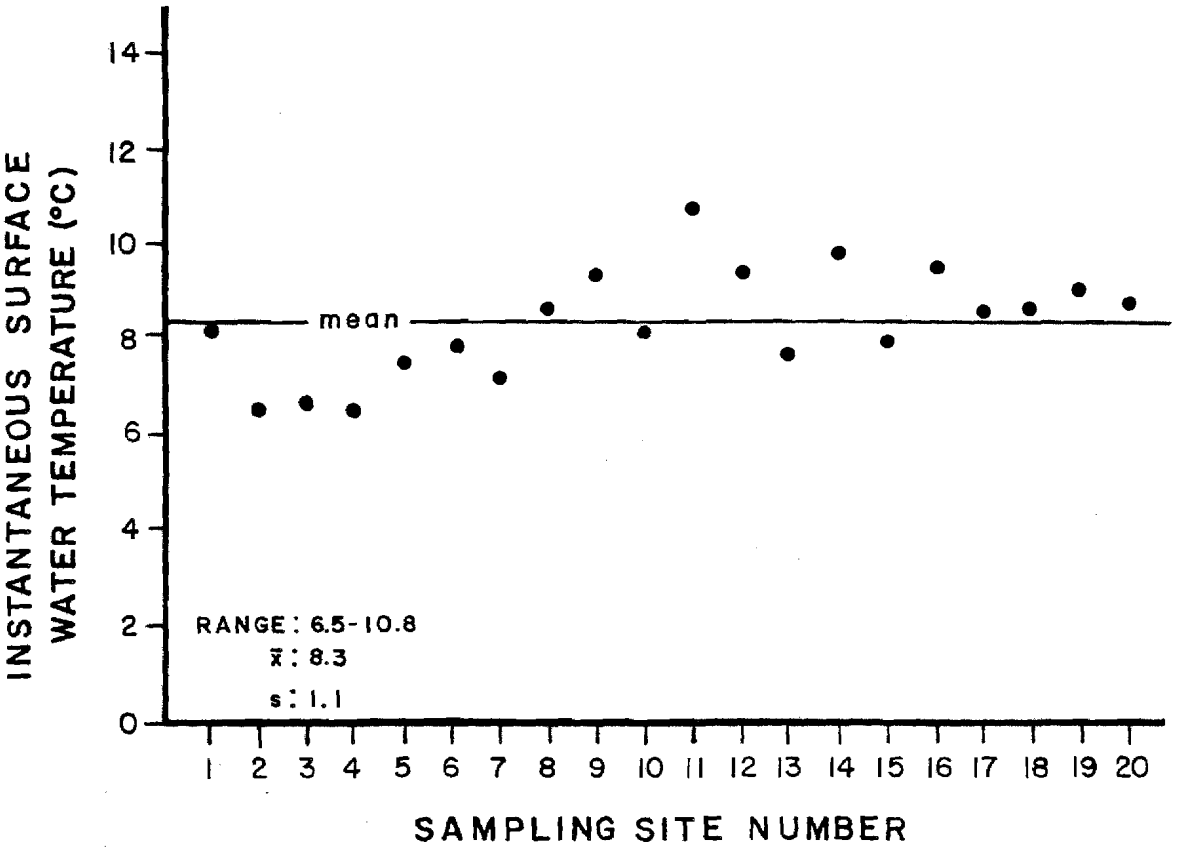
To compare the mainstem surface water temperatures and discharges associated with the movement patterns and timing of spawning of eulachon, average daily surface water temperature of the mainstem Susitna River at RM 4.5 and mean daily discharge of mainstem Susitna River at Susitna Station (USGS 1983 provisional data) were plotted with catch per unit effort (see Barrett, Thompson and Wick, 1984) for the gill net sets at high tides May 10 through June 8, 1983. These data are presented in Figure 11-5.

Table 11-1. Sites and dates at which 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 11-2. 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)
1	830523	8.1	6.6	95	10.2
2	830524	6.5	6.8	93	6.4
3	830524	6.7	6.9	93	8.1
4	830524	6.5	6.9	93	8.6
5	830524	7.5	6.8	94	8.7
6	830524	7.8	6.9	94	8.3
7	830524	7.2	6.9	94	7.3
8	830524	8.6	6.9	96	6.1
9	830524	9.3	6.9	99	6.1
10	830524	8.1	6.8	95	8.9
11	830525	10.8	7.2	98	10.6
12	830525	9.3	7.0	99	10.3
13	830525	7.8	7.0	98	10.3
14	830525	9.8	7.0	101	9.4
15	830525	8.0	6.7	102	5.9
16	830525	9.5	6.8	102	6.5
17	830526	8.6	7.2	103	11.3
18	830526	8.6	7.2	103	10.8
19	830526	9.1	6.8	108	6.2
20	830526	8.8	7.1	103	10.1
	mean:	8.3	6.9	98	8.5
	range:	6.5-10.8	6.7-7.2	93-108	5.9-11.3



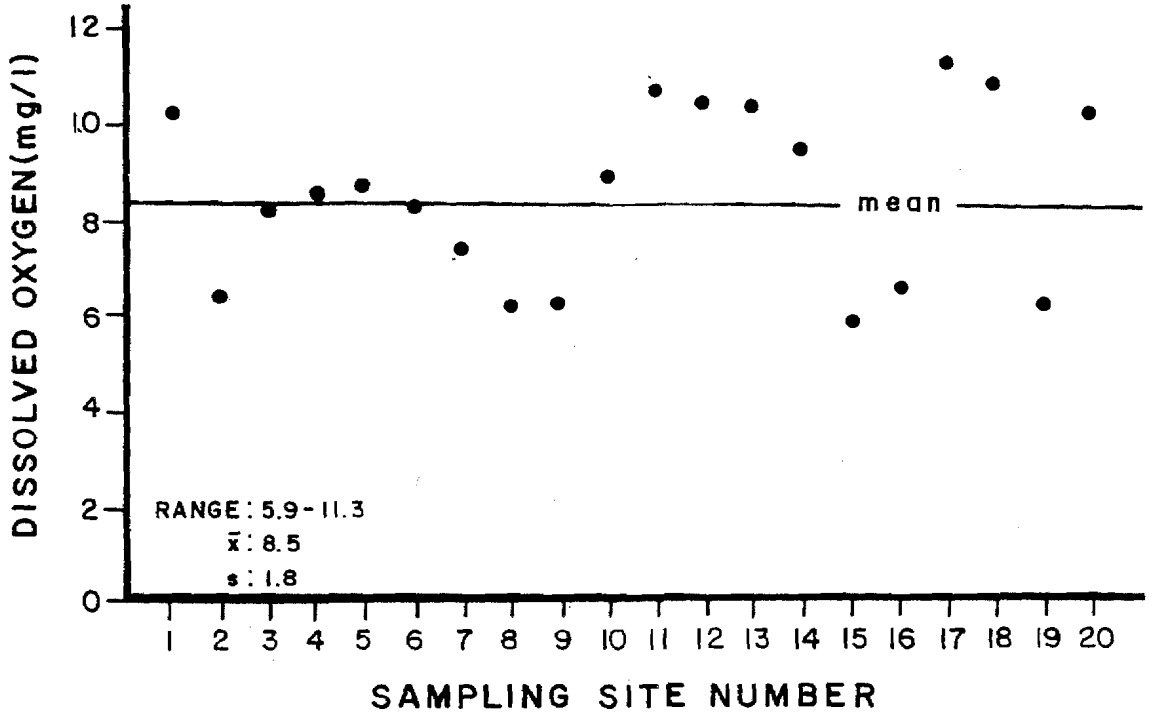


Figure 11-1

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.

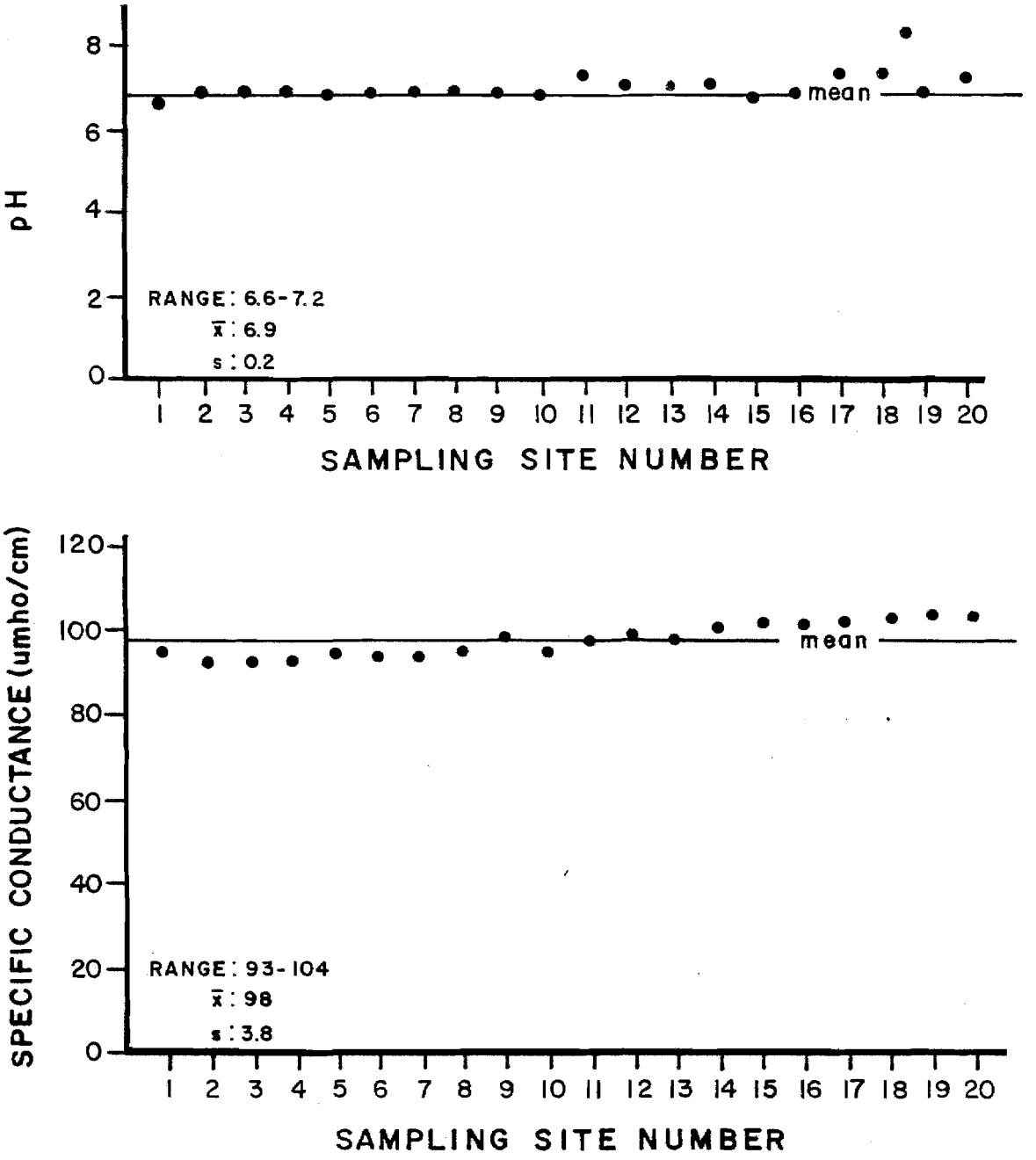


Figure 11-2 Instantaneous measurements of pH and specific conductance collected at sites at which eulachon spawning habitat surveys were conducted on dates field surveys were performed: May 23-26, 1983.

Table 11-3. 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)	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)

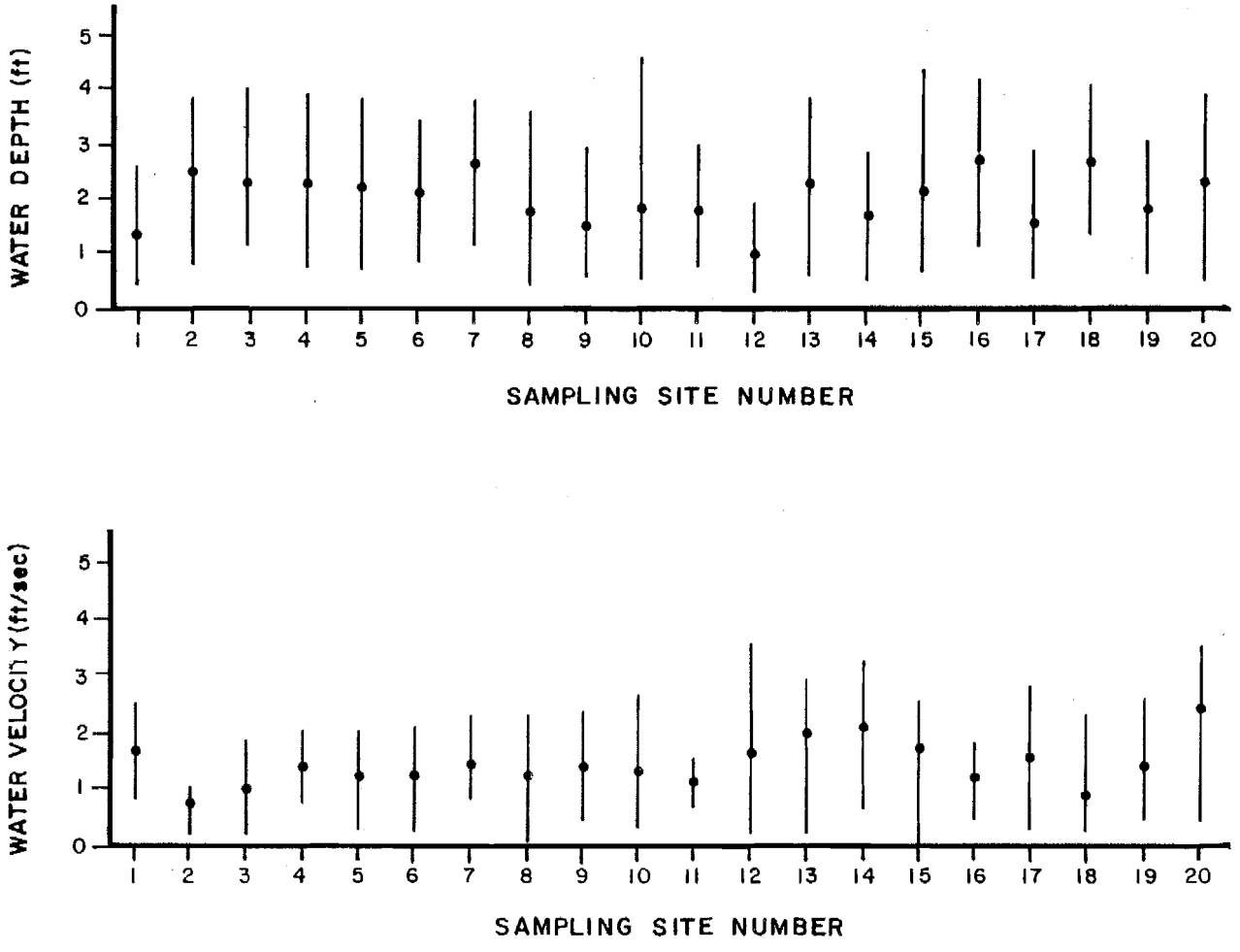


Figure II-3 Means and ranges of water depths and velocities at sites at which eulachon spawning habitat surveys were conducted on dates field surveys were performed: May 23-26, 1983.

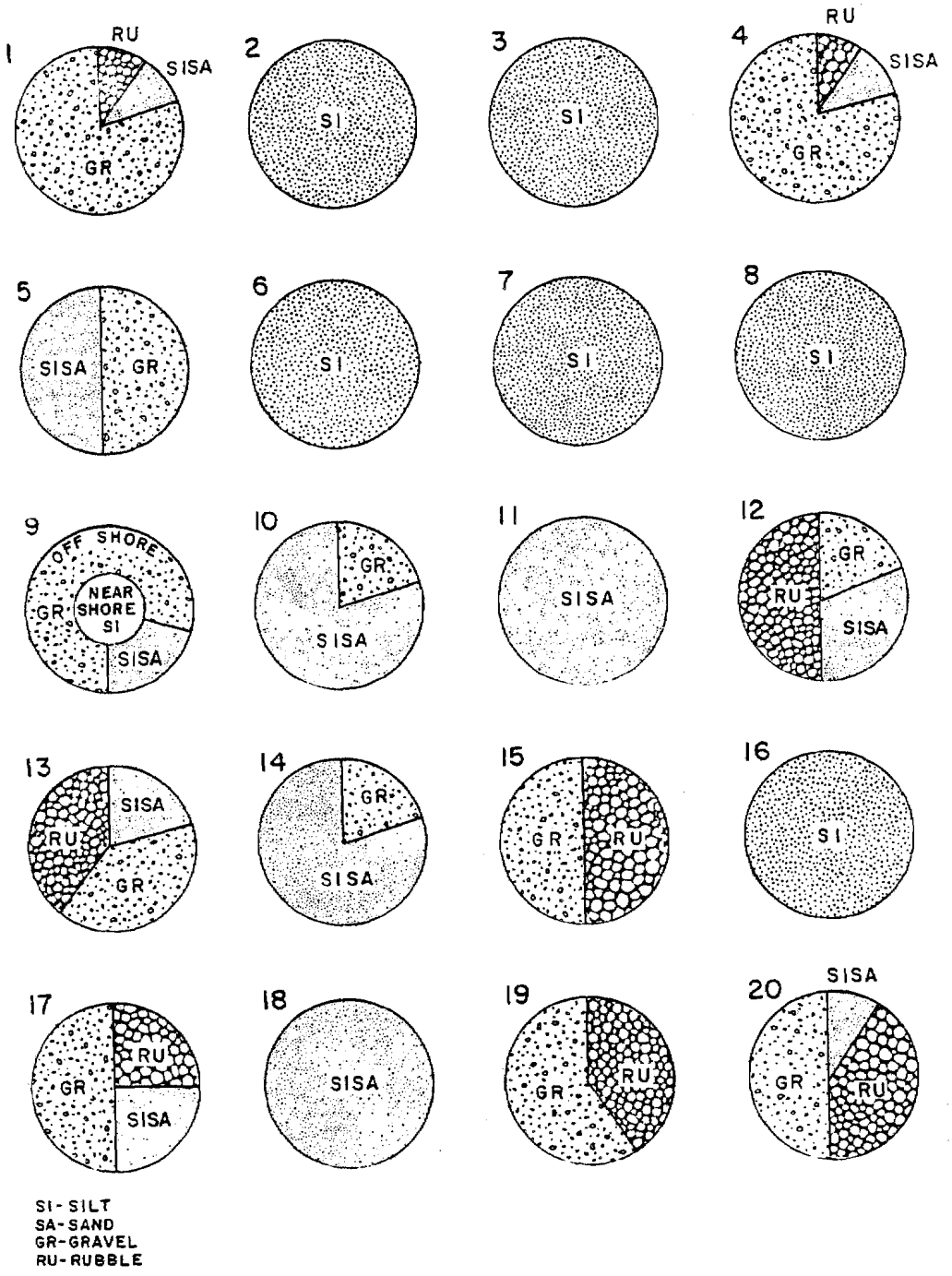


Figure II-4 Compositions of substrates at sites at which eulachon spawning habitat surveys were conducted on dates field surveys were performed: May 23-26, 1983.

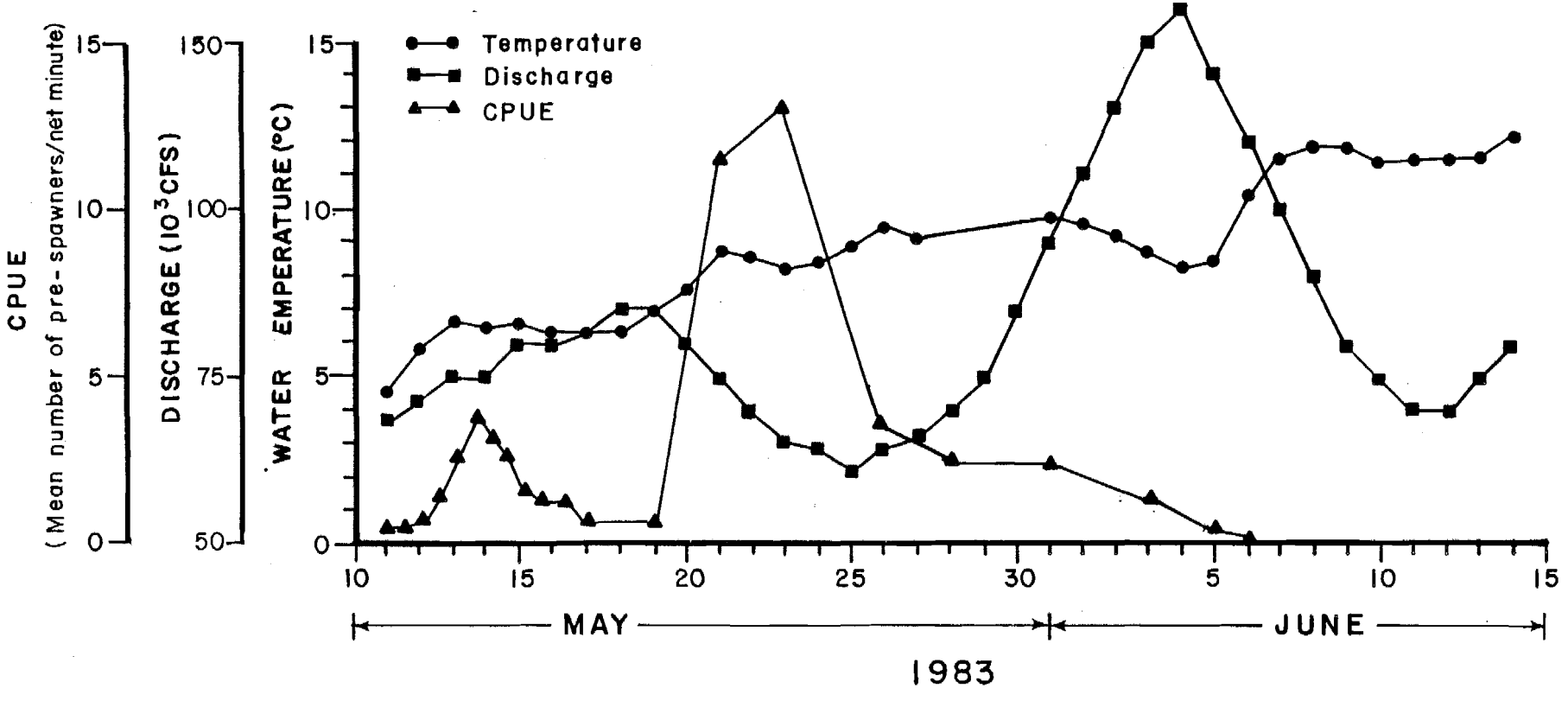


Figure 11-5 Provisional mainstem discharge of the Susitna River (USGS provisional data) at Susitna Station and daily mean surface water temperature of the Susitna River at RM 4.5 compared at catch per unit effort for the gill net set at RM 5.0: (see Report #1 of this report series) May 11-June 14, 1983.

To determine water depths and velocities utilized and preferred for spawning, frequency distributions of measured instantaneous water depths and velocities were constructed. 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) in Figures 11-6a and 11-6b. The 1982 and 1983 data were combined to form an overall data base for the years 1982 through 1983 in Figure 11-6c. 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) in Figure 11-7a and 11-7b. The 1982 and 1983 data were combined to form an overall data base for the years 1982 through 1983 in Figure 11-7c.

A representative sub-sample of the surveyed eulachon spawning sites were chosen for further study (Table 11-4) to determine whether physical habitat conditions similar to those that were present at the time of eulachon spawning might exist under different mainstem flow conditions. At each of these sites, survey data were collected along two study transects to develop streambank/streambed profiles. These profiles are presented in Appendix Figures 11-A-21 through 11-A-26. Water surface elevations were obtained on each transect when spawning occurred and during subsequent visits to determine the effect of different mainstem discharge levels on water surface levels at each cross section. These data are provided as insert tables in each appendix figure. Measurements of instantaneous water depths and velocities were also obtained at the time of eulachon spawning at each study site selected for further study. Frequency distributions of these instantaneous water depths and velocities obtained at the time of spawning at

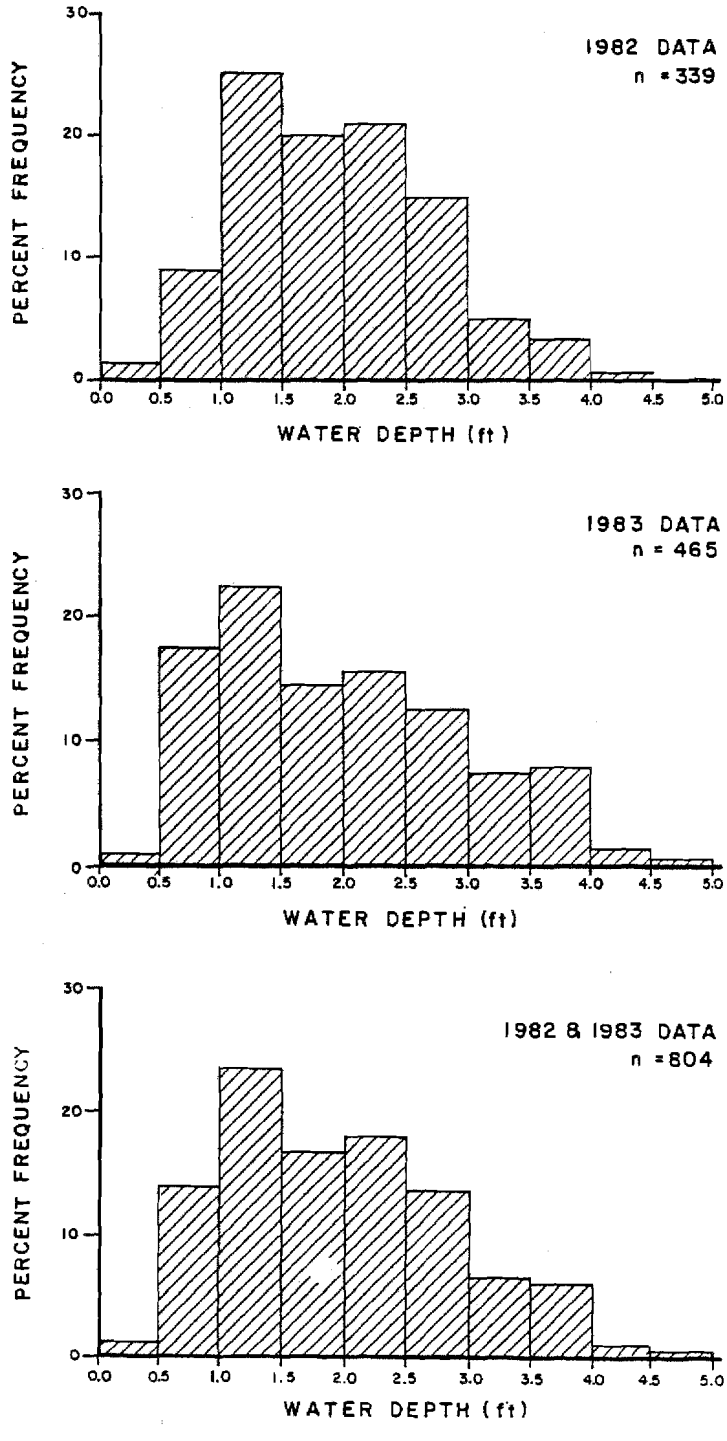


Figure 11-6

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).

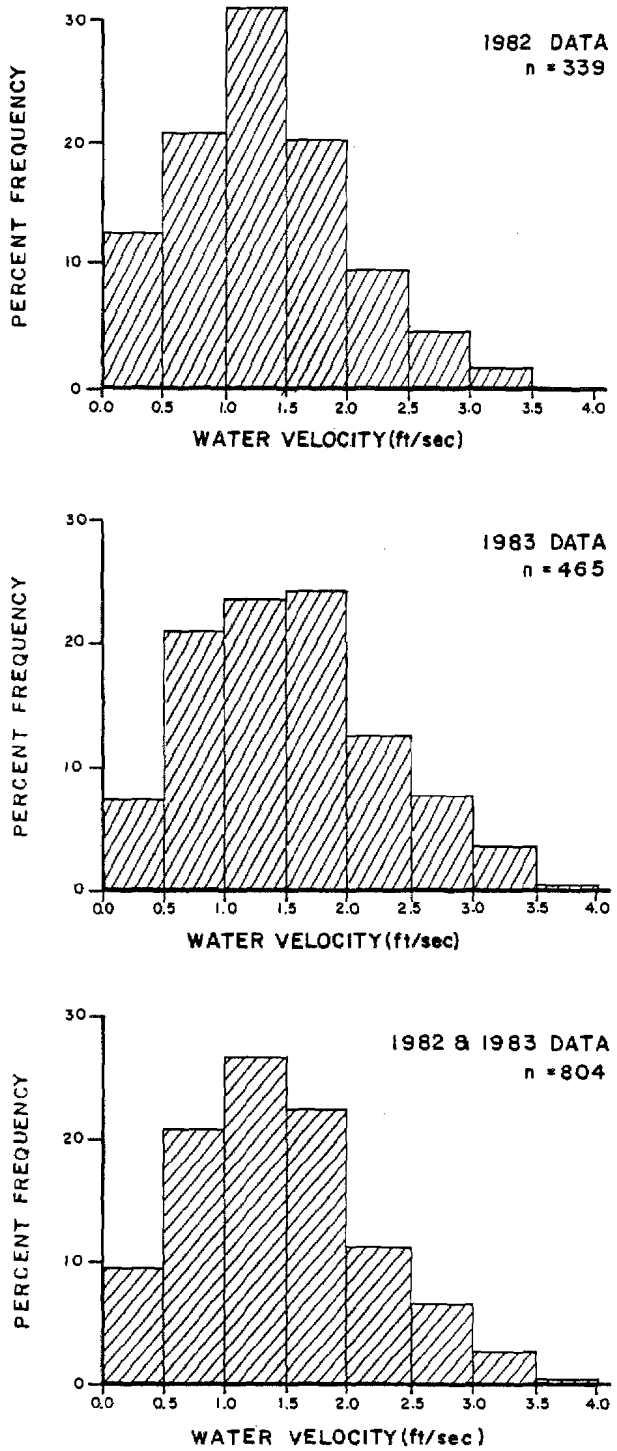


Figure 11-7

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).

Table 11-4. 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

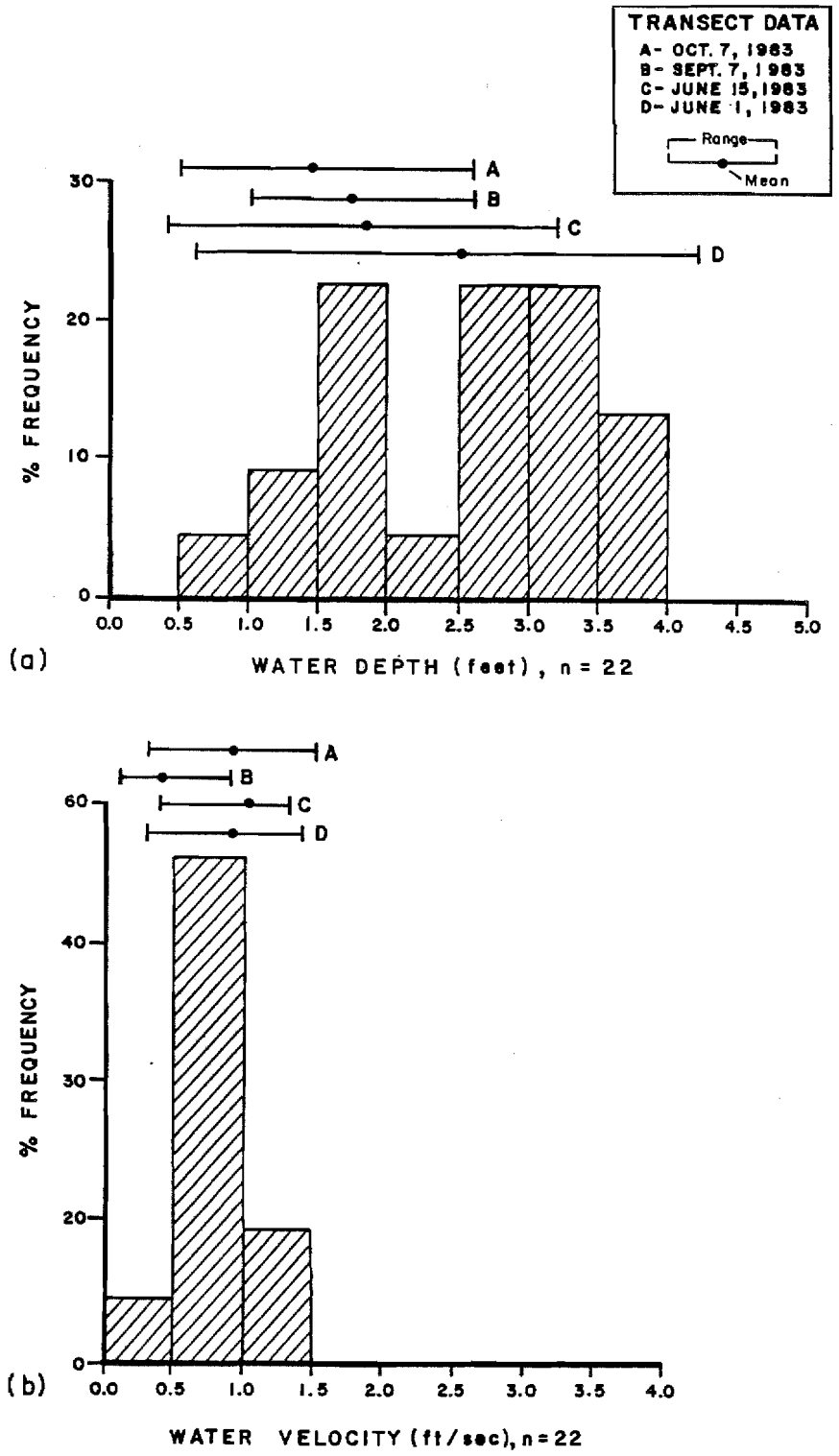


Figure 11-8

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. Ranges and means of instantaneous water depths and velocities measured along study transects during subsequent visits are also shown.

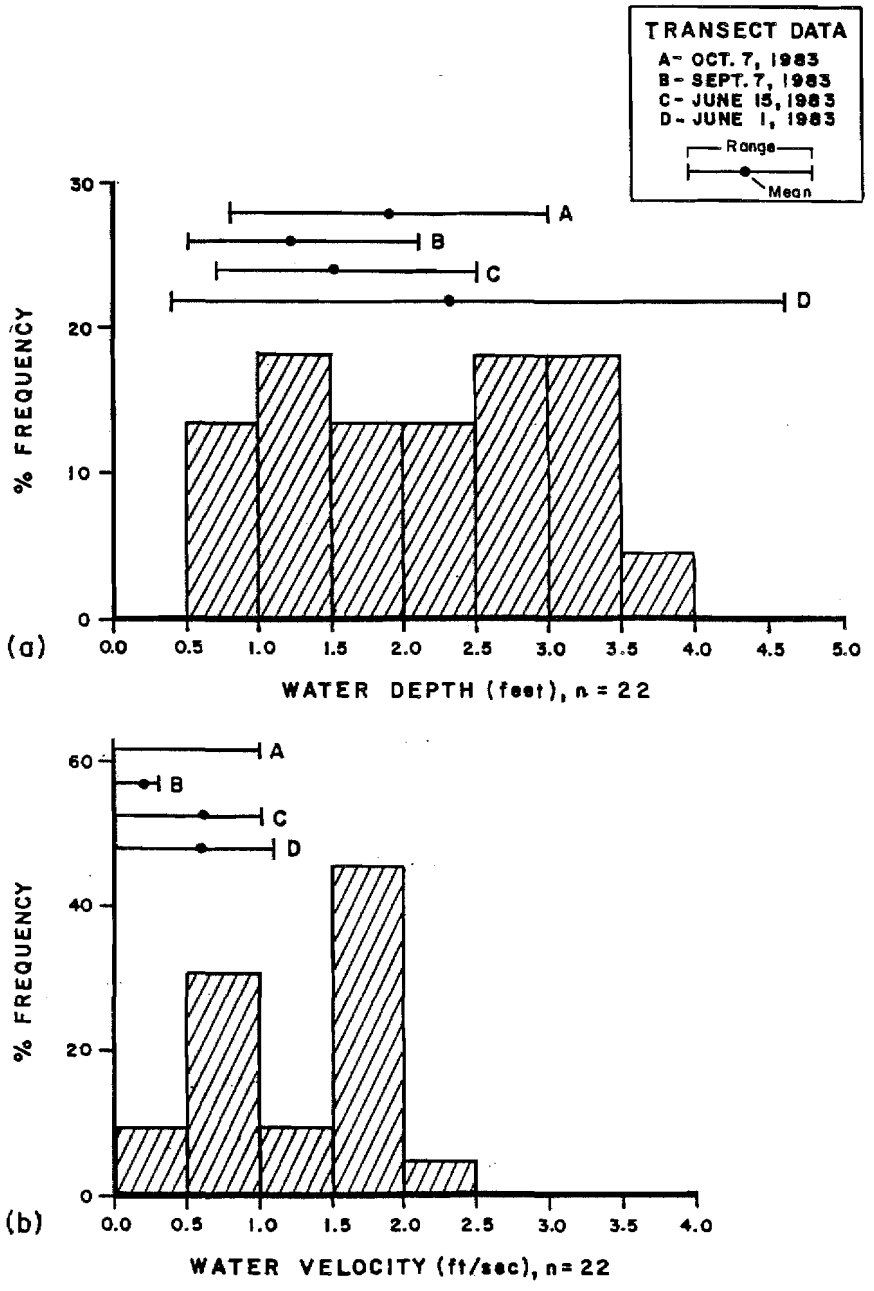


Figure 11- 9

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 16.2. Ranges and means of instantaneous water depths and velocities measured along study transects during subsequent visits are also shown.

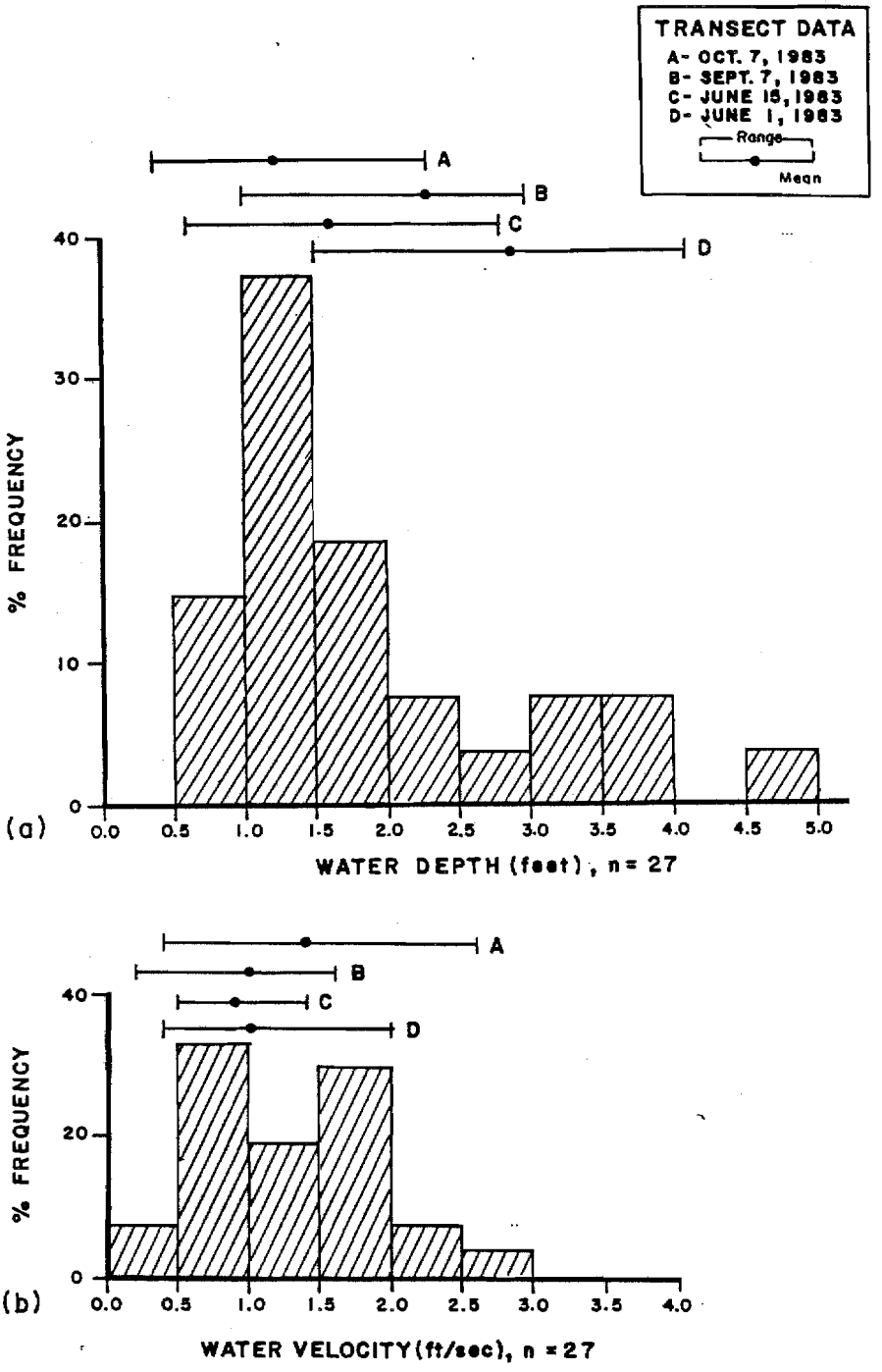


FIGURE 11-10 Frequency distributions of instantaneous water depths (A) and velocities (B) obtained at the time of eulachon spawning at the eulachon spawning study site at RM 23.0. Ranges and means of instantaneous water depths and velocities measured along study transects during subsequent visits are also shown.

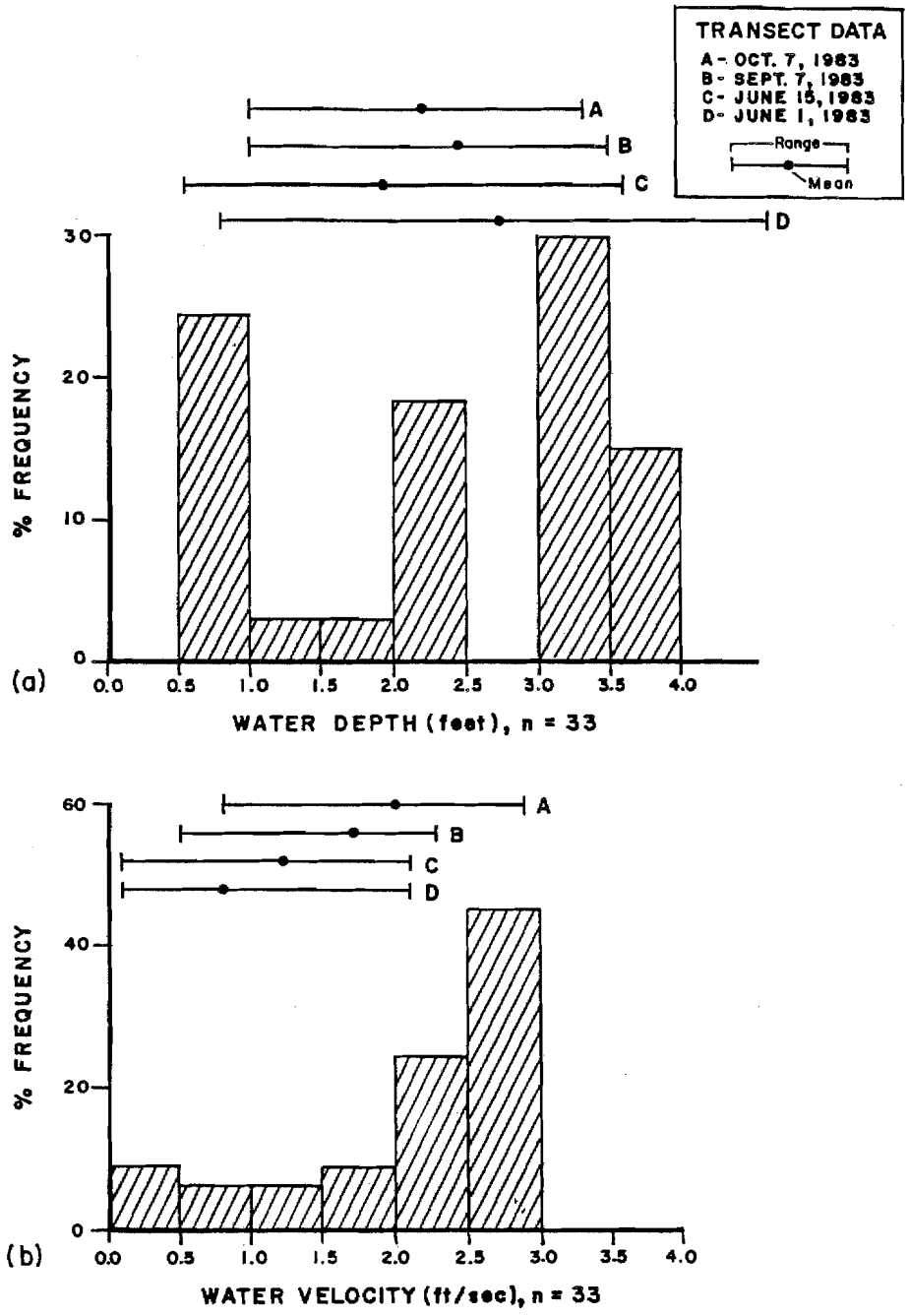


Figure 11 - 11

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 23.1. Ranges and means of instantaneous water depths and velocities measured along study transects during subsequent visits are also shown.

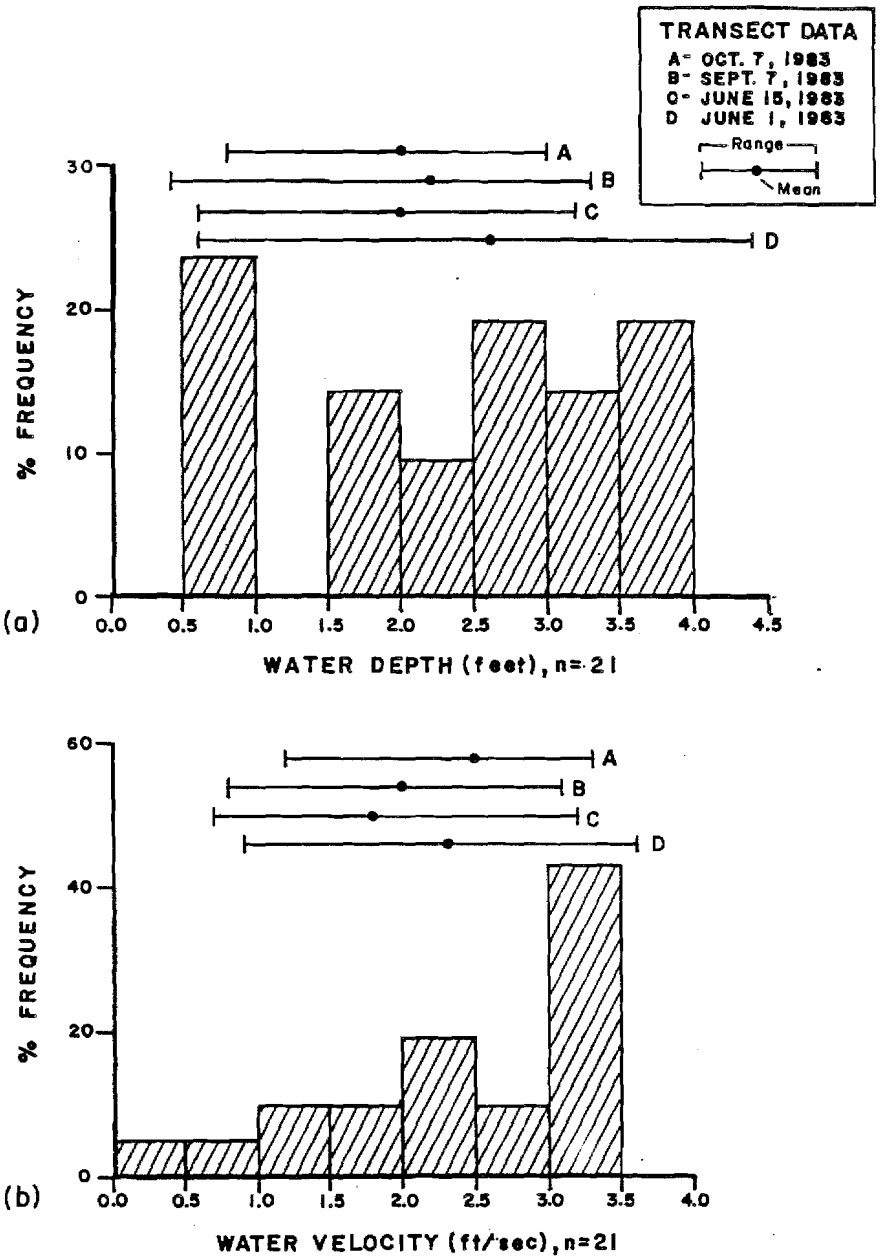


Figure II-12

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. Ranges and means of instantaneous water depths and velocities measured along study transects during subsequent visits are also shown.

these sites are presented in Figures 11-8 through 11-12. Additional instantaneous water depth and velocity measurements were collected along study transects during subsequent samplings at different mainstem discharge levels. Ranges and means of instantaneous water depths and velocities obtained during subsequent samplings are also presented on Figures 11-8 through 11-12.

4.0 DISCUSSION

Based on 1982 (ADF&G 1983a) and 1983 (Report #1 of this report series) catch data at gillnet sets in the tidally influenced zone of the mouth of the Susitna River, eulachon begin their spawning migration into the Susitna River during early to mid May. The earliest capture of eulachon during 1982 and 1983 occurred on May 16 and May 11, respectively. Because both these dates correspond to the first sampling effort for 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, the second or later run was larger than the first or earlier 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 shows 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. For example, the surface water temperature of the mainstem did not reach 6°C until May 29 in 1982 while in 1983 it reached 6°C on May 21. 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 (Figure 11-5).

During 1983, eulachon were observed from the mouth of the Susitna River (RM 0) to a point upstream on the east channel of the Susitna River to RM 50.3. This compares to 1982 findings which showed an upstream limit of migration to RM 49.5 (ADF&G 1983a).

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

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

Eulachon have been reported to spawn over course sand and pea-sized gravel in water up to 7.6 feet deep. (Morrow 1980). During both 1982 and 1983, spawning occurred throughout the mainstem Susitna River and its associated side channels below RM 45.0. Bar and riffle zone were most commonly utilized. No spawning was documented in clear water tributaries or sloughs during either 1982 or 1983. Based on 1982 (ADF&G 1983b) and 1983 habitat data collected at spawning sites, the habitat requirements necessary for

eulachon spawning appear quite broad. Substrates used for spawning during 1982 (ADF&G 1983b) and 1983 (Figure 11-4) 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.

The mean water depth measured at surveyed spawning sites during 1983 (Table 3) ranged from 1.1-2.7 feet with the range of depths varying at all survey sites from 0.3-4.5 feet over a range of mainstem discharges from 62,000 - 64,000 cfs as measured at the USGS Susitna Station monitoring station. These values compare with values obtained during the 1982 study of 1.1-3.1 feet and 0.3-4.3 feet, respectively (ADF&G 1983b) over a range of mainstem discharges from 65,000 - 110,000 cfs as measured at the USGS Susitna Station monitoring station. Frequency distributions of water depths measured at surveyed spawning sites during 1982 and 1983 show that depths ranging from 0.5-3.0 feet appear to be preferred (i.e., 10% frequency) for spawning (Figure 11-6).

The mean water velocity measured at surveyed spawning sites during 1983 (Table 3) ranged from 0.7-2.4 feet/second with the range of velocities varying at all survey sites from 0.0-3.4 feet/second over a range of mainstem discharges from 62,000 - 64,000 cfs as measured at the USGS Susitna Station monitoring station. These values compare with values obtained during the 1982 study of 0.6-1.9 feet/second and 0.0-3.2 feet/second, respectively (ADF&G 1983) over a range of mainstem discharges from 65,000 - 110,000 cfs as measured at the USGS Susitna Station monitoring station. Frequency distributions of water velocities measured at surveyed spawning sites during 1982 and 1983 show that water velocities ranging from 0.5-2.5 feet/second appear to be preferred (i.e., 10% frequency) for spawning (Figure 11-7).

Water temperatures at spawning sites surveyed during 1982 (ADF&G 1983b) and 1983 (Table 11-2) ranged from 6.2-11.2°C with a mean of 8.5°C with a mean of 8.3°C, respectively. These observed water temperatures are higher than previously reported preferred spawning temperatures of 4.7-7.8°C (Morrow 1980).

To determine whether similar suitable physical habitat conditions that were present at the time eulachon spawning occurred might exist at different mainstem flow conditions, a representative number of the surveyed spawning sites were chosen for further study. Based on the data obtained during these studies (Figure 11-8 through 11-17), it appears that similar physical habitat conditions will be present under both decreased and increased mainstem discharge conditions. The data show similar water depths and velocities were available along study transects under both decreased and increased mainstem discharge conditions. These data however should not be interpreted to mean that eulachon spawning will not be affected by the proposed hydroelectric development. Other possible impacts such as altered water temperatures and its impact on timing of eulachon spawning and migration, must first be addressed.

5.0 CONTRIBUTORS

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6.0 ACKNOWLEDGEMENTS

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8.0 APPENDICES

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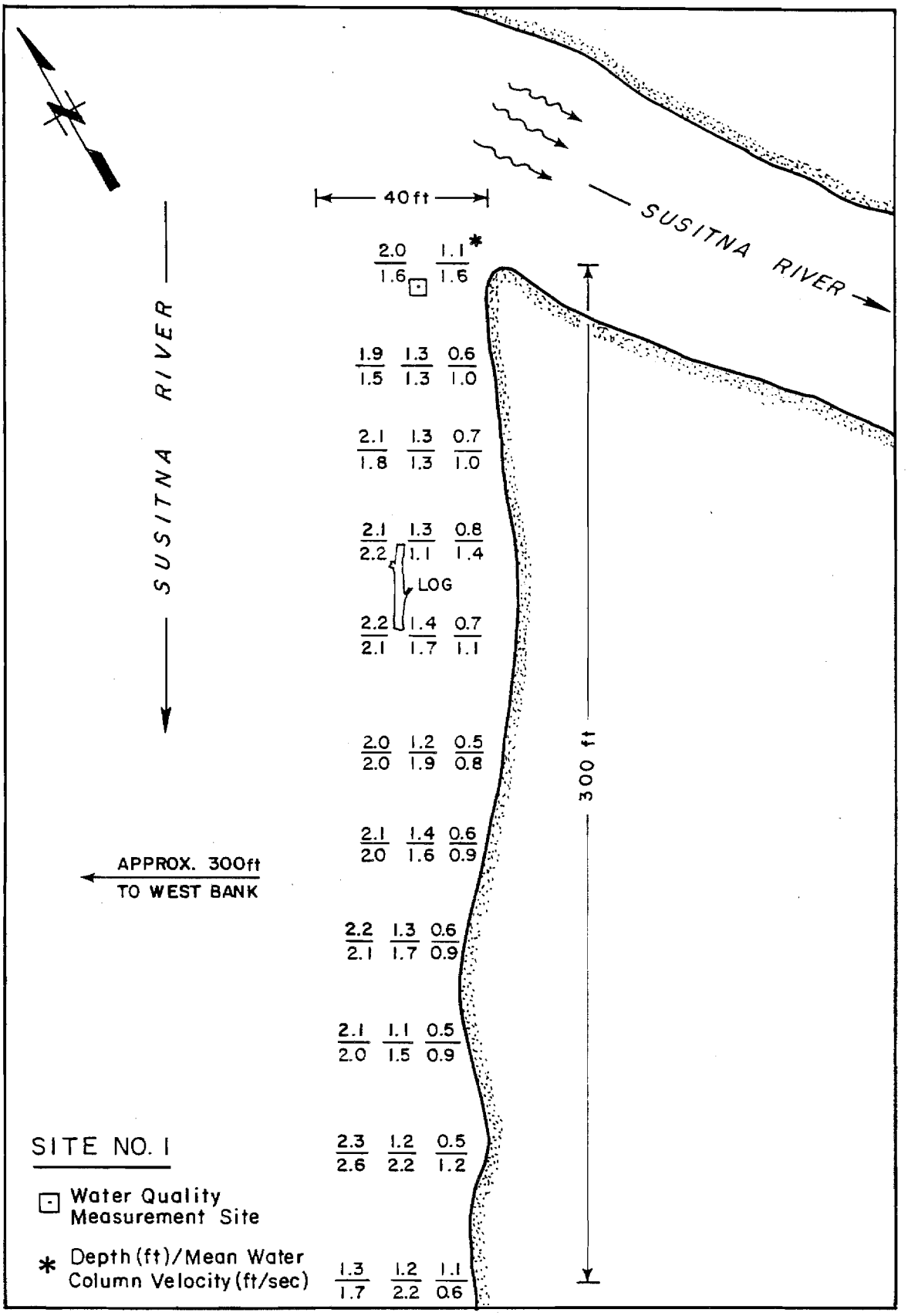


Figure II-A-1 Eulachon spawning area on the Susitna River at RM 21.0 (GC S16N07W09DDB): May 23, 1983.

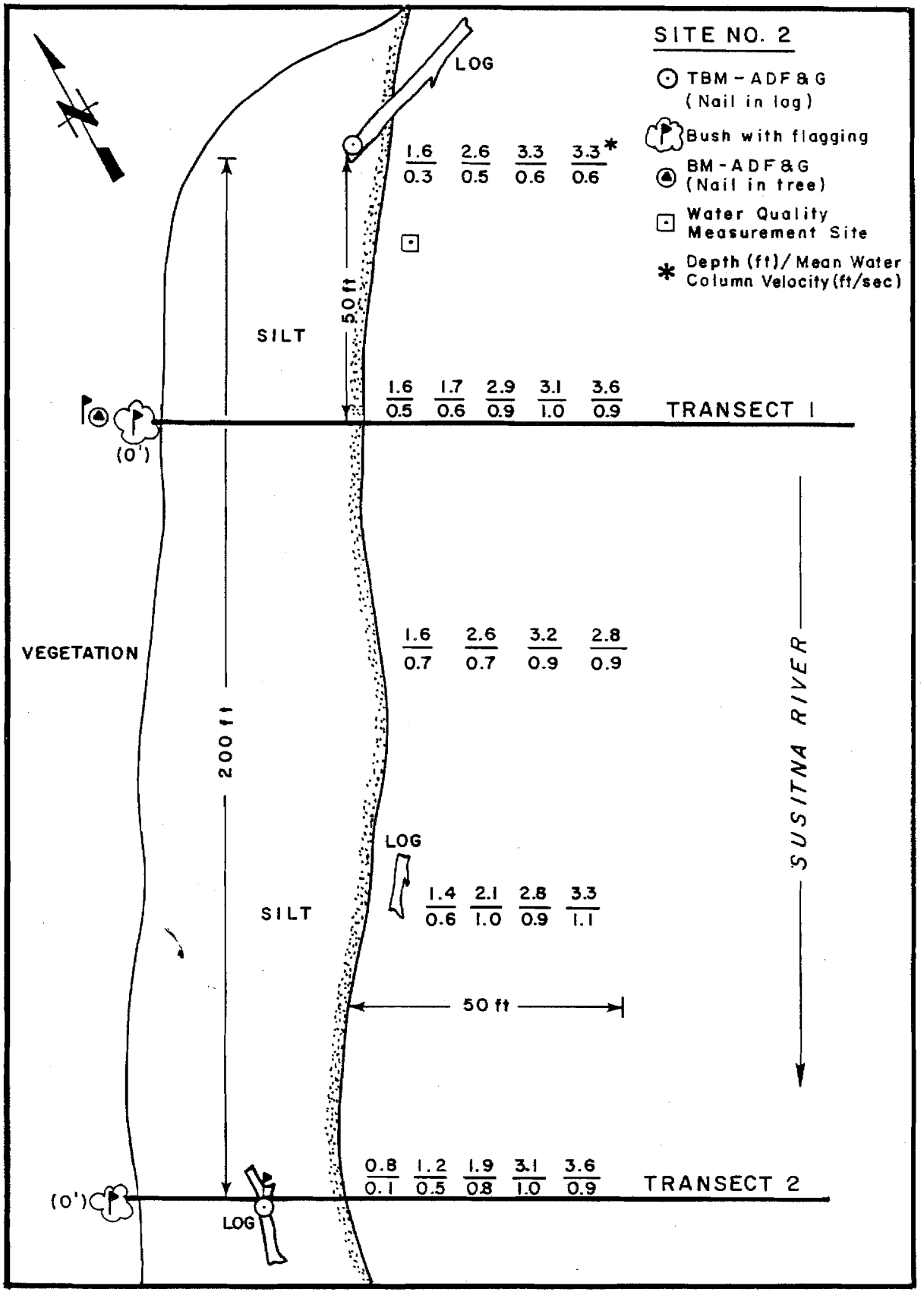
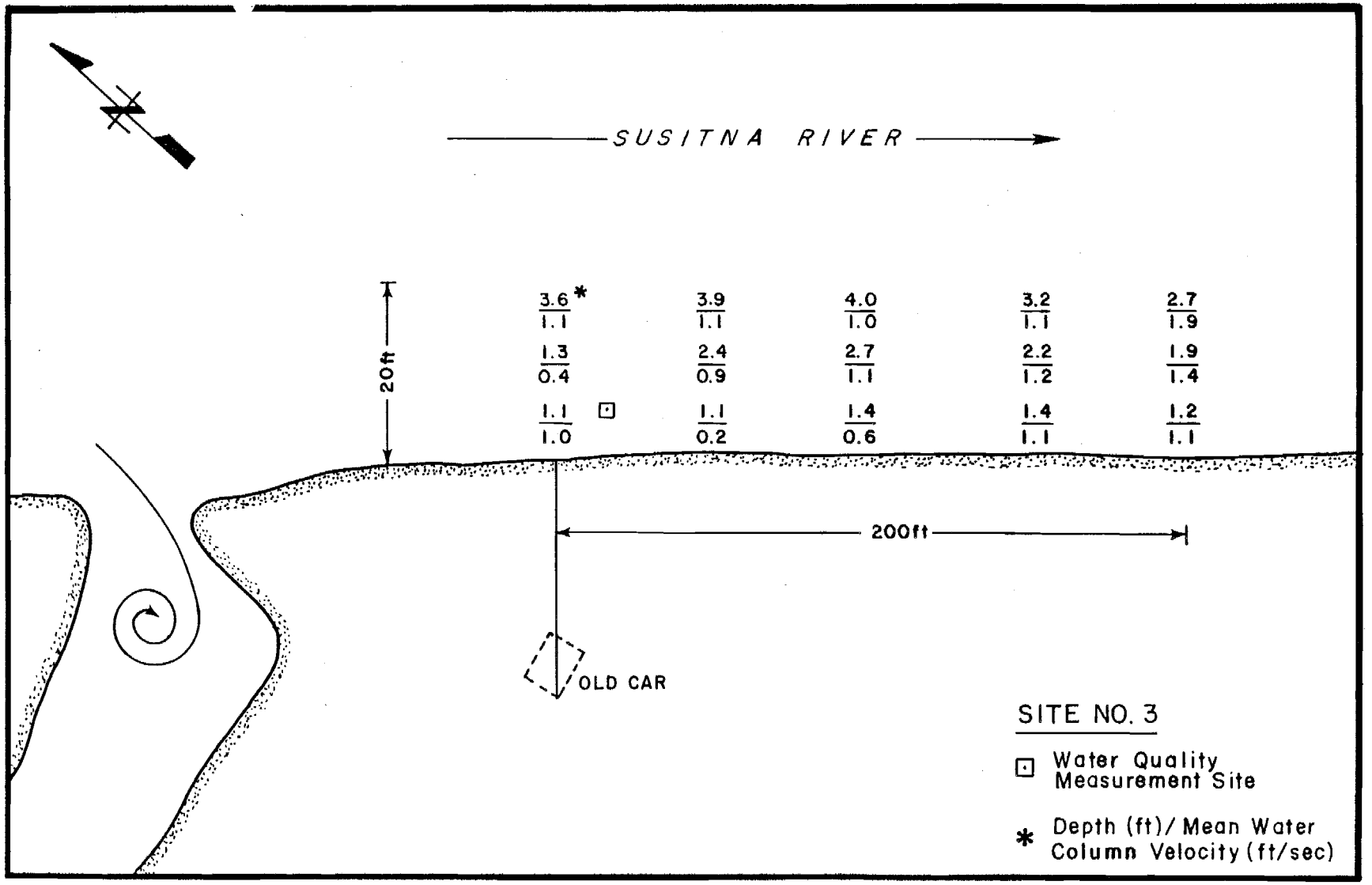


Figure 11-A-2

Eulachon spawning area on the Susitna River at RM 12.8 (GC S15N07W12BCB): May 24, 1983.



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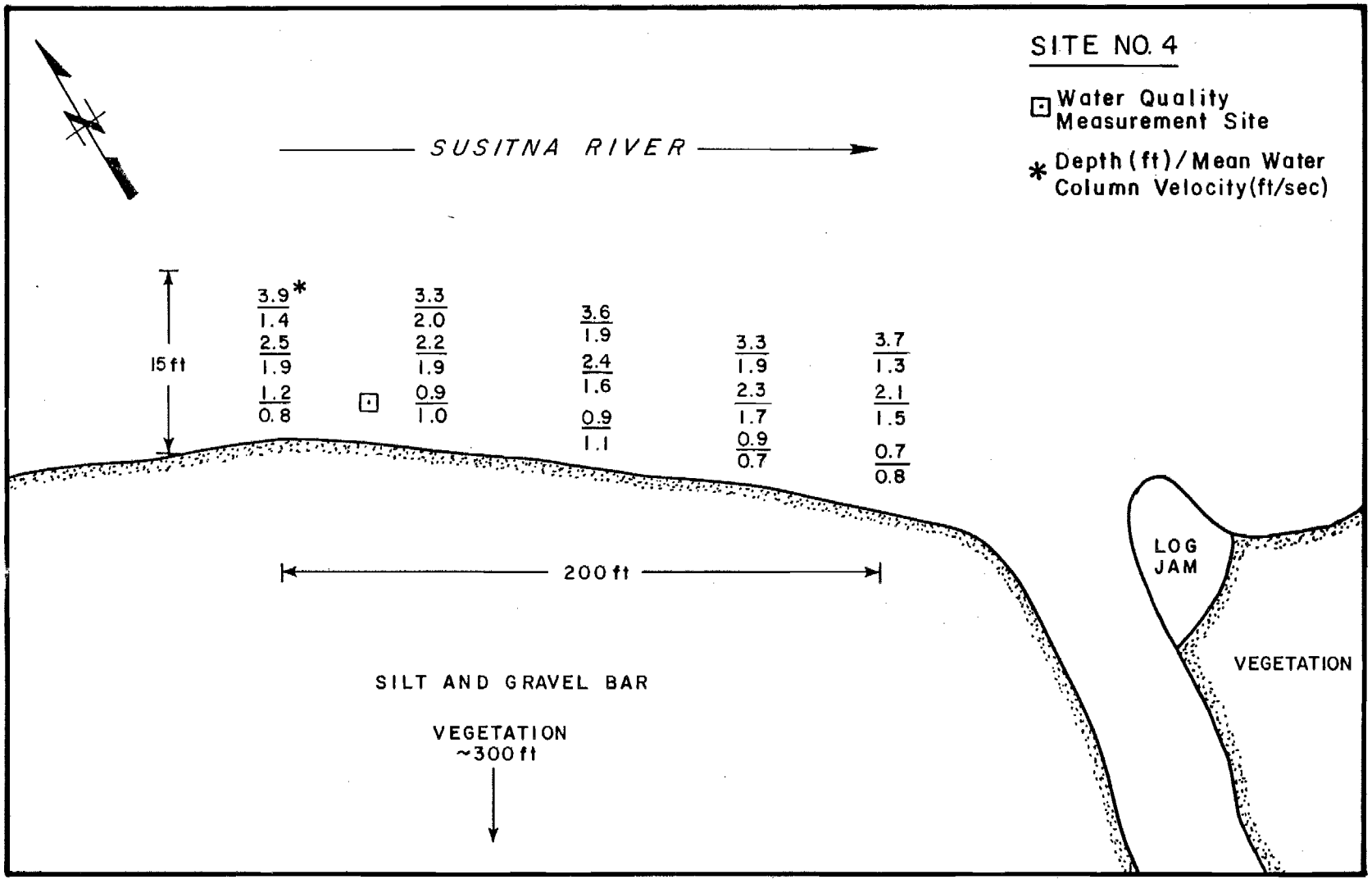
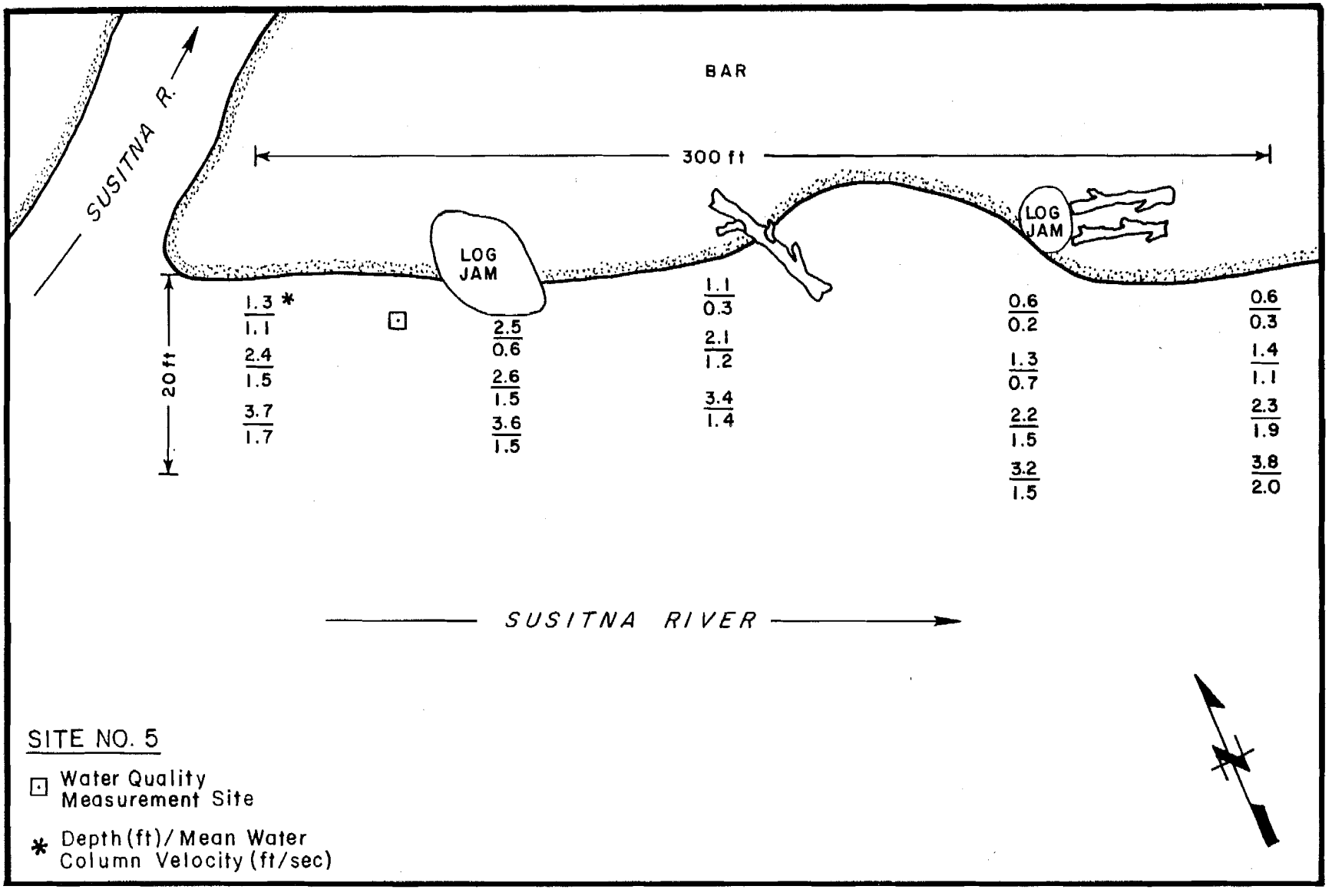


Figure II-A-4 Eulachon spawning area on the Susitna River at RM 15.0 (GC S16N07W35CDA): May 24, 1983.



Eulachon spawning area on the Susitna River at RM 15.0 (GC S16N07W35BDA): May 24, 1983.

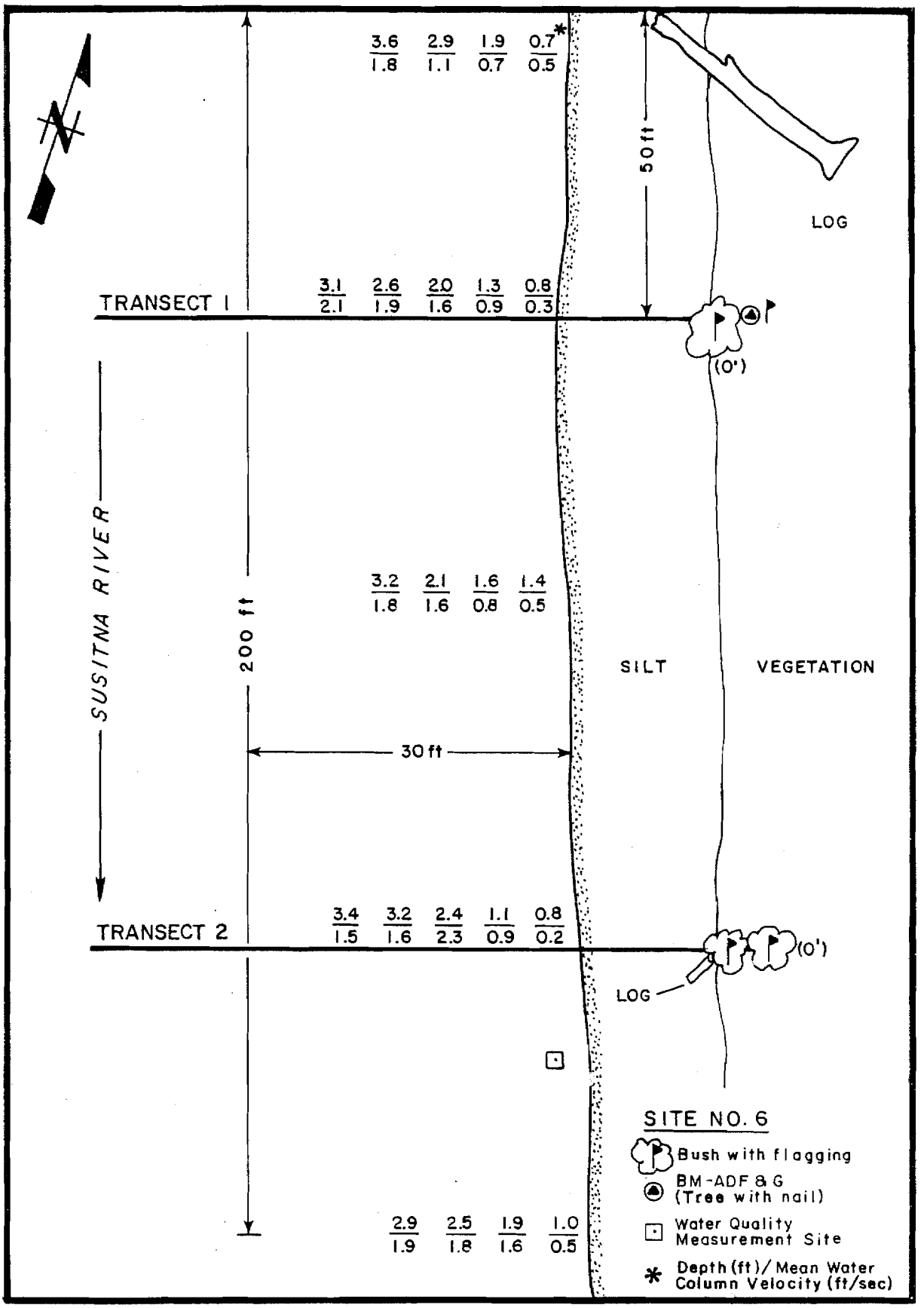
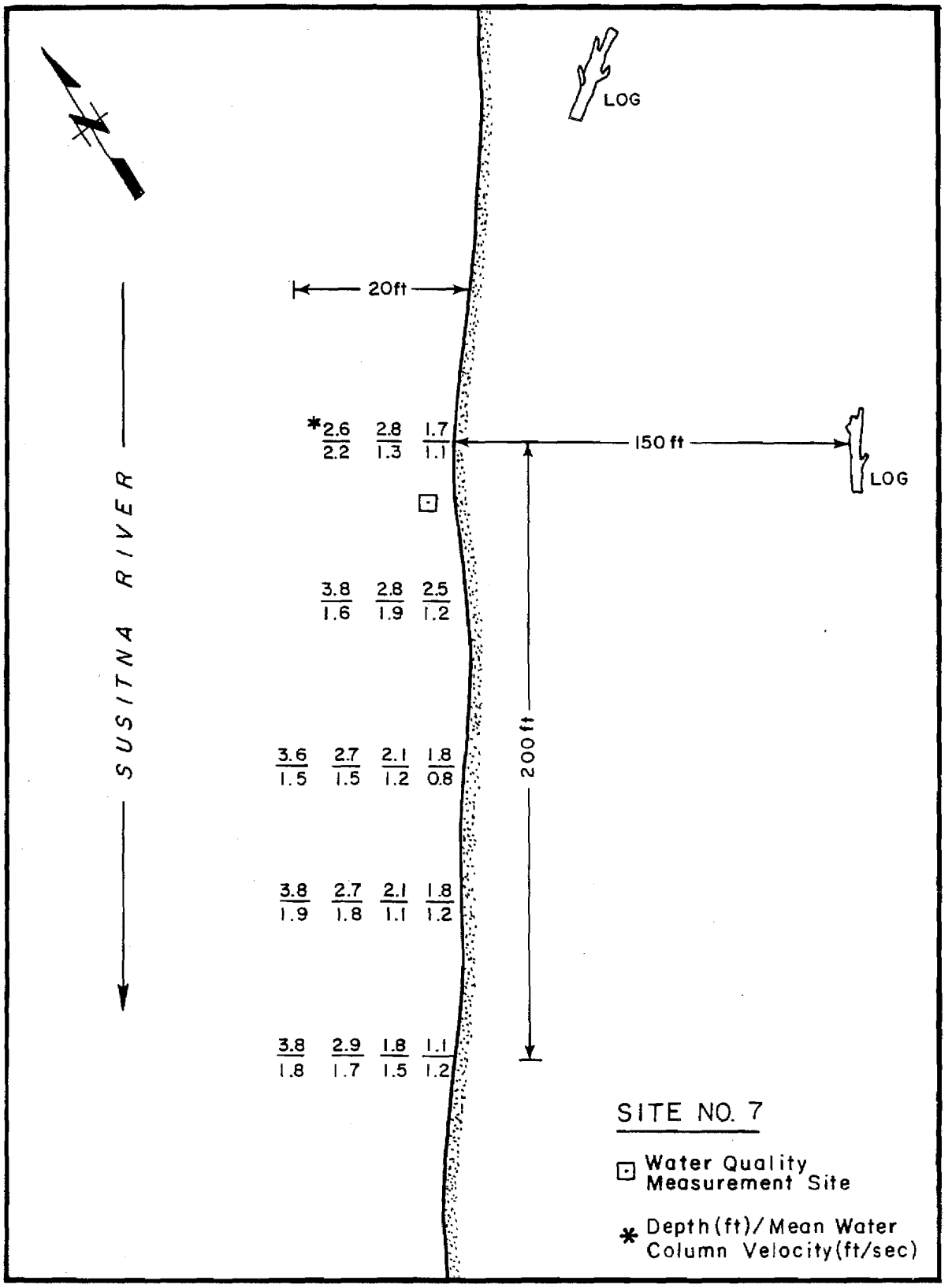


Figure II-A-6 Eulachon spawning area on the Susitna River at RM 16.2 (GC S16N07W26BDB): May 24, 1983.



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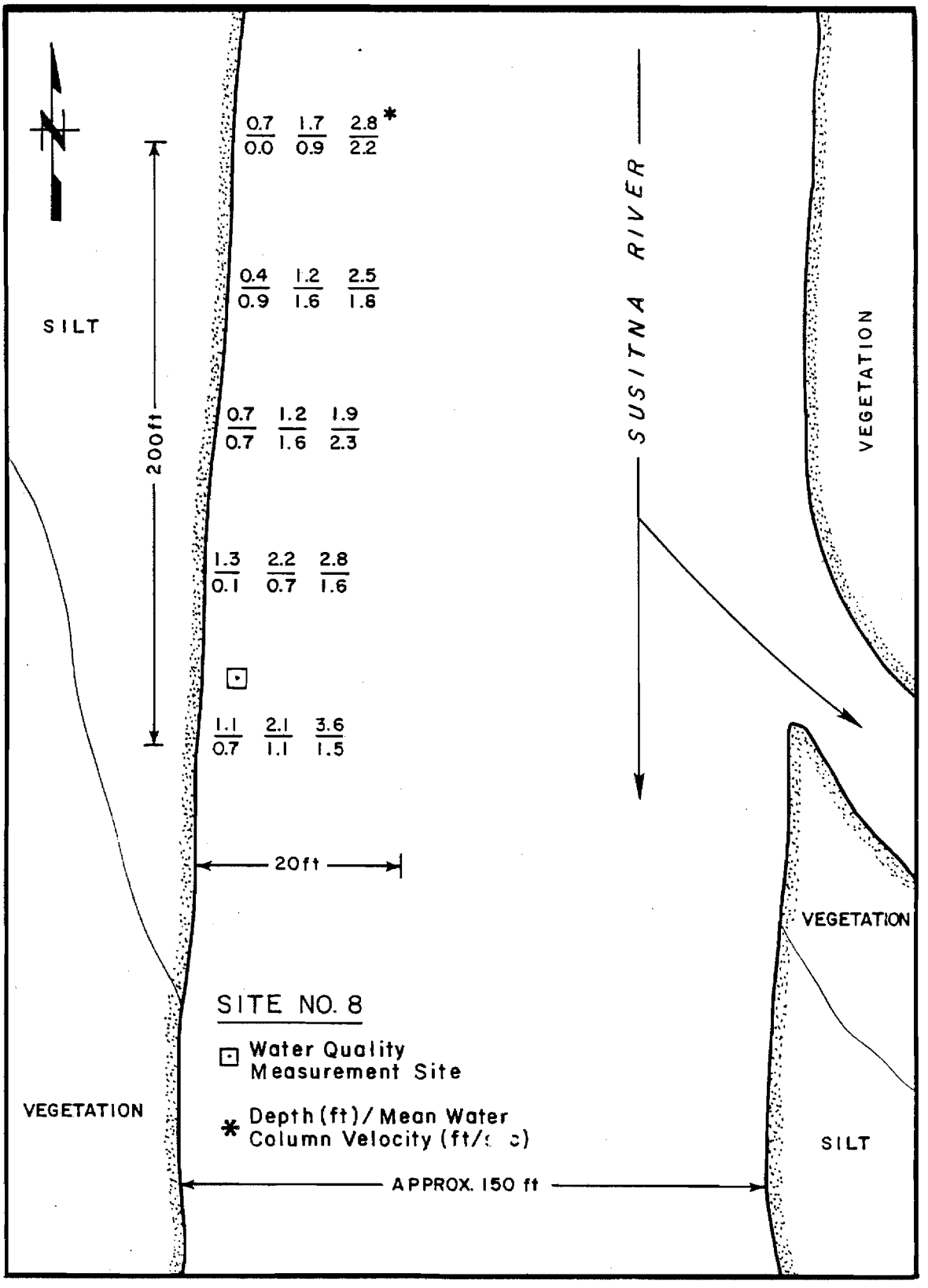

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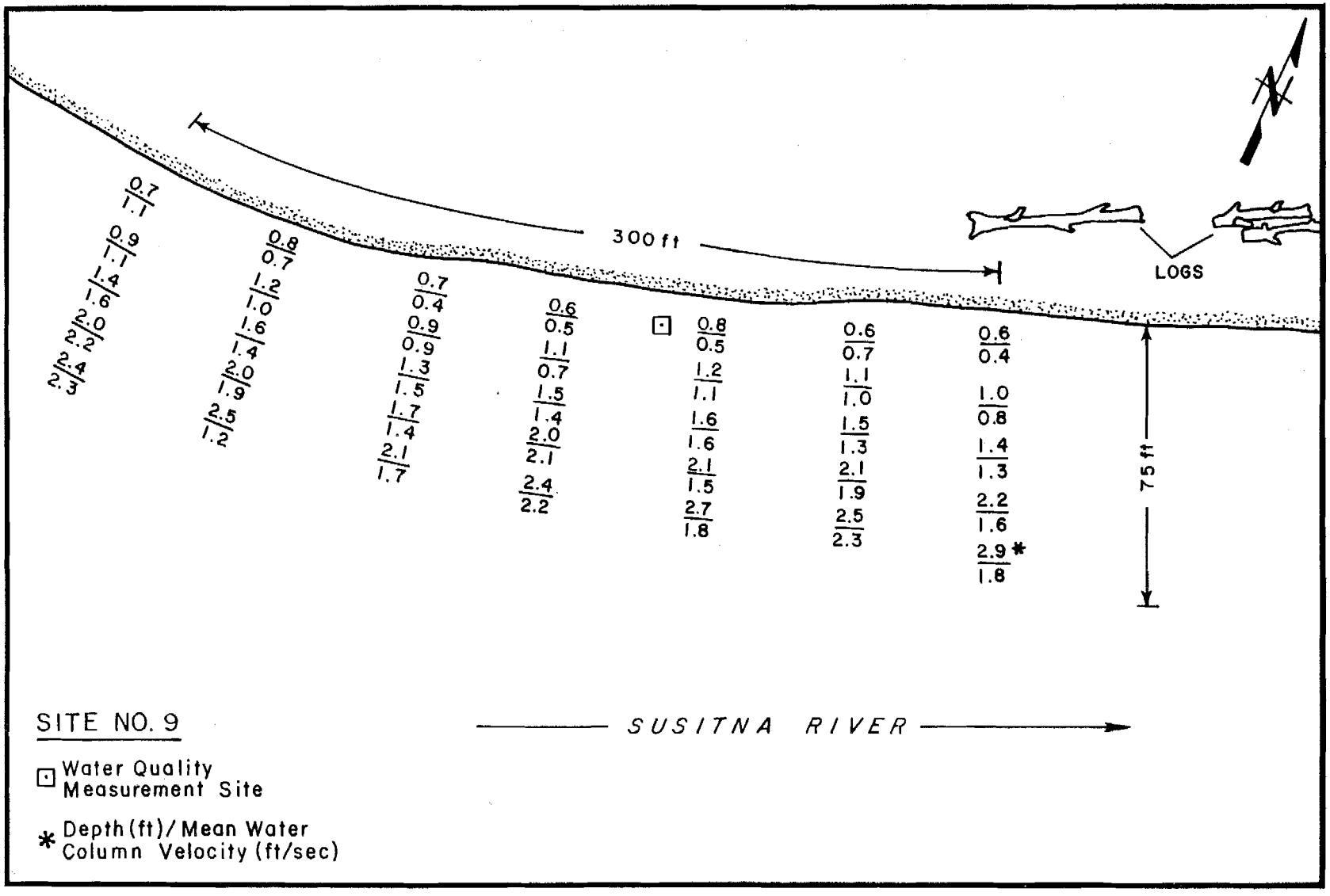

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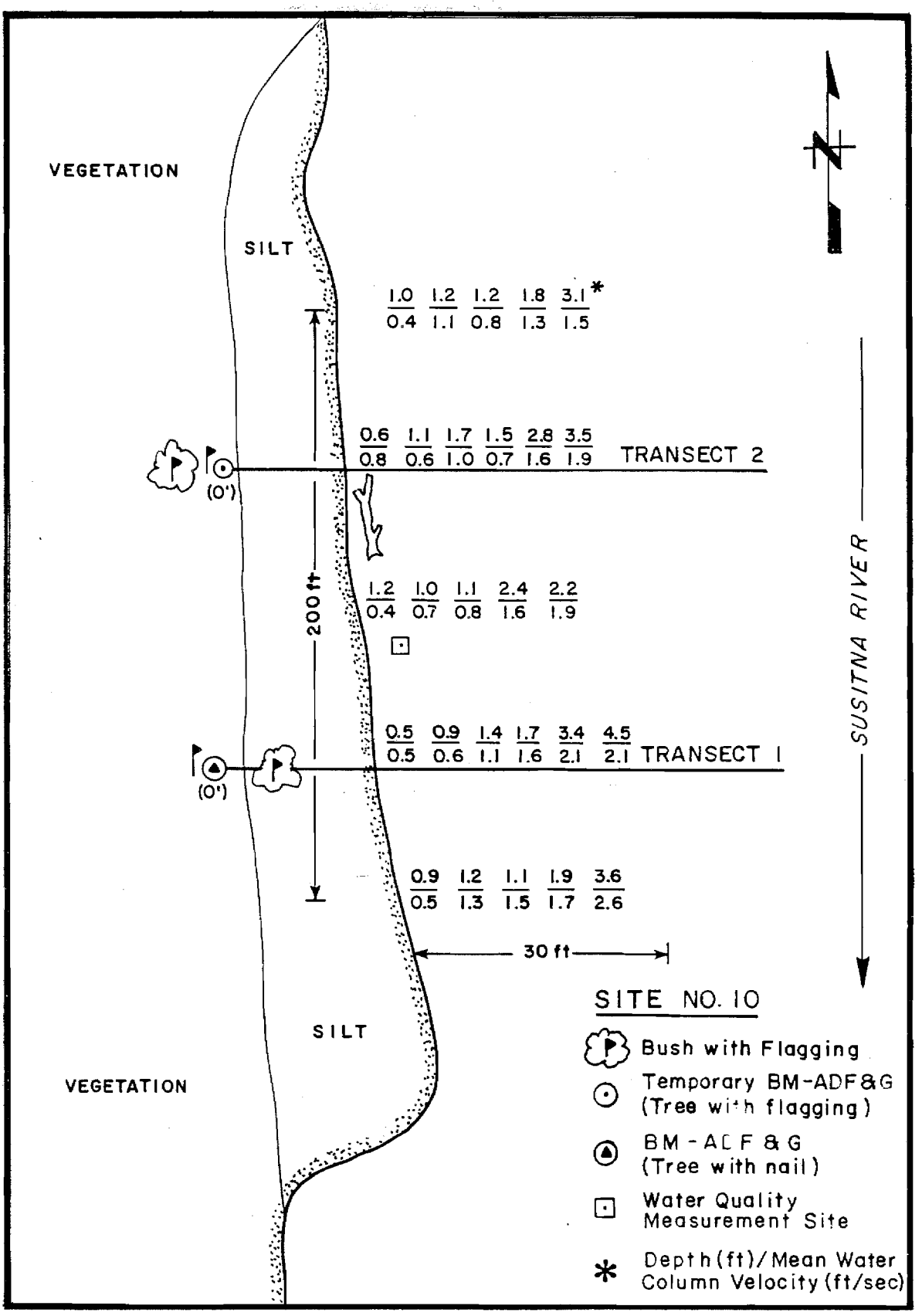


Figure 11-A-10 Eulachon spawning area on the Susitna River at RM 23.0 (GC S17N07W33DBB): May 24, 1983.

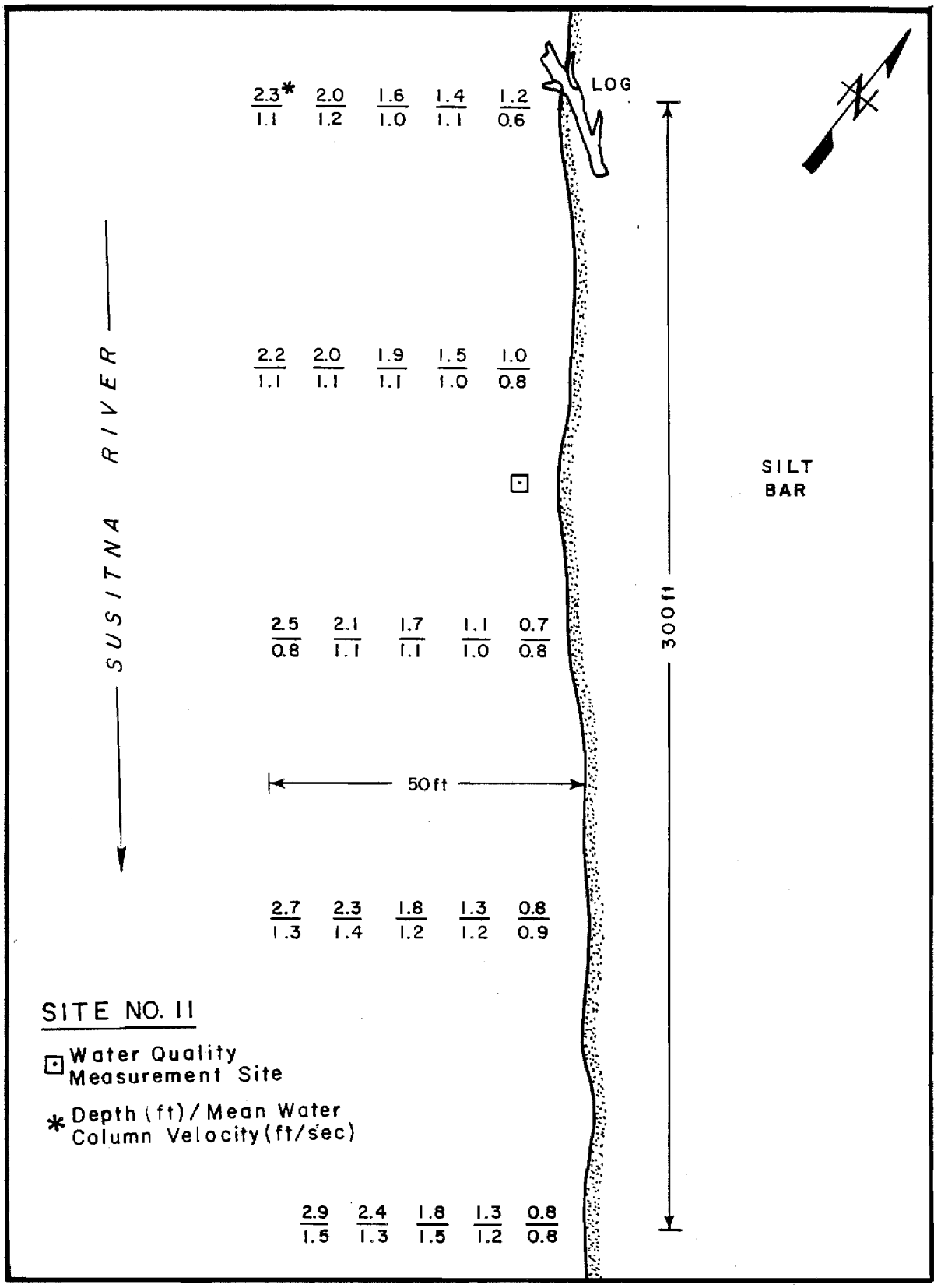
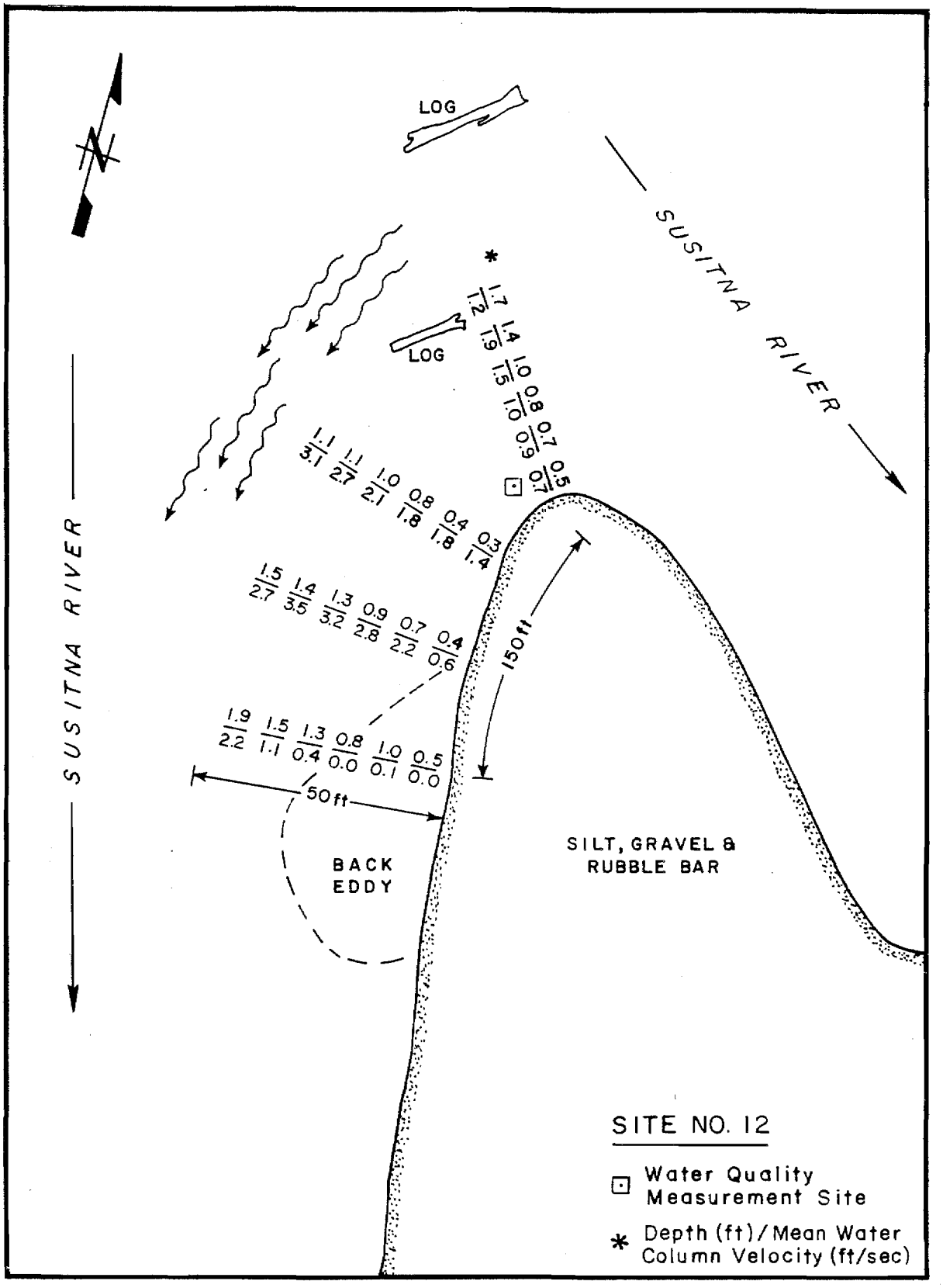


Figure II-A-11 Eulachon spawning area on the Susitna River at RM 20.5 (GC S16N07W08DCA): May 25, 1983.



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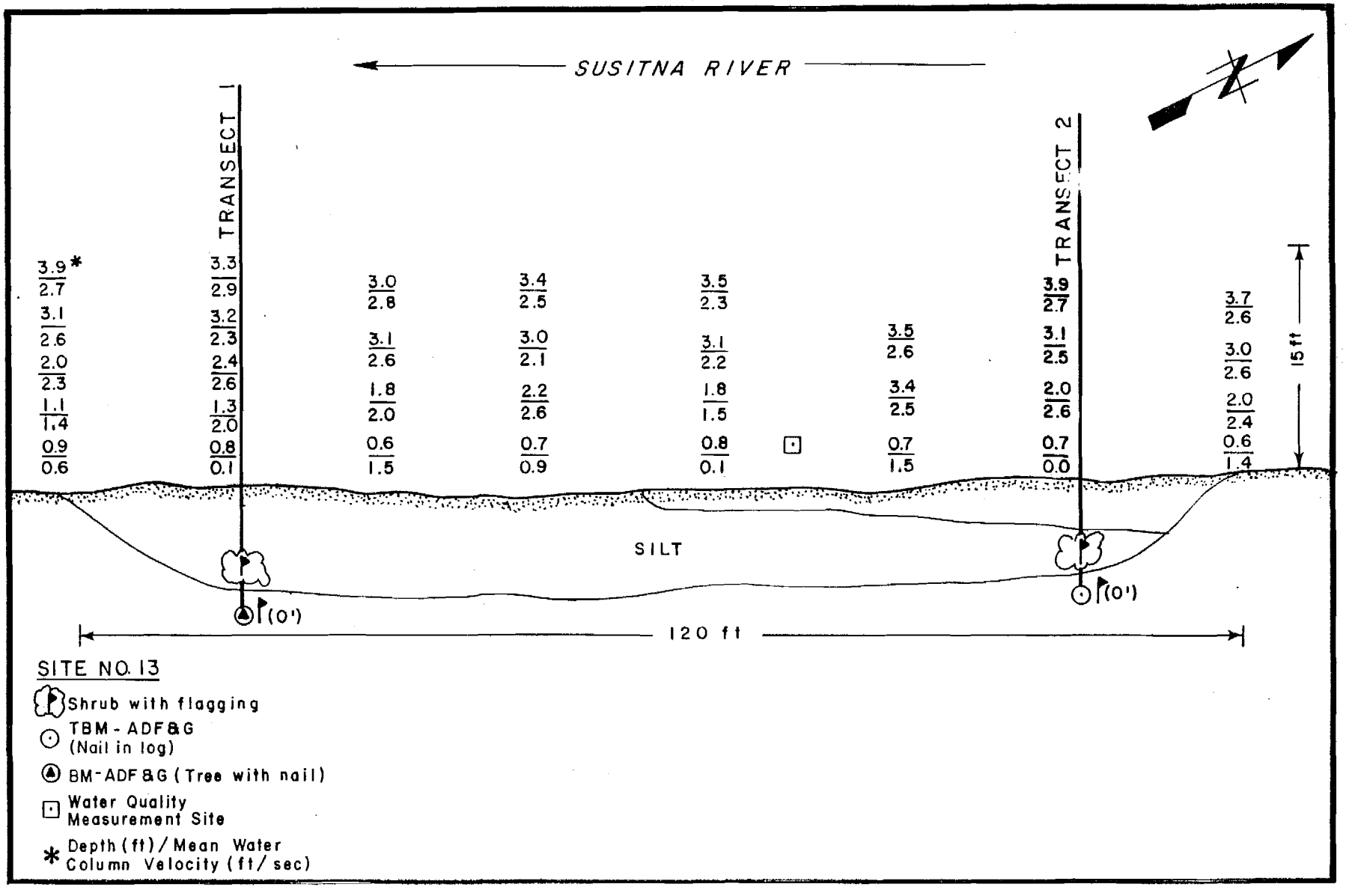


Exhibit II-A-13 Eulachon spawning area on the Susitna River at RM 23.1 (GC S17N07W33BCD): May 25, 1983.

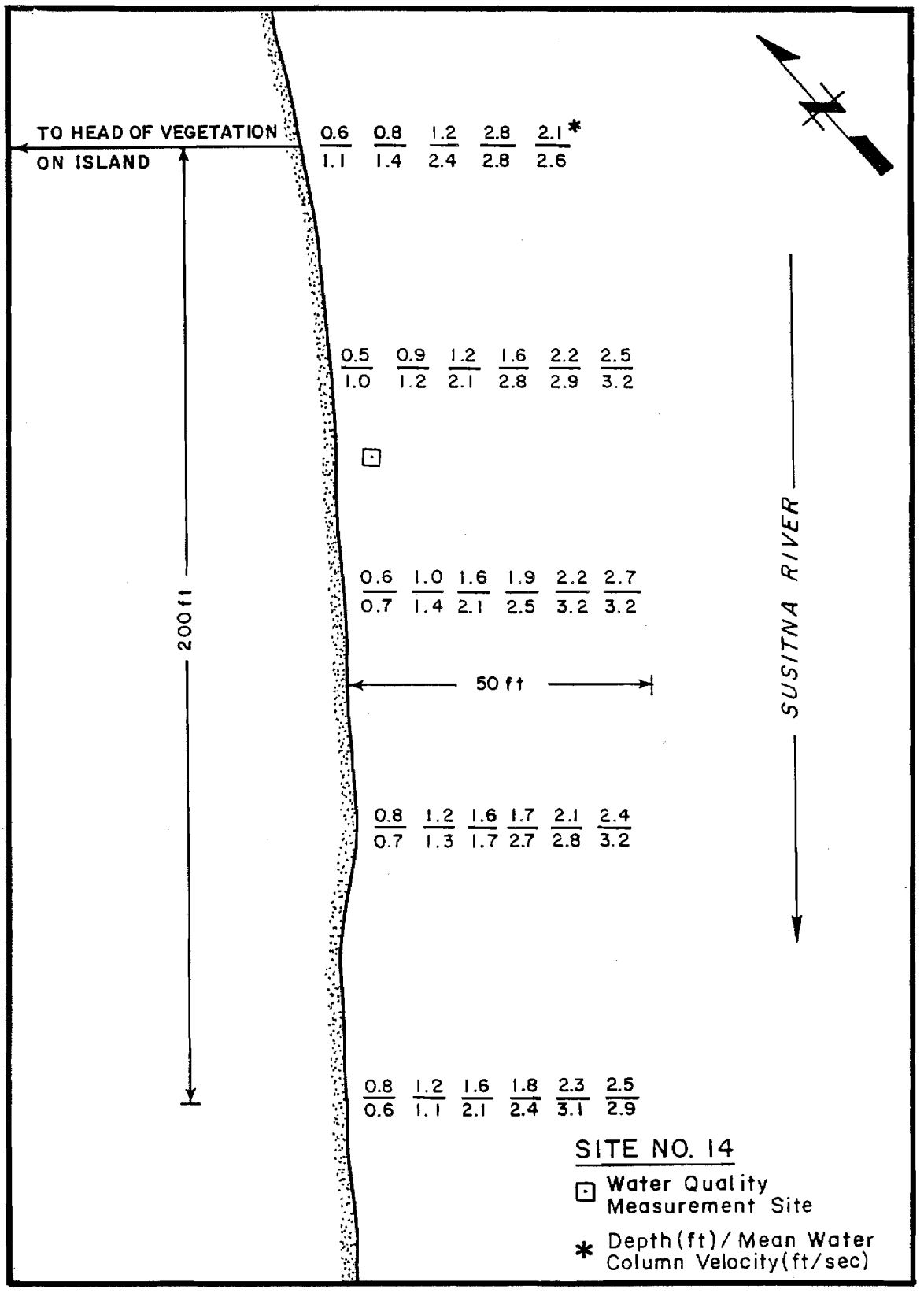


Figure 11-A-14 Eulachon spawning area on the Susitna River at RM 24.9 (GC S17N07W27BBD): May 25, 1983.

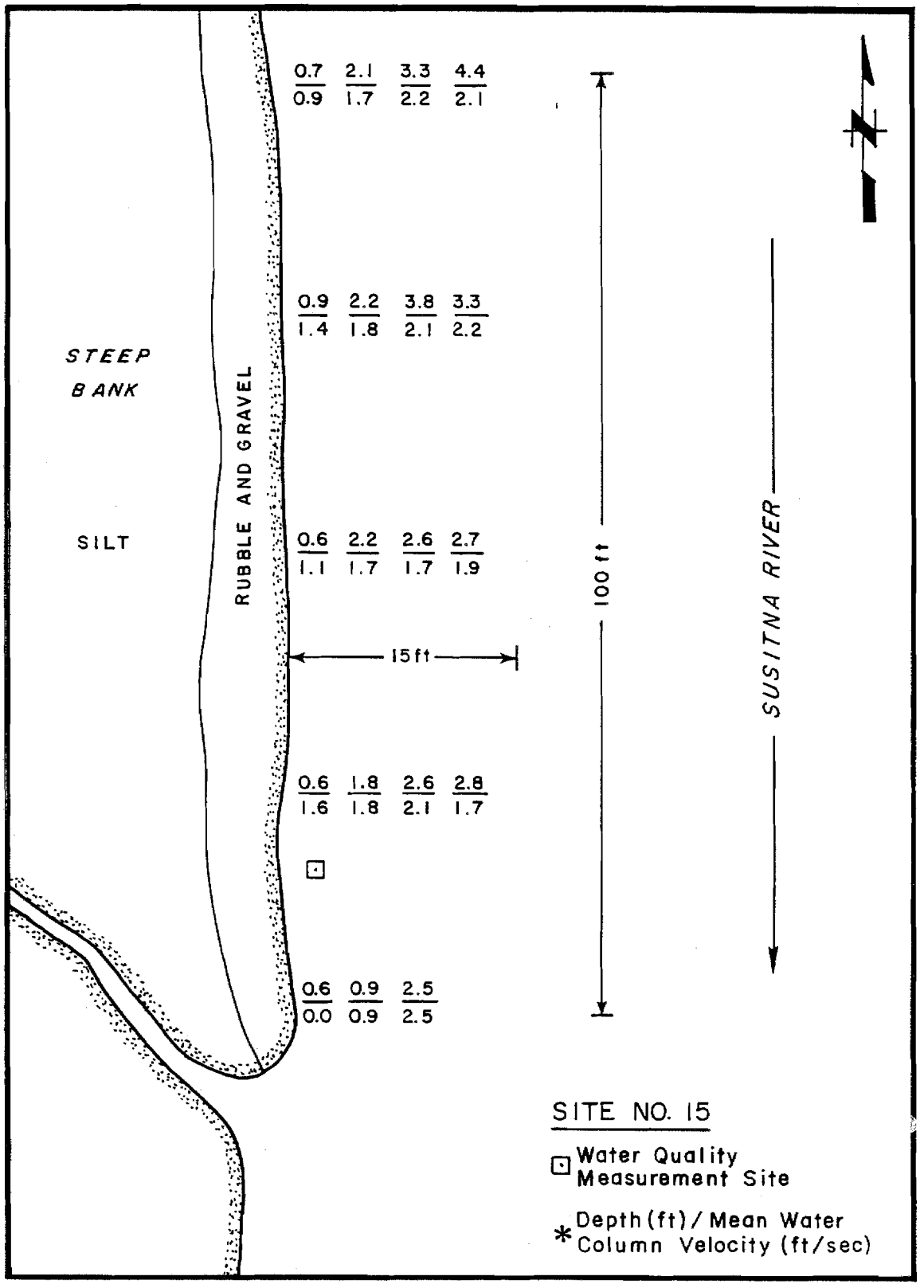
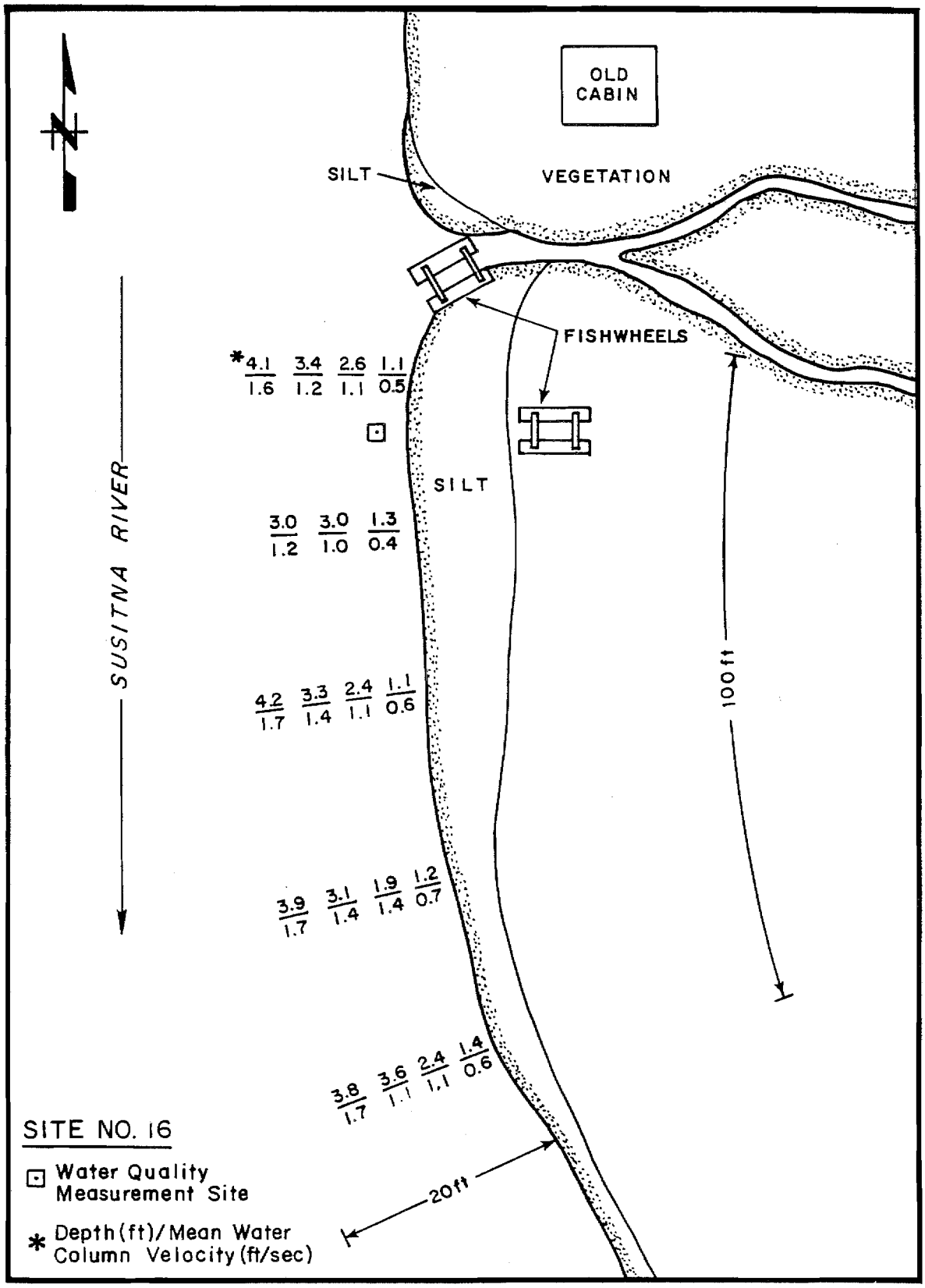


Figure 11-A-15 Eulachon spawning area on the Susitna River at RM 26.2 (GC S17N07W22ADA): May 25, 1983.



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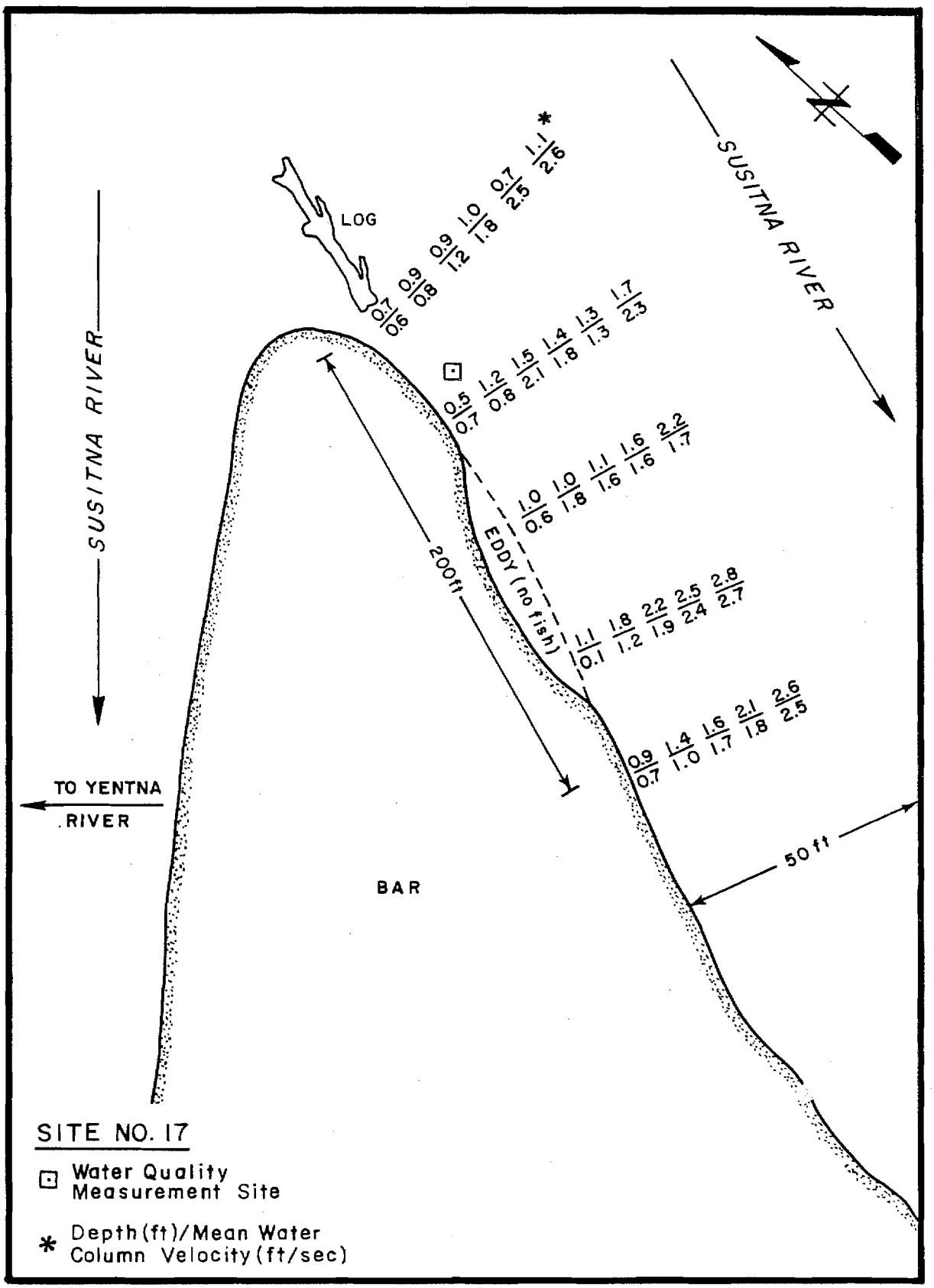


Figure II-A-17 Eulachon spawning area on the Susitna River at RM 28.0 (GC S17N07W13BAD): May 26, 1983.

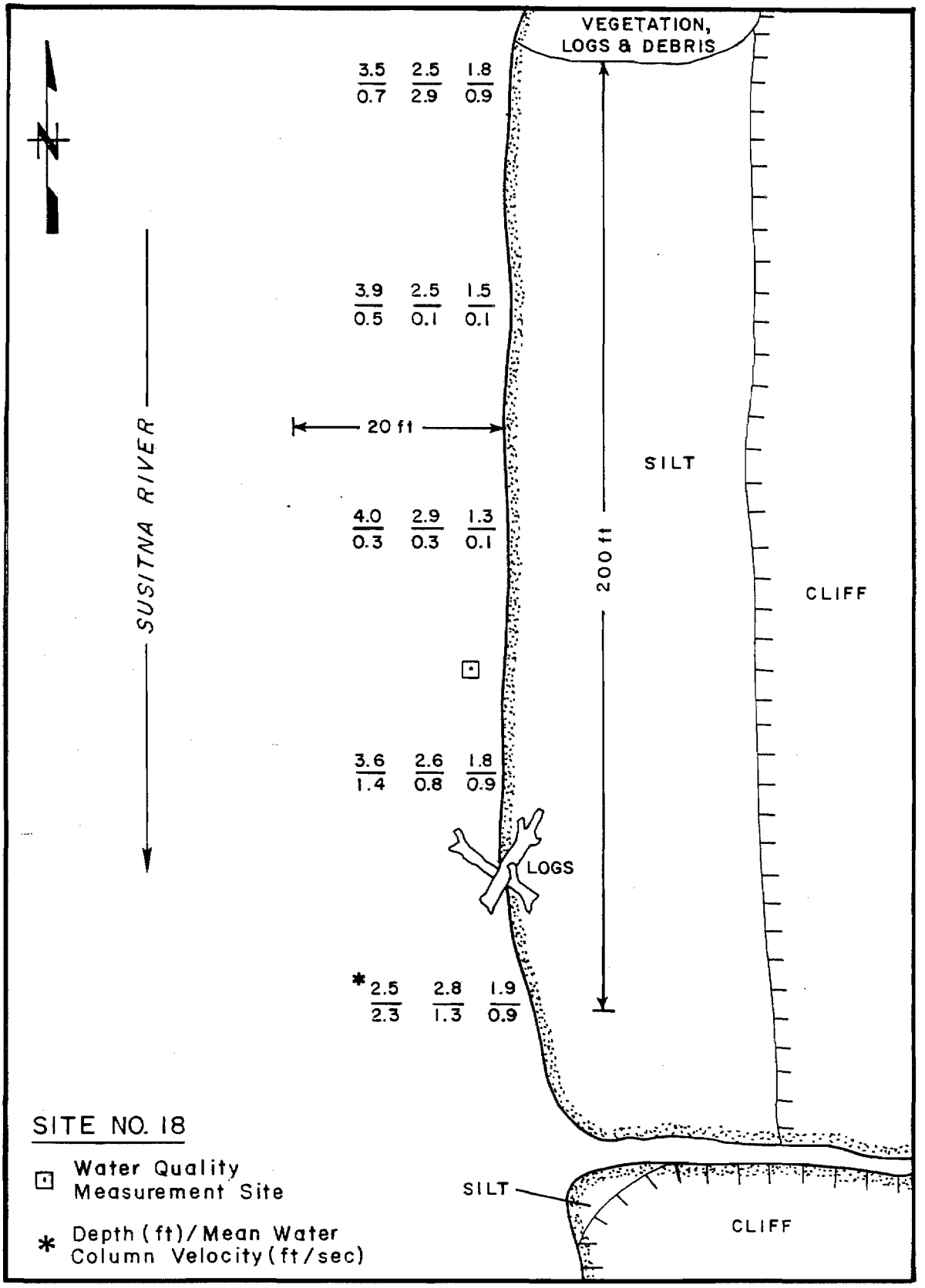


Figure 11-A-18 Eulachon spawning area on the Susitna River at RM 30.1 (GC S17N06W08CBD): May 26, 1983.

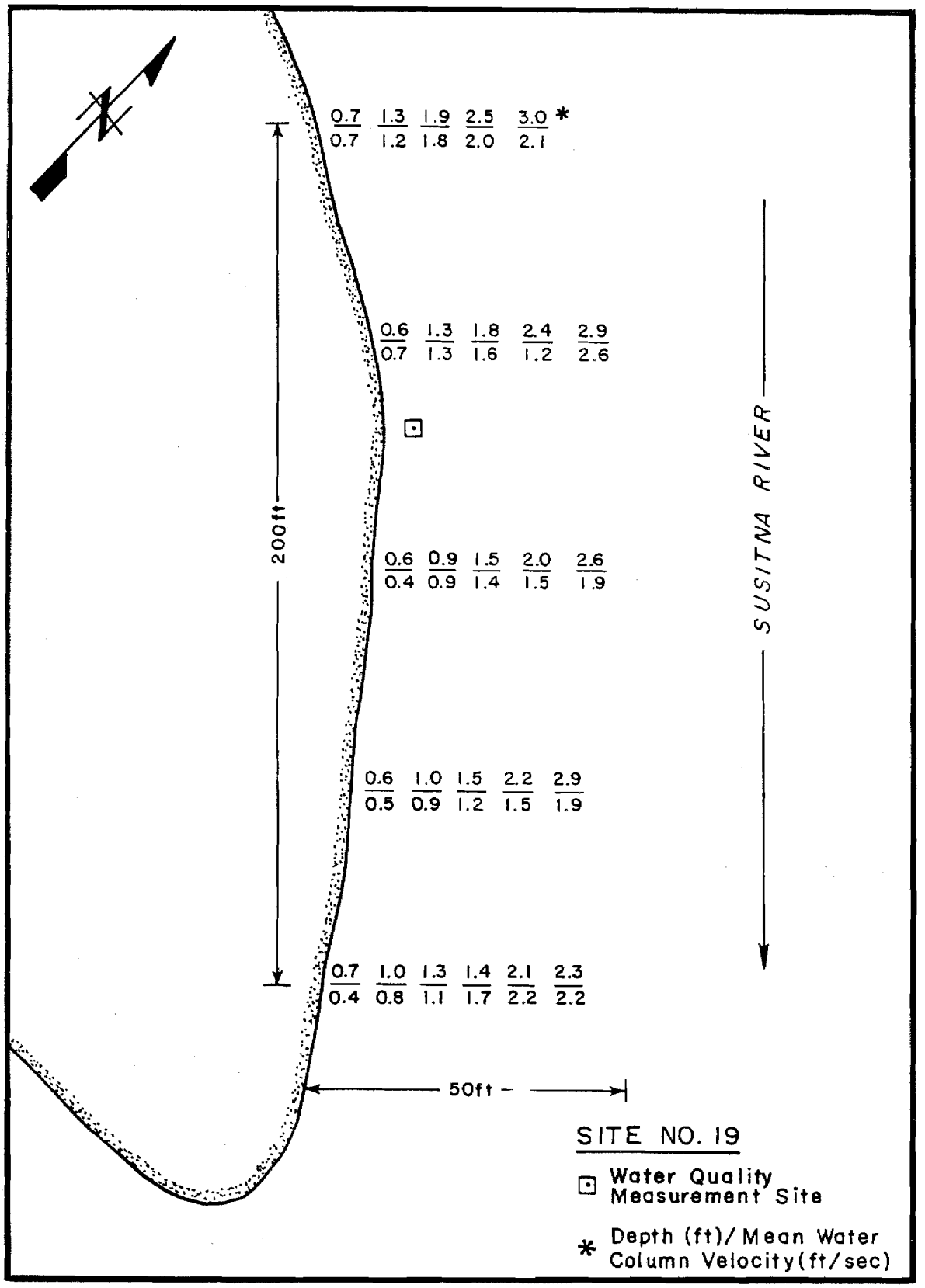


Figure 11-A-19 Eulachon spawning area on the Susitna River at RM 33.4 (GC S18N06W33ABD): May 26, 1983.

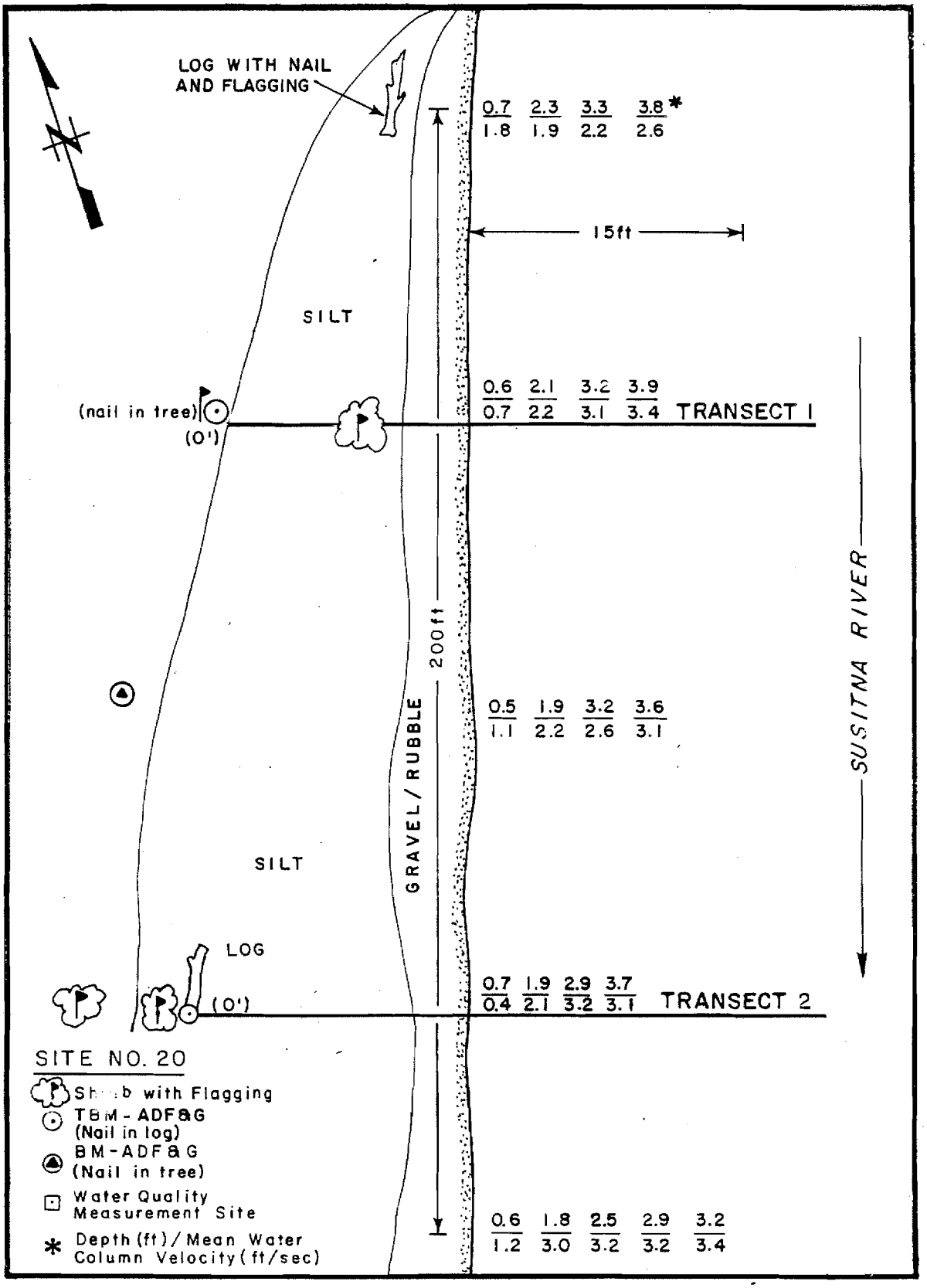
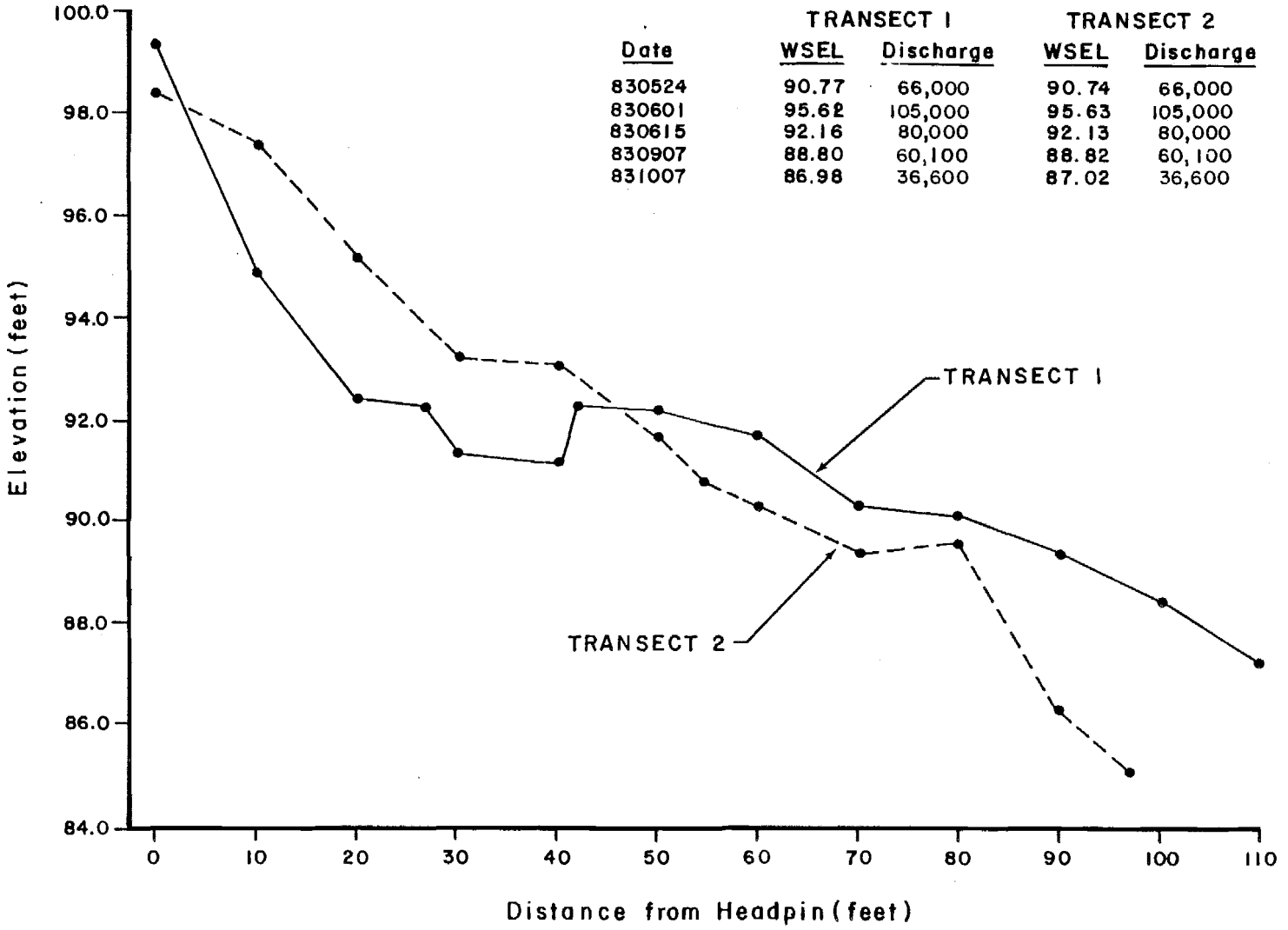


Figure 11-A-20 Eulachon spawning area on the Susitna River at RM 36.5 (GC S18N06W15BBA): May 26, 1983.

Date	TRANSECT 1 WSEL	TRANSECT 1 Discharge	TRANSECT 2 WSEL	TRANSECT 2 Discharge
830524	90.77	66,000	90.74	66,000
830601	95.62	105,000	95.63	105,000
830615	92.16	80,000	92.13	80,000
830907	88.80	60,100	88.82	60,100
831007	86.98	36,600	87.02	36,600



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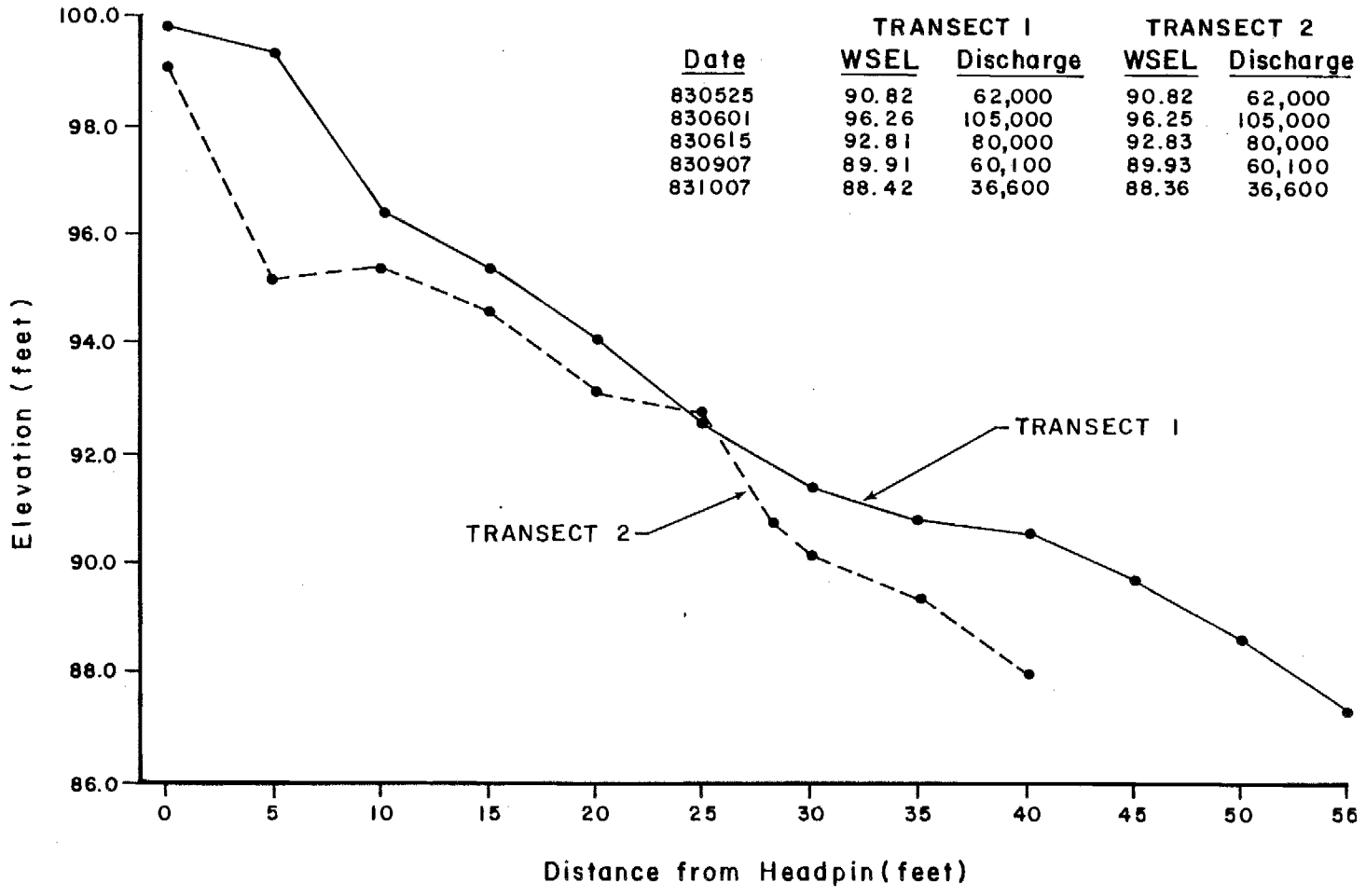
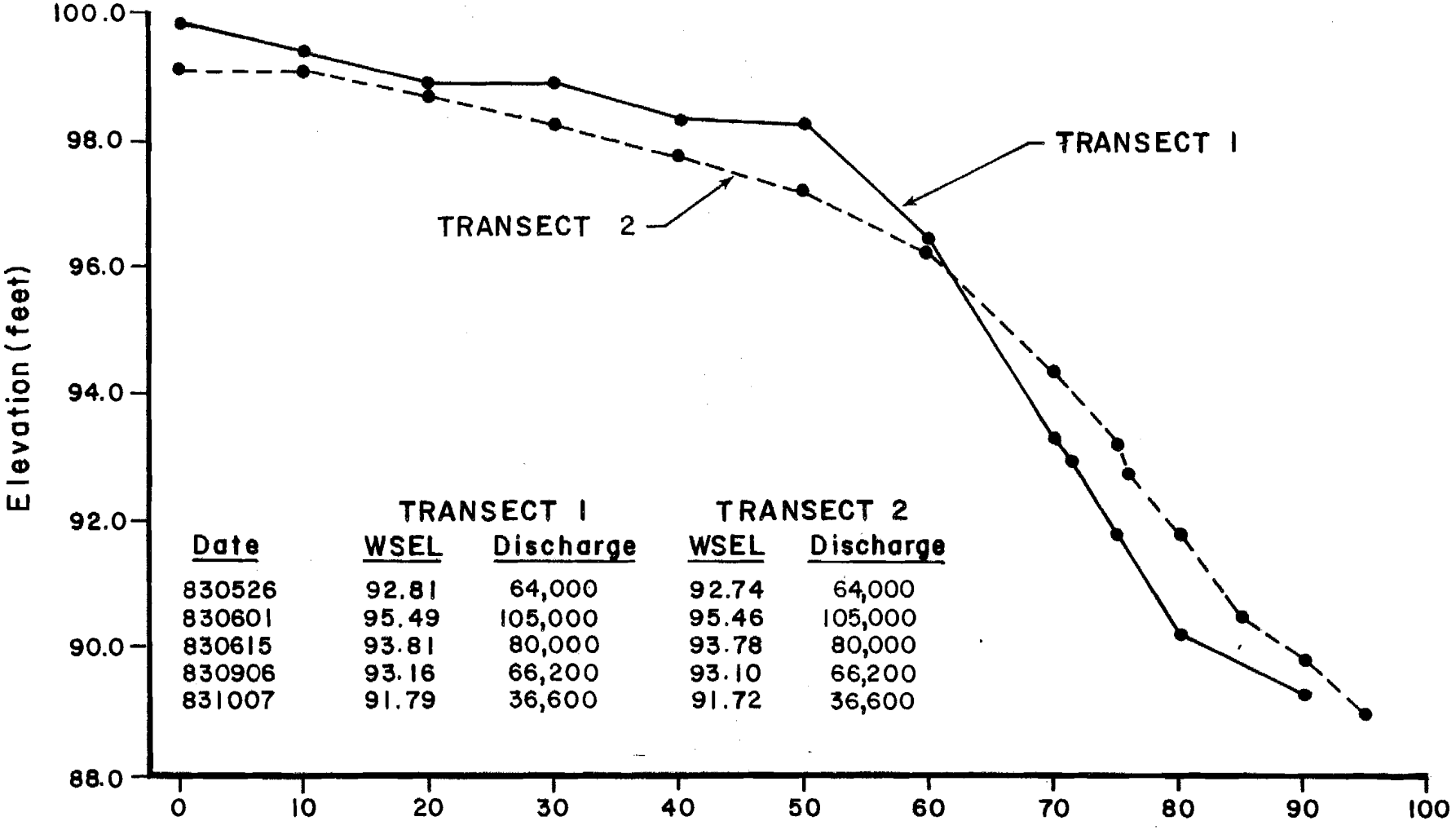
Streambank/streambed profiles obtained at two transects at the eulachon spawning study site located at RM 23.0. Water surface elevations (WSEL) obtained on each transect at the time of measurement and during subsequent visits along with corresponding mainstem discharges at Susitna Station (provisional USGS data) are presented in the insert table.



Date	TRANSECT 1 WSEL	TRANSECT 1 Discharge	TRANSECT 2 WSEL	TRANSECT 2 Discharge
830525	90.82	62,000	90.82	62,000
830601	96.26	105,000	96.25	105,000
830615	92.81	80,000	92.83	80,000
830907	89.91	60,100	89.93	60,100
831007	88.42	36,600	88.36	36,600

Figure 11-A-22

Streambank/streambed profiles obtained at two transects at the eulachon spawning study site located at RM 23.1. 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 11-A-23

Streambank/streambed profiles obtained at two transects at the eulachon spawning study site located at RM 36.5. 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
830524	94.02	64,000	94.00	64,000
830601	97.40	105,000	97.36	105,000
830615	95.00	80,000	94.98	80,000
830907	92.36	60,100	92.30	60,100
831007	90.95	36,600	90.93	36,600

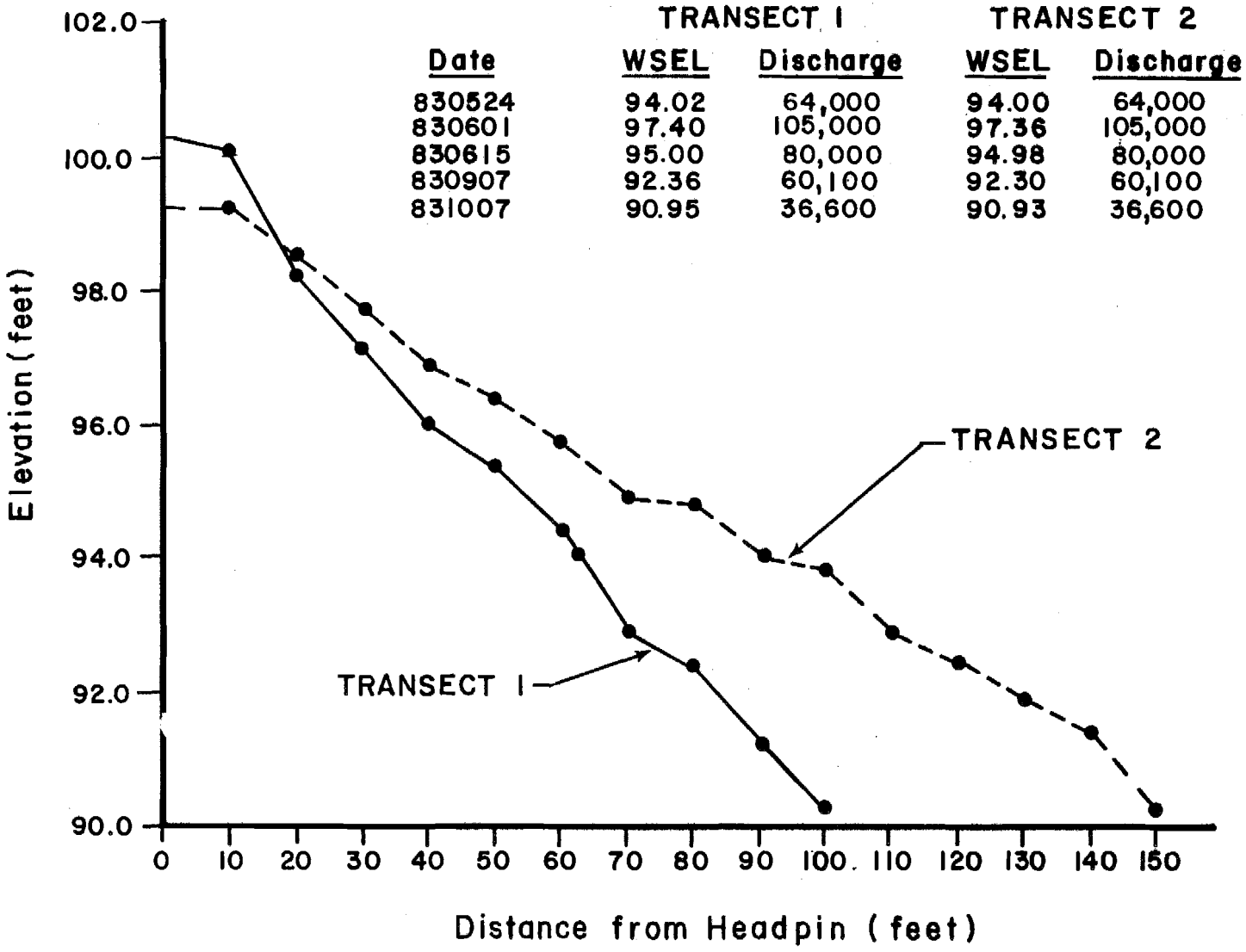
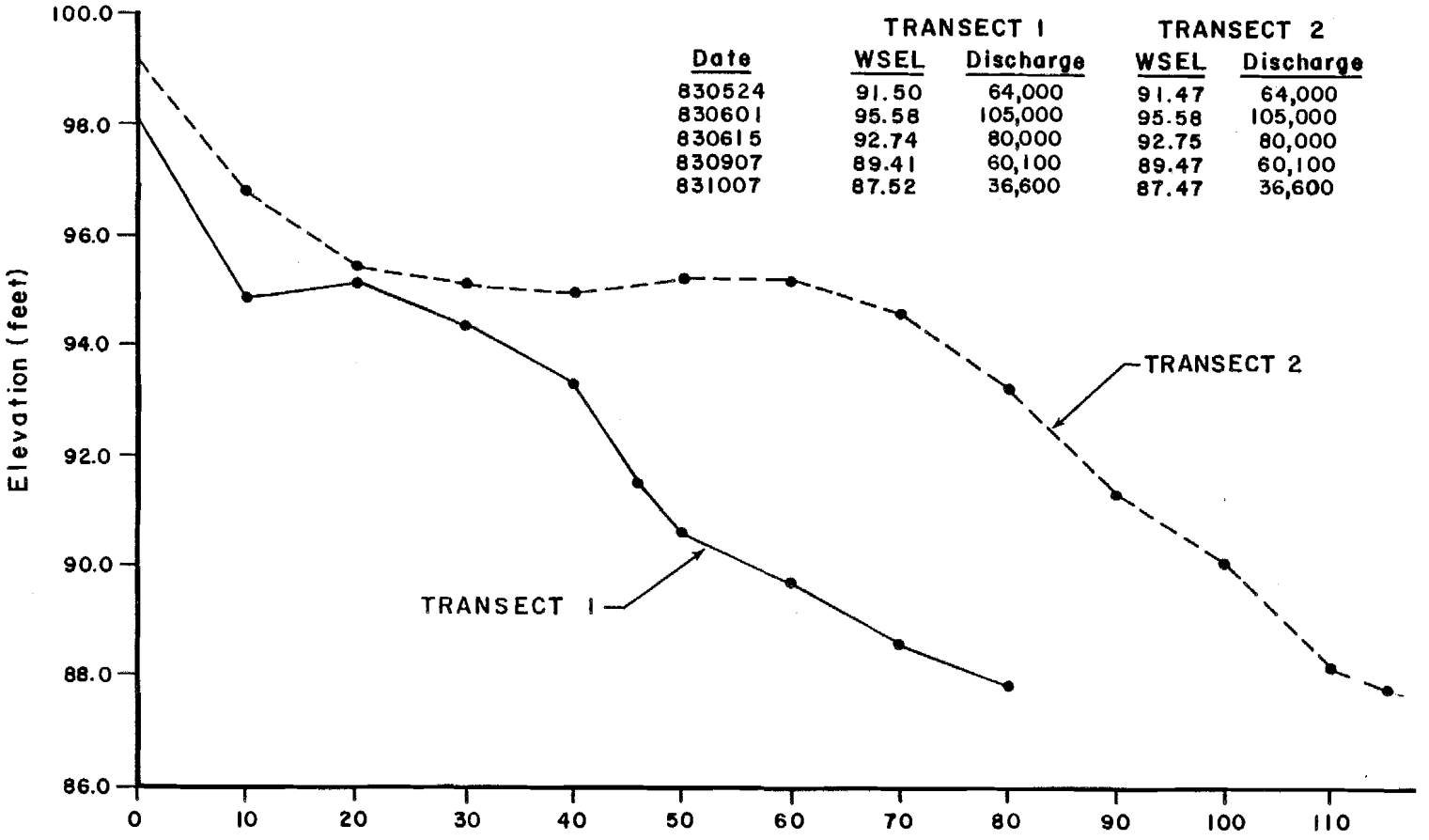


Figure 11-A-24

Streambank/streambed profiles obtained at two transects at the eulachon spawning study site located at RM 12.8. 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
830524	91.50	64,000	91.47	64,000
830601	95.58	105,000	95.58	105,000
830615	92.74	80,000	92.75	80,000
830907	89.41	60,100	89.47	60,100
831007	87.52	36,600	87.47	36,600

Figure 11-A-25

Streambank/streambed profiles obtained at two transects at the eulachon spawning study site located at RM 16.2. 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.