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PACIFIC HERRING (*Clupea harengus pallasii*) SPAWNING GROUND RESEARCH IN SOUTHEASTERN ALASKA, 1978, 1979, AND 1980

By:
Dennis Blankenbeckler
and
Robert Larson

March 1982

ALASKA DEPARTMENT OF FISH AND GAME
P.O. Box 3-2000, Juneau, Alaska 99802

Ronald O. Skoog
Commissioner

ADF&G TECHNICAL DATA REPORTS

This series of reports is designed to facilitate prompt reporting of data from studies conducted by the Alaska Department of Fish and Game, especially studies which may be of direct and immediate interest to scientists of other agencies.

The primary purpose of these reports is presentation of data. Description of programs and data collection methods is included only to the extent required for interpretation of the data. Analysis is generally limited to that necessary for clarification of data collection methods and interpretation of the basic data. No attempt is made in these reports to present analysis of the data relative to its ultimate or intended use.

Data presented in these reports is intended to be final, however, some revisions may occasionally be necessary. Minor revisions will be made via errata sheets. Major revisions will be made in the form of revised reports.

PACIFIC HERRING *(Clupea harengus pallasii)* SPAWNING GROUND RESEARCH IN SOUTHEASTERN ALASKA, 1978, 1979, and 1980

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Dennis Blankenbeckler

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Robert Larson

Alaska Department of Fish and Game
Division of Commercial Fisheries
Ketchikan, Alaska 99901

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ABSTRACT

A recent commercial interest, especially in herring *(Clupea harengus pallasii)* sac roe, has prompted a study of major herring spawning ground areas in Southeastern Alaska. Specifically, the baseline information obtained will be used to determine the feasibility for developing a survey method for annually assessing herring escapement and documenting spawning ground conditions.

Total biomass of herring can be computed from estimates of egg densities combined with the area receiving spawn. A percentage of the estimated biomass can then be used as a harvest level for the fishery. Actual spawning time can be predicted as an aid in setting season openings. Visual estimates of density show promise in developing a fast method for evaluating spawning grounds. A large variation in density was observed as the result of the extent of egg deposition and substrate availability. A large variation in suitable substrate (kelp and sea grasses) available was noted in different spawning areas. Depth of spawnings was observed from +12 tidal depth to 36 foot depth. Southeastern herring spawned at temperatures ranging from 41° to 49° F. Predation studies were not adequate to draw any meaningful conclusions. Photography was valuable in substrate and bottom condition documentation. The spawning ground assessment function is the most important segment of the project. Data generated is valuable in effective management of the resource.

INTRODUCTION

This is the third in a series of reports designed to discuss ongoing studies of herring *(Clupea harengus pallasii)* spawn production in Southeastern Alaska in which limited aerial surveys on known spawning areas, including detailed comprehensive surveys on selected areas, are summarized and discussed. The studies are a follow-up of investigations initiated and reported by Blankenbeckler (1976; 1977) and are expanded from the 1976-77 work. They are designed to collect herring life history information and determine the feasibility of estimating the number of spawning herring from their egg deposition. The quantifiable data will be compared to hydroacoustical biomass estimates made prior to spawning, provide a data base for estimating egg mortality, and provide an abundance estimate to determine harvest quotas. Life history information includes the following:

1) Vegetation type on spawning grounds and herring preference,

2) Determination of egg densities for varied substrates,

3) Timing and temperature of spawning,

4) Egg development,

5) Estimates of egg mortality for varied densities and substrates, and

6) Predation.

Initial studies were also conducted to evaluate the use of underwater television still photography and observer estimates as alternative methods to determine the density of herring eggs.

The studies were conducted throughout Southeastern Alaska. Index of linear miles of beach receiving spawn was documented on a time and funds available basis for known spawning areas. This index has been calculated by the Department of Fish and Game (ADF&G) on a limited basis since statehood and by the U.S. Bureau of Commercial Fisheries prior to 1960. Comprehensive studies on selected spawning ground have been conducted annually since 1976 targeting on sac roe harvest areas. Figure 1 illustrates the areas studied.

The obtained baseline information will be used to determine the feasibility for developing a survey method for annually assessing herring escapement and spawning ground conditions in Southeastern Alaska.

EGG DEPOSITION STUDIES

Methods

The following methods were used in the estimation of egg deposition.

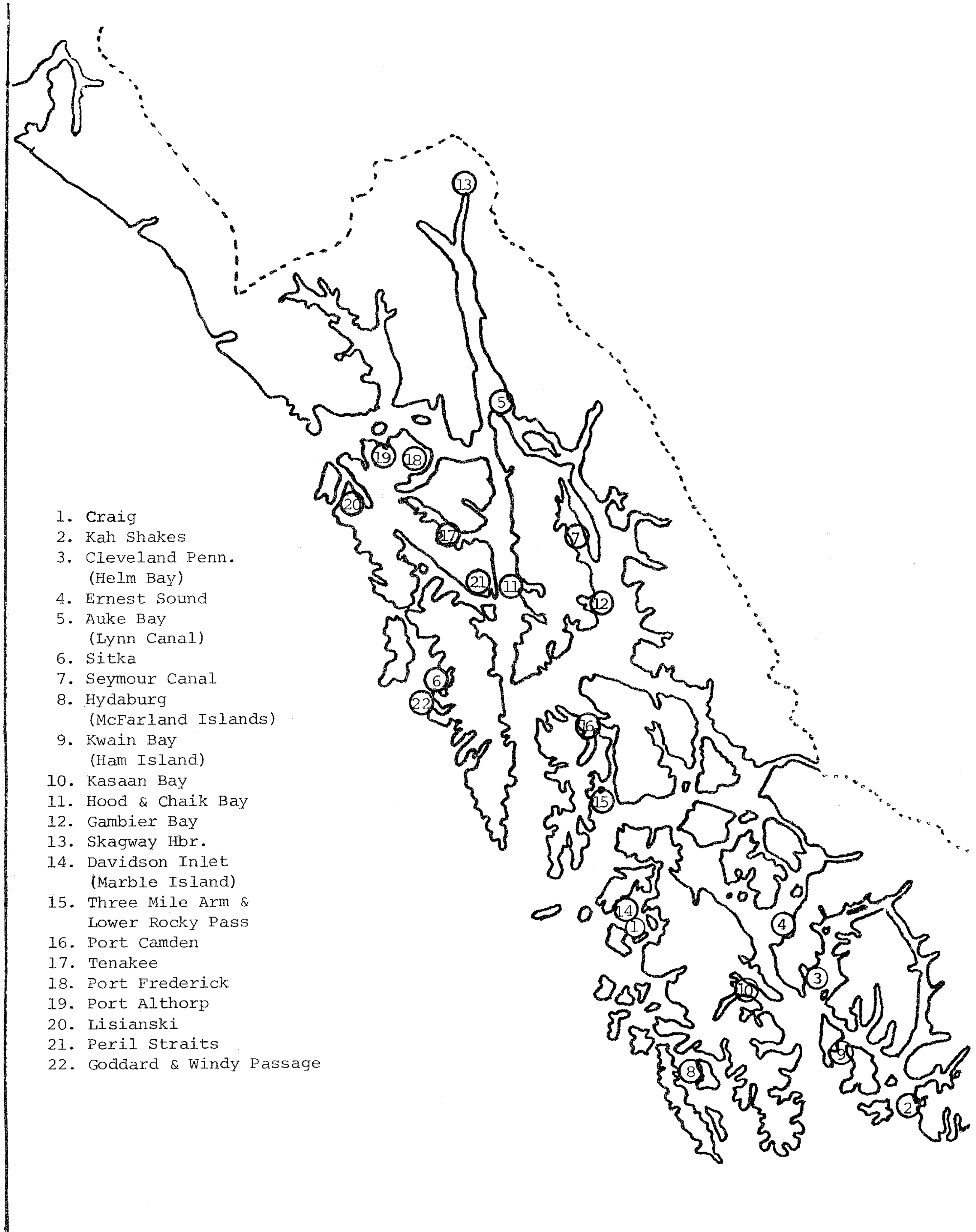


Figure 1. Southeastern spawning study areas 1978, 1979, and 1980.

Index of Beach Receiving Spawn:

An index reported as linear miles of beach receiving spawn was determined by aerial and boat surveys in Southeastern Alaska.

Aerial surveys were conducted on a periodic schedule to document presence of eggs on intertidal kelp, milt present in the water, herring schools, and bird and sea mammal activity. Most types of small aircraft were acceptable with a Cessna 180 or 185 type airplane ideal allowing for greater range over a Super Cub (traditional fish spotting airplane). In certain areas skiffs were used to monitor the coastline, collecting the same information.

Favorable weather conditions, experienced observers, and low tidal conditions were pre-requisites to collecting meaningful data.

Comprehensive Spawning Ground Surveys:

SCUBA divers were used to collect samples and to document biological and physical parameters on established transect lines.

Spawning study areas were delineated by systematic aerial and boat surveys. Once the spawning area was defined transects were established at 400 to 800 m (1/4 to 1/2 mi) intervals along the beach. Transect lines or compass courses were set perpendicular to shore measured at 5 m intervals. Divers followed the transect line or compass heading until spawn or vegetation disappeared. Data collected included depth, temperature, substrate type, egg layers, visual estimates of eggs in a 0.1 square meter frame, and subsequent collection of eggs and kelp from the frame. A series of photographs were taken of the frame and deposition for comparison of the actual count from selected sample points. Sampling equipment used was as follows:

1) 100 m 6.35 mm (1/4 in) nylon line graduated at 5 m intervals with florescent orange surveyor tape and weighted at each end. The line was coiled into a garbage can and laid by skiff perpendicular to the shore.

2) 0.1 square meter sample frame made from perforated 18.30 mm (3/4 in) plastic pipe. A pocket meat thermometer and photograph index reference was permanently mounted on the sample frame.

3) Small sample bags (approximately 2 liter (0.5 gallon capacity) and a larger diver collection bag to hold individual samples.

4) Standard diving equipment including depth gauge, compass, and underwater timer.

5) Underwater still photographic equipment.

    A) Flash meter

    B) Nikonva III camera

        (1) 28 mm lens

(2) Close lens, 12-28 Hydrophoto

(3) Viewfinder, Novatek S-75

C) Strobes

(1) Oceanic - Farallon (rechargable) 05-2001

(2) Slave (Oceanic - Farallon 2000)

D) Mount

(1) Oceanic - Farallon

a. 21-1003 Universal shoe w/grip

b. 09-1103 Arm knuckle

c. 09-1001 Ball joint arm

E) Environmental carrying case - Oceanic - Farallon 11-1000

Photographs were taken at approximately 533 mm (21 in) which covers the sample frame area. Pictures were taken with ASA 200 film at 1/30 of a second and bracketed over various camera settings.

Kelp and egg samples were transferred from the divers bag to 4 liter (gallon) size water tight zip lock bags and preserved in Gilson fluid for later laboratory analysis. Only a small amount, 1/4 to 1/2 liter (1/2 to 1 pint), of Gilson fluid was added to the sample for preservation. Approximately 19 liter (five gallon) of Gilson fluid can be prepared in the following manner:

228 g	-	Hg Cl_2
76 ml	-	Glacial Acetic Acid
285 ml	-	70^{70} Nitric Acid
1140 ml	-	Anhydrous Alcohol
17480 ml	-	H_2O

Preserved samples are then taken to the laboratory for chemical separation and counting. General laboratory methods are discussed by Blankenbeckler (1976). The following is a detailed procedure for determining egg densities from collected samples:

1) Decant the Gilson fluid from the sample bags.

2) Add INKOH to the sample bag and thoroughly mix through the sample. Allow the sample to soak for 1.5 hours in KOH digestive hydrolysis. Placing the sample bag in a hot water bath accelerates digestion (eel grass can stand a strong digestion, while other kelps disintegrate quickly impeding egg sortings).

3) Drain off KOH and place sample in a 4 liter (gallon) plastic bucket.

4) Repeated cold water washes of the sample will loosen many of the attached eggs. Decant and filter each wash through a fine mesh sieve. Majority of the eggs in the sample can be removed and collected from the filtrate.

5) The remaining eggs must be cleaned from the substrate by careful manual scraping. The loose eggs must be clean of kelp debris for accurate volumetric analysis.

6) Hand count and record all eggs that are lost or cannot be cleaned from the substrate.

7) The loose egg sample must be allowed to soak in 1.0 N buffered formal saline solution for approximately 24 hours to assure a standardized volumetric displacement.

8) The preliminary step in quantitative analysis is to determine the standard displacement of 1,000 eggs. This is done by handcounting 1,000 eggs from a number of samples and determining the average displacement.

9) Hand count totals are added to the sample displacement and this figure is expanded by a factor of 10 to determine eggs/m^2 at each sample station. One technician can work up approximately six samples per day at a chemical cost of approximately $2.00 per sample.

Chemical are prepared as follows:

1) IN KOH - 1 equivalent weight = 56.11 g KOH per liter.

2) Buffered formal saline.

A) IN NaCl - 1 equivalent weight - 58.44 g NaCl per liter.

Buffer to PH 6.5

Buffer by adding following g sodium Bicarbonate per liter IN NaCl =

Addition	PH
2.5	6.5+
2.0	6.5
1.5	6.0+
1.0	6.0

B) Add 1 part 30% formalin to 10 parts buffered saline.

Results

The following baseline data for Boca de Quadra, Kasaan Bay, Helm Bay, Three-mile Arm, Sitka, Juneau, and Seymour Canal is summarized in Tables 1 through 7.

1) Year data collected.

2) Spawning time.

   Period in which active spawning observed from aerial or skiff surveys.

3) Sampling time.

   Period in which comprehensive diving surveys were conducted.

4) Linear miles of beach receiving spawn.

   Extent of spawn related to miles of beach receiving spawn documented from aerial and/or skiff surveys. A summary of linear miles of beach receiving spawn for all areas surveyed in Southeastern Alaska is shown in Table 8. Location of comprehensive studies including sampling transects in Figures 2 through 13.

5) Estimates of herring eggs present at time of survey.

   The number of eggs is calculated by determining the area receiving spawn and applying the density computed for each transect. Large variations in density and area receiving spawn has been documented during the study period.

6) Herring average standard length, weight, and fecundity.

   This data is calculated from on the ground project sampling and from commercial catches. The data is used to reflect stock condition, commercial quality, and information needed to compute biomass available. Summary of data used to compute average fecundity is shown in Table 9.

7) Escapement computed from egg densities.

   Escapement in pounds of mature herring is computed from the following formula for each separate transect:

$$E = \frac{A \times D}{F} \times C \times W \times P$$

   Where

   E = Escapement
   D = Density average
   F = Fecundity average
   C = 2 (account for males) (assuming 50:50 sex ratio)
   W = Weight average
   P = Predation factor

Table 1. Summary of data collected in research studies near Boca de Quadra 1976 through 1980.

YEAR	SPAWNING TIME	SAMPLING TIME	LINEAR MILES OF BEACH RECEIVING SPAWN	ESTIMATE OF EGGS PRESENT AT TIME OF SURVEY x 10^9	HERRING AVERAGE STANDARD LENGTH IN MILLIMETERS	HERRING AVERAGE WEIGHT IN POUNDS	AVERAGE FECUNDITY	ESCAPEMENT INCLUDING PREDATION FACTOR	ACOUSTICAL ESTIMATE OF ABUNDANCE	COMMERCIAL HARVEST IN POUNDS X 10^6
1976	3/10-4/4	4/13-4/24	9.5	364	N.A.	.33	20,000	11.4	N.A.	.85
1977	3/29-4/4	4/13-4/19	11.3	257	224.0	.38	33,309	8.0	N.A.	1.66
1978	4/1-4/5	4/10-4/11	4.5	504	222.0	.30	33,309	11.3	N.A.	.35
1979	3/27-4/4	4/9-4/12	3.8	842	227.0	.34	35,244	21.6	N.A.	1.00
1980	3/23-4/3	4/7-4/11	12.5	1209	191.4	.22	22,948	30.9	N.A.	2.20

YEAR	TOTAL HERRING BIOMASS IN POUNDS X 10^6	% HARVEST OF BIOMASS	POUNDS OF HERRING PER LINEAR MILE X 10^6	% AGE COMPOSITION OF SPAWNERS		DEPTH IN FEET SPAWN OBSERVED	TIDAL DEPTH PREFERENCE FOR SPAWNING %	TEMPERATURE RANGE FOR SPAWNING ° F	PLAKTON BLOOM OBSERVED	BIRD ACTIVITY OBSERVED	WEATHER CONDITIONS DURING INCUBATION
1976	12.25	7	1.2	III-1.0 IV- 1.0	IV-98	12 to -16		41 - 42	Moderate	Heavy	
1977	9.66	17	.7	III-6.0 IV- 7.0	IV-87	12 to -26		44 - 46	Moderate	Heavy	
1978	11.68	3	2.5	III-9.9 IV-15.0	IV-76	13 to -15		42 - 45	Moderate	Heavy	
1979	22.60	4	5.8	III-12.0 IV-12.0	IV-76	12 to -26	Upper -15 Mid&Low-27 Sub -58	46 - 46	Moderate	Heavy	Light inshore
1980	33.10	7	2.5	III-71.0 IV -11.0	IV-18	12 to -36	Upper -15 Mid&Low -37 Sub -48	44 - 56	Moderate	Moderate	Strong inshore

Table 2. Summary of data collected in research studies Kassan Bay 1976 through 1980

YEAR	SPAWNING TIME	SAMPLING TIME	LINEAR MILES OF BEACH RECEIVING SPAWN	ESTIMATE OF EGGS PRESENT AT TIME OF SURVEY x 10^9	HERRING AVERAGE STANDARD LENGTH IN MILLIMETERS	HERRING AVERAGE WEIGHT IN POUNDS	AVERAGE FECUNDITY	ESCAPEMENT INCLUDING PREDATION FACTOR	ACOUSTICAL ESTIMATE OF ABUNDANCE	COMMERCIAL HARVEST IN POUNDS X 10^6
1976			4.0		1	1	1		4.1	.21
1977	4/24-4/26	5/4-5/5	2.5	35		.33	20,000	1.55	.9	-0-
1978			.1						-0-	-0-
1979	4/30	5/1	2.3	24		.33	20,000	1.60	-0-	-0-
1980			.5						-0-	-0-

YEAR	TOTAL HERRING BIOMASS IN POUNDS X 10^6	% HARVEST OF BIOMASS	POUNDS OF HERRING PER LINEAR MILE X 10^6	% AGE COMPOSITION OF SPAWNERS	DEPTH IN FEET SPAWN OBSERVED	TIDAL DEPTH PREFERENCE FOR SPAWNING %	TEMPERATURE RANGE FOR SPAWNING ° F	PLAKTON BLOOM OBSERVED	BIRD ACTIVITY OBSERVED	WEATHER CONDITIONS DURING INCUBATION
1976										
1977	1.6	-0-	.64	N.A.	+10 to -5	N.A.	47 - 49	N.A.	Heavy	N.A.
1978										
1979	1.6	-0-	.69	N.A.	+10 to -20	N.A.	46	Heavy	Heavy	N.A.

1. Sampling data not available therefore average weight of .33 lbs and fecundity of 20,000 used.

Table 3. Summary of data collected in research studies at Helm Bay 1976 through 1980.

YEAR	SPAWNING TIME	SAMPLING TIME	LINEAR MILES OF BEACH RECEIVING SPAWN	ESTIMATE OF EGGS PRESENT AT TIME OF SURVEY $x 10^9$	HERRING AVERAGE STANDARD LENGTH IN MILLIMETERS	HERRING AVERAGE WEIGHT IN POUNDS	AVERAGE FECUNDITY	ESCAPEMENT INCLUDING PREDATION FACTOR	ACOUSTICAL ESTIMATE OF ABUNDANCE	COMMERCIAL HARVEST IN POUNDS $X 10^6$
1976	Varies over long period		2.0							-0-
1977			3.2							-0-
1978			.5							-0-
1979	4/28	5/4	3.4	28	220-229	.33	20,000	1.8	N.A.	-0-
1980			1.5							-0-

YEAR	TOTAL HERRING BIOMASS IN POUNDS $X 10^6$	% HARVEST OF BIOMASS	POUNDS OF HERRING PER LINEAR MILE $X 10^6$	% AGE COMPOSITION OF SPAWNERS	DEPTH IN FEET SPAWN OBSERVED	TIDAL DEPTH PREFERENCE FOR SPAWNING %	TEMPERATURE RANGE FOR SPAWNING ° F	PLAKTON BLOOM OBSERVED	BIRD ACTIVITY OBSERVED	WEATHER CONDITIONS DURING INCUBATION
1976										
1977										
1978										
1979	1.8	-0-	.52	N.A.	+10 to -20	Majority - Mid & Low	45 - 48	Heavy	Heavy	N.A.
1980										

Table 4. Summary of data collected in research studies Three Mile Arm 1976 through 1980.

YEAR	SPAWNING TIME	SAMPLING TIME	LINEAR MILES OF BEACH RECEIVING SPAWN	ESTIMATE OF EGGS PRESENT AT TIME OF SURVEY $x 10^9$	HERRING AVERAGE STANDARD LENGTH IN MILLIMETERS	HERRING AVERAGE WEIGHT IN POUNDS	AVERAGE FECUNDITY	ESCAPEMENT INCLUDING PREDATION FACTOR	ACOUSTICAL ESTIMATE OF ABUNDANCE	COMMERCIAL HARVEST IN POUNDS $X 10^6$
1976										
1977										
1978			.4							
1979			1.5							
1980	4/11-5/4	5/22	5.25	[1]	N.A.	N.A.	N.A.	1.5	N.A.	-0-

YEAR	TOTAL HERRING BIOMASS IN POUNDS $X 10^6$	% HARVEST OF BIOMASS	POUNDS OF HERRING PER LINEAR MILE $X 10^6$	% AGE COMPOSITION OF SPAWNERS	DEPTH IN FEET SPAWN OBSERVED	TIDAL DEPTH PREFERENCE FOR SPAWNING %	TEMPERATURE RANGE FOR SPAWNING ° F	PLAKTON BLOOM OBSERVED	BIRD ACTIVITY OBSERVED	WEATHER CONDITIONS DURING INCUBATION
1976										
1977										
1978										
1979										
1980	1.5-2.0	-0-	.25	N.A.	+5 to -5	90% Inter-tidal 10% Sub-Tidal	46 - 48	Light	Light	N.A.

1. Visual estimates only, spawn light and intermittent.

Table 5. Summary of data collected in research studies Sitka Sound 1976 through 1980.

YEAR	SPAWNING TIME	SAMPLING TIME	LINEAR MILES OF BEACH RECEIVING SPAWN	ESTIMATE OF EGGS PRESENT AT TIME OF SURVEY $x 10^9$	HERRING AVERAGE STANDARD LENGTH IN MILLIMETERS	HERRING AVERAGE WEIGHT IN POUNDS	AVERAGE FECUNDITY	ESCAPEMENT INCLUDING PREDATION FACTOR	ACOUSTICAL ESTIMATE OF ABUNDANCE	COMMERCIAL HARVEST IN POUNDS $X 10^6$
1976	4/14-4/20	5/1-5/6	10.0	163	213	.27	31,973	3.68	14.6	1.60
1977	4/13-4/19	4/26-2/28	6.0	264	215	.37	31,973	8.15	11.3	-0-
1978	4/3-4/13	4/18-4/21	9.8	136	182	.19	18,299	3.77	29.6	.35
1979	4/14-4/24		31.0	-					62.7	4.50
1980	4/4-4/10		49.0						79.0	8.77

YEAR	TOTAL HERRING BIOMASS IN POUNDS $X 10^6$	% HARVEST OF BIOMASS	POUNDS OF HERRING PER LINEAR MILE $X 10^6$	% AGE COMPOSITION OF SPAWNERS	DEPTH IN FEET SPAWN OBSERVED	TIDAL DEPTH PREFERENCE FOR SPAWNING %	TEMPERATURE RANGE FOR SPAWNING ° F	PLAKTON BLOOM OBSERVED	BIRD ACTIVITY OBSERVED	WEATHER CONDITIONS DURING INCUBATION
1976	5.28	30.3	.53	III-1 IV-16 IV-83	+8 to -26		44 - 48	Heavy	Light	N.A.
1977	8.15		1.36	III-14 IV-11 IV-75	+11 to-20		44 - 48	Moderate	Light	N.A.
1978	4.12	8.4	.42	II-26.0 III-45.0-IV-6.0	+12 to-38	Upper -26 Low &Mid-29 Sub - 45	40 - 45	Heavy	Light	N.A.

Table 6. Summary of data collected in research studies near Juneau 1976 through 1980.

YEAR	SPAWNING TIME	SAMPLING TIME	LINEAR MILES OF BEACH RECEIVING SPAWN	ESTIMATE OF EGGS PRESENT AT TIME OF SURVEY x 10^9	HERRING AVERAGE STANDARD LENGTH IN MILLIMETERS	HERRING AVERAGE WEIGHT IN POUNDS	AVERAGE FECUNDITY	ESCAPEMENT INCLUDING PREDATION FACTOR	ACOUSTICAL ESTIMATE OF ABUNDANCE	COMMERCIAL HARVEST IN POUNDS X 10^6
1976			14.6						10.8	
1977			9.5						13.6	
1978	4/24-4/27	5/2-5/4	8.0	94	215	.33	33,567	2.53	10.8	2.0
1979	4/25-4/28		4.0						5.3	0
1980		5/13-5/15	5.5	344	210	.27	35,244	7.03	10.0	2.0

YEAR	TOTAL HERRING BIOMASS IN POUNDS X 10^6	% HARVEST OF BIOMASS	POUNDS OF HERRING PER LINEAR MILE X 10^6	% AGE COMPOSITION OF SPAWNERS		DEPTH IN FEET SPAWN OBSERVED	TIDAL DEPTH PREFERENCE FOR SPAWNING %	TEMPERATURE RANGE FOR SPAWNING ° F	PLAKTON BLOOM OBSERVED	BIRD ACTIVITY OBSERVED	WEATHER CONDITIONS DURING INCUBATION
1976											
1977											
1978	4.53	44	.57	III-4 IV-2	IV-94	+12 to-20		40 - 43	Heavy	Heavy	N.A.
1979											
1980	9.03	22	1.28	III-1 IV-22	IV-77	+10 to-25	Upper -3 Mid&Low-0 Sub -97	42 - 46	Moderate	Heavy	N.A.

Table 7. Summary of data collected in research studies Seymour Canal 1976 through 1980.

YEAR	SPAWNING TIME	SAMPLING TIME	LINEAR MILES OF BEACH RECEIVING SPAWN	ESTIMATE OF EGGS PRESENT AT TIME OF SURVEY x 10^9	HERRING AVERAGE STANDARD LENGTH IN MILLIMETERS	HERRING AVERAGE WEIGHT IN POUNDS	AVERAGE FECUNDITY	ESCAPEMENT INCLUDING PREDATION FACTOR	ACOUSTICAL ESTIMATE OF ABUNDANCE	COMMERCIAL HARVEST IN POUNDS X 10^6
1976										
1977										
1978	5/9-5/12	5/14-5/16	3.3	45.0	195	.23	22,948	1.18	7.5	1.57
1979										
1980		5/15-5/16	4.5	667.0	170	.15	16,911	12.15	N.A.	-0-

YEAR	TOTAL HERRING BIOMASS IN POUNDS X 10^6	% HARVEST OF BIOMASS	POUNDS OF HERRING PER LINEAR MILE X 10^6	% AGE COMPOSITION OF SPAWNERS	DEPTH IN FEET SPAWN OBSERVED	TIDAL DEPTH PREFERENCE FOR SPAWNING %	TEMPERATURE RANGE FOR SPAWNING ° F	PLAKTON BLOOM OBSERVED	BIRD ACTIVITY OBSERVED	WEATHER CONDITIONS DURING INCUBATION
1976										
1977										
1978	2.75	57	.36	III-8 IV-17 IV-75	+12 to -9		44 - 47	Moderate	Light	N.A.
1979										
1980	12.15	-0-	2.70		+8 to -20	Upper -40 Mid&Low -11 Sub -49	46 - 48	Moderate	Light	N.A.

Table 8. Summary of linear miles of beach receiving herring spawn in Southeast Alaska.

YEAR AND LINEAR MILES OF BEACH SPAWN OBSERVED

LOCATION	1953	1954	1955	1956	1957	1958	1959	1960	1961
CRAIG	12.2		11.7	13.6	11.6	11.5	12.6	3.5	
KAH SHAKES -Boca de Quardra SHORE NAKAT			7.9	9.2	3.4	2.5	5.7	7.0	
CLEVELAND PENN. BEHM CANAL			5.9	6.4	3.5	5.9	7.8	5.5	
ERNEST SOUND ROCKY BAY				7.5	2.6				
AUKE BAY LYNN CANAL	8.2	9.4	12.2	10.0	28.1	24.1	10.8	12.9	
				Includes all of Sitka Area					
SITKA TO DOROTHY NARROWS				100.0	79.8	92.8	45.9	44.5	
SEYMOUR CANAL									
HYDABURG McFARLAND ISLAND									
KWAIN BAY HAM ISLAND									
KASAAN BAY									
HOOD & CHAIK BAY									
GAMBLER BAY									
SKAGWAY HARBOR									
DAVIDSON IN./MARBLE ISLAND									
THREE MILE ARM LOWER ROCKY PASS									
PORT CAMDEN									
TENAKEE INLET									
PORT FREDERICK									
PORT ALTHORP									
LISIANSKI INLET									
PERIL STRAITS									
GODDARD									
WINDY PASSAGE & SOUTH									

LOCATION	1962	1963	1964	1965	1966	1967	1968	1969	1970
CRAIG		11.5	11.2	12.3	14.2	12.4	3.2		11.7
KAH SHAKES -Boca de Quardra SHORE NAKAT									
CLEVELAND PENN. BEHM CANAL									2.0
ERNEST SOUND ROCKY BAY									
AUKE BAY LYNN CANAL									11.5
			Sitka Sound only						
SITKA TO DOROTHY NARROWS			19.2	20.8	23.0	15.0	16.5	15.0	11.3
SEYMOUR CANAL									
HYDABURG McFARLAND ISLAND			8.0	9.0	7.8	5.0	4.5		
KWAIN BAY HAM ISLAND									
KASAAN BAY									
HOOD & CHAIK BAY									
GAMBLER BAY									
SKAGWAY HARBOR									
DAVIDSON IN./MARBLE ISLAND									
THREE MILE ARM LOWER ROCKY PASS									
PORT CAMDEN									
TENAKEE INLET									
PORT FREDERICK									
PORT ALTHORP									
LISIANSKI INLET									
PERIL STRAITS									
GODDARD									
WINDY PASSAGE & SOUTH									

-Continued-

Table 8. Summary of linear miles of beach receiving herring spawn in Southeast Alaska (continued).

YEAR AND LINEAR MILES OF BEACH SPAWN OBSERVED

LOCATION	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
CRAIG	4.5	7.5	7.1				2.8	3.5	1.0	1.0
KAH SHAKES - Boca de Quadra SHORE NAKAT	0.5			6.0	11.0	9.5	11.3	5.5	3.75	12.5
CLEVELAND PENN. BEHM CANAL	3.0		1.0	2.0	1.0		3.2	.5	3.4	2.5
ERNEST SOUND ROCKY BAY	3.0				3.0	3.0		2.2	3.5	4.0
AUKE BAY LYNN CANAL		8.5	10.6	13.2	10.9	15.9	9.7	9.2	5.75	13.3
		Sitka Sound only								
SITKA TO DOROTHY NARROWS	13.1	10.8	7.5	8.5	8.0	10.0	6.0	9.8	23.5	49.0
SEYMOUR CANAL	3.0				4.5	3.2	2.5	3.3	1.12	4.5
HYDABURG McFARLAND ISLAND	4.0	1.8	0.7				0.7	.5	2.0	1.0
KWAIN BAY HAM ISLAND	3.0			3.0	3.0		3.2	.1	.1	2.0
KASAAN BAY	4.0	1.0	1.0	1.0	1.0	4.0	2.5	.1	2.25	.5
HOOD & CHAIK BAY	1.5	10.0	2.0	1.7	3.4	2.3	1.7	1.7		1.0
GAMBLER BAY	0.5									
SKAWAY HARBOR	1.0									
DAVIDSON IN./MARBLE ISLAND		1.0	1.0	1.0	1.0					
THREE MILE ARM LOWER ROCKY PASS								.4	1.50	1.0
PORT CAMDEN							0.3	.2	1.5	5.25
TENAKEE INLET								3.4	6.0	4.0
PORT FREDERICK								1.1		1.5
PORT ALTHORP								2.3	1.0	
LISIANSKI INLET								1.3	1.0	.25
PERIL STRAITS							3.5	5.3	.5	
GODDARD								1.2		
WINDY PASSAGE & SOUTH								1.5	13.75	

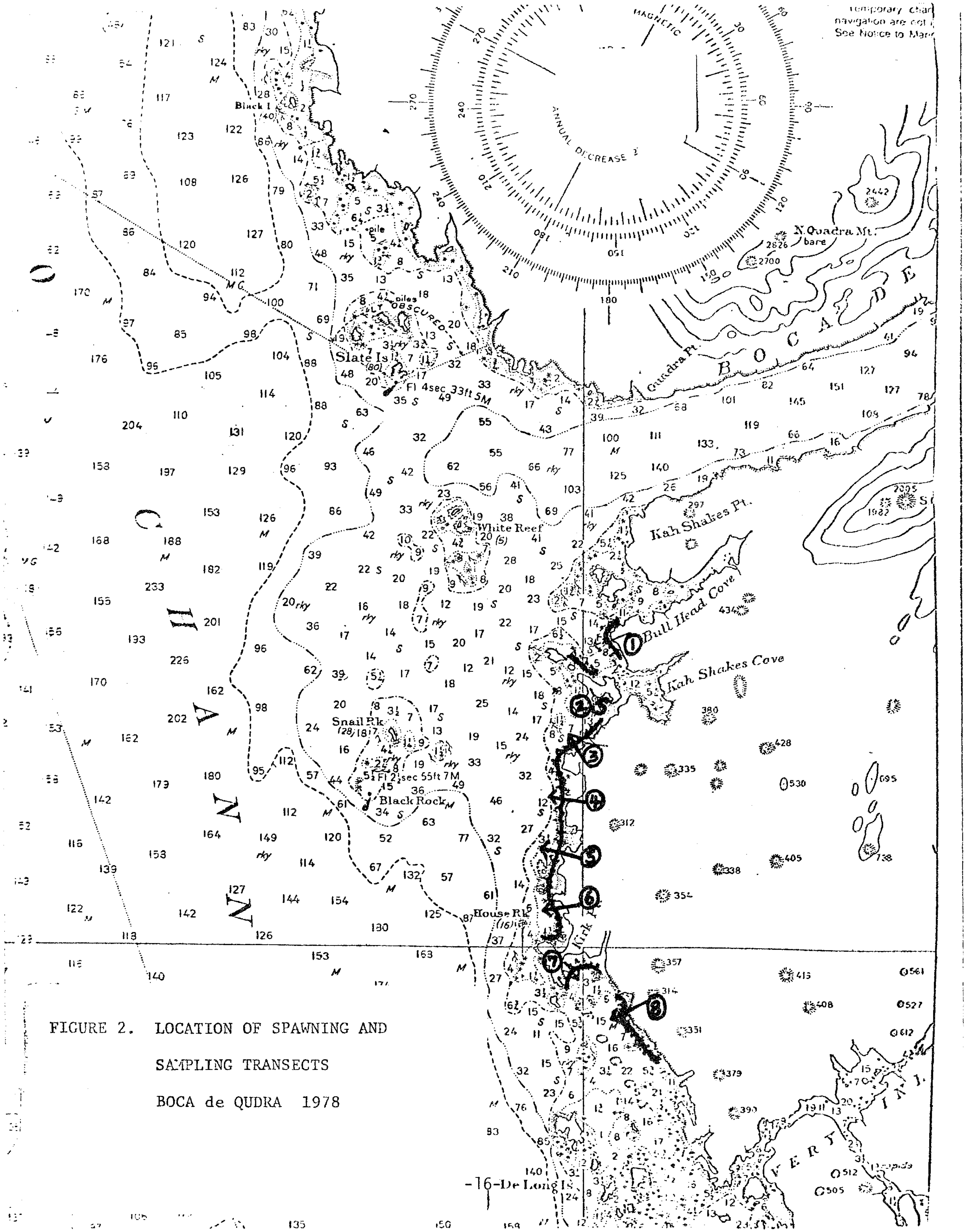


FIGURE 2. LOCATION OF SPAWNING AND SAMPLING TRANSECTS BOCA de QUDRA 1978

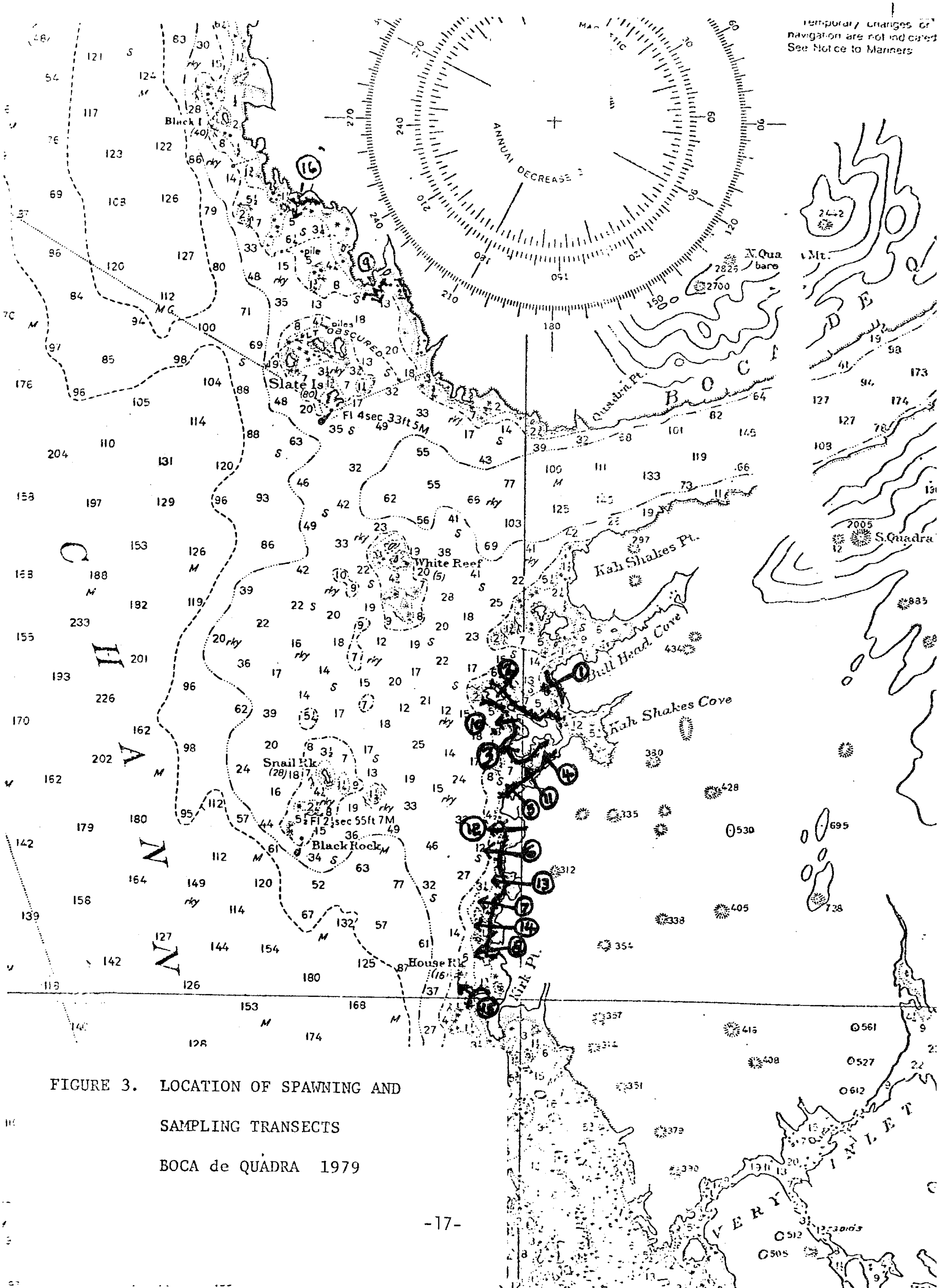


FIGURE 3. LOCATION OF SPAWNING AND SAMPLING TRANSECTS BOCA de QUADRA 1979

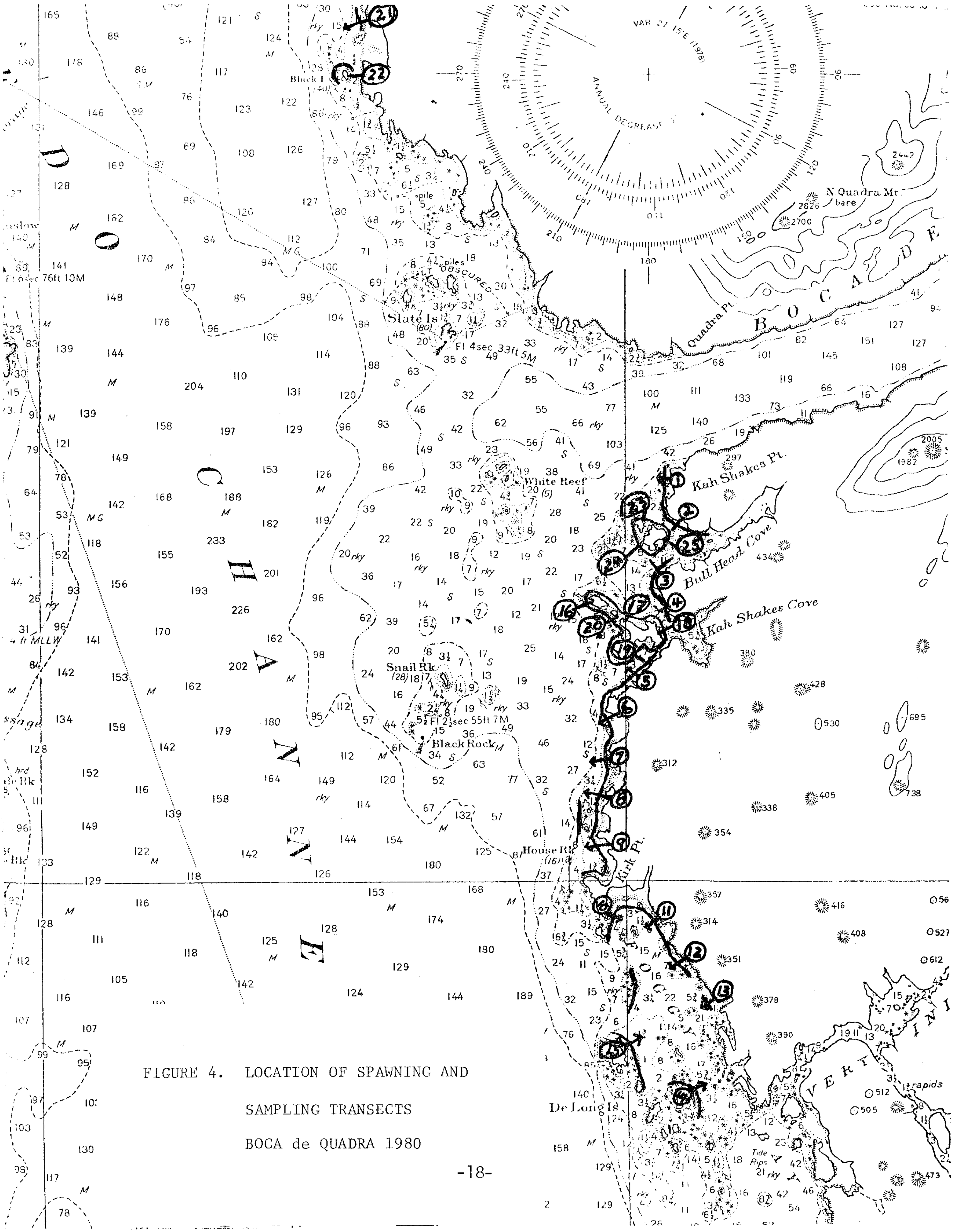


FIGURE 4. LOCATION OF SPAWNING AND SAMPLING TRANSECTS BOCA de QUADRA 1980

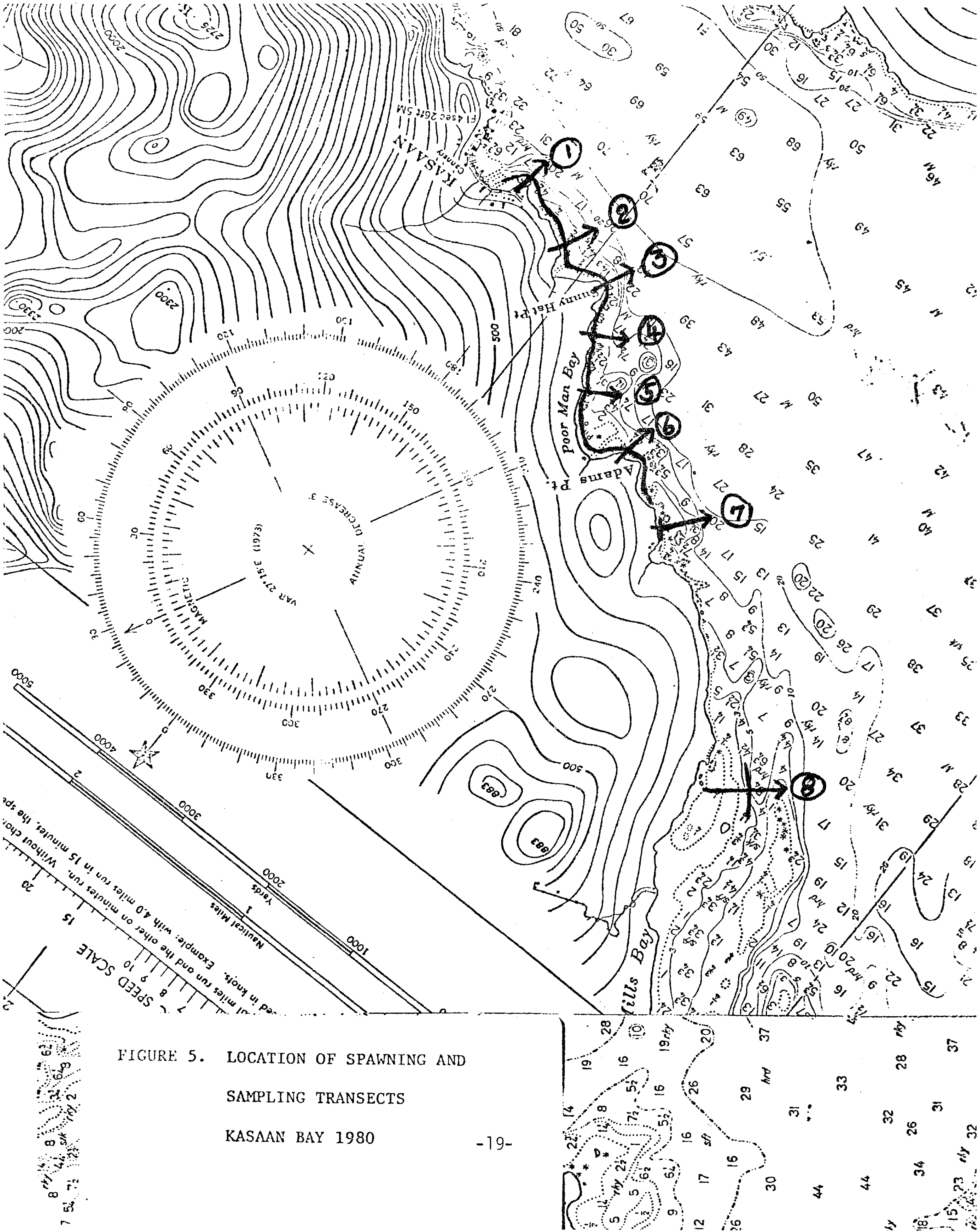


FIGURE 5. LOCATION OF SPAWNING AND SAMPLING TRANSECTS KASAAN BAY 1980

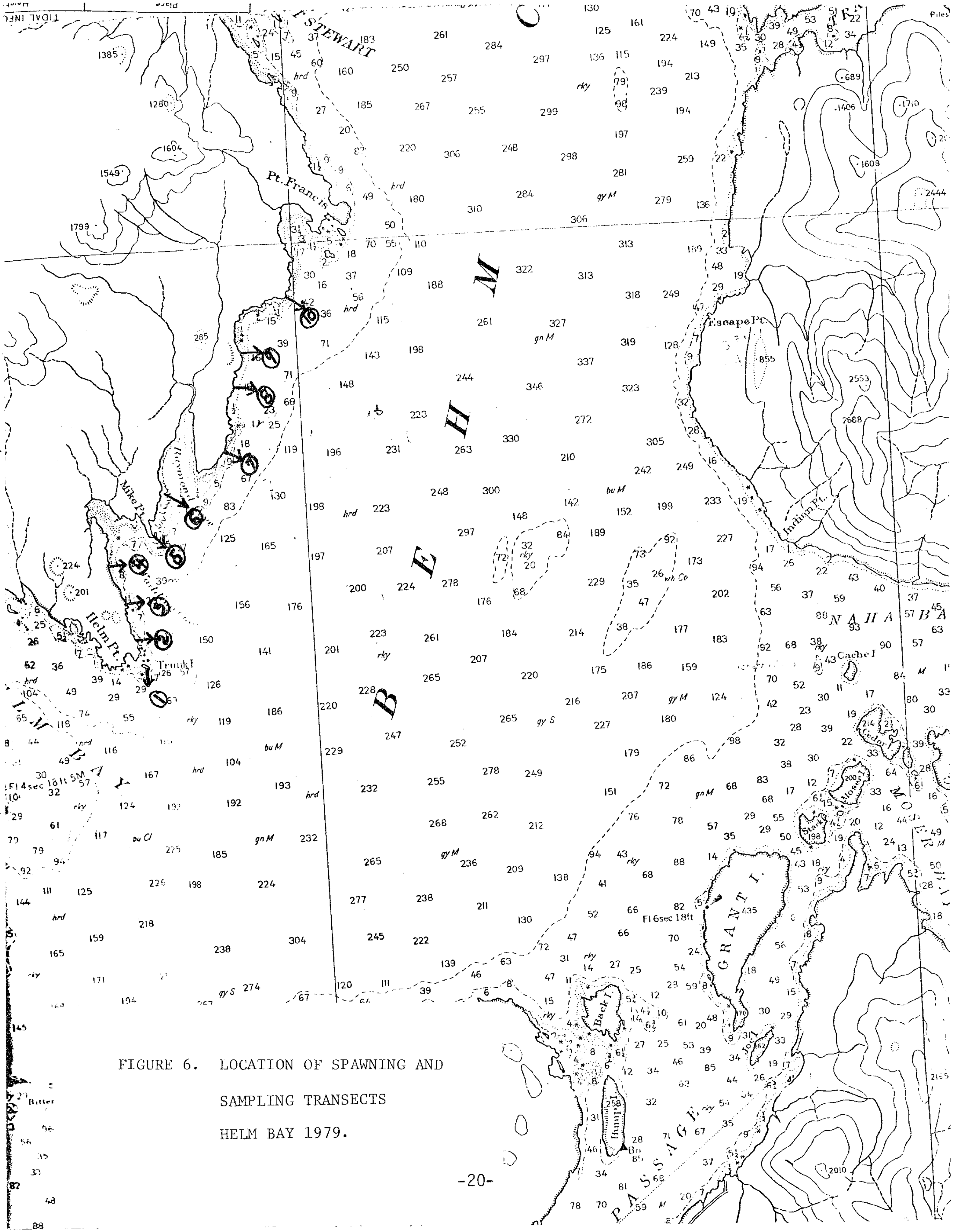


FIGURE 6. LOCATION OF SPAWNING AND SAMPLING TRANSECTS HELM BAY 1979.

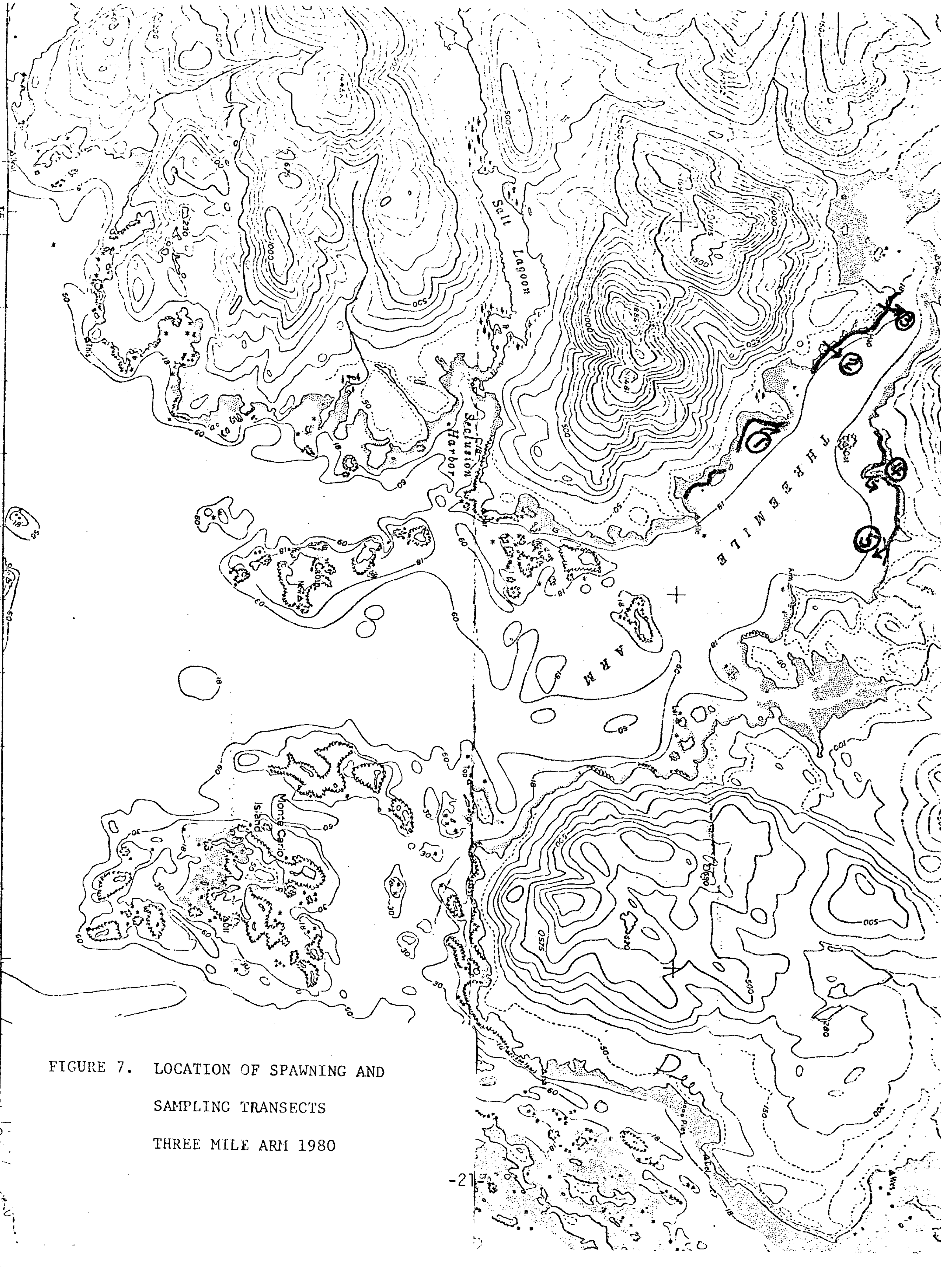


FIGURE 7. LOCATION OF SPAWNING AND SAMPLING TRANSECTS THREE MILE ARM 1980

FIGURE 8. CONTINUED LOCATION OF SPAWNING AND SAMPLING TRANSECTS THREE MILE ARM AREA 1980

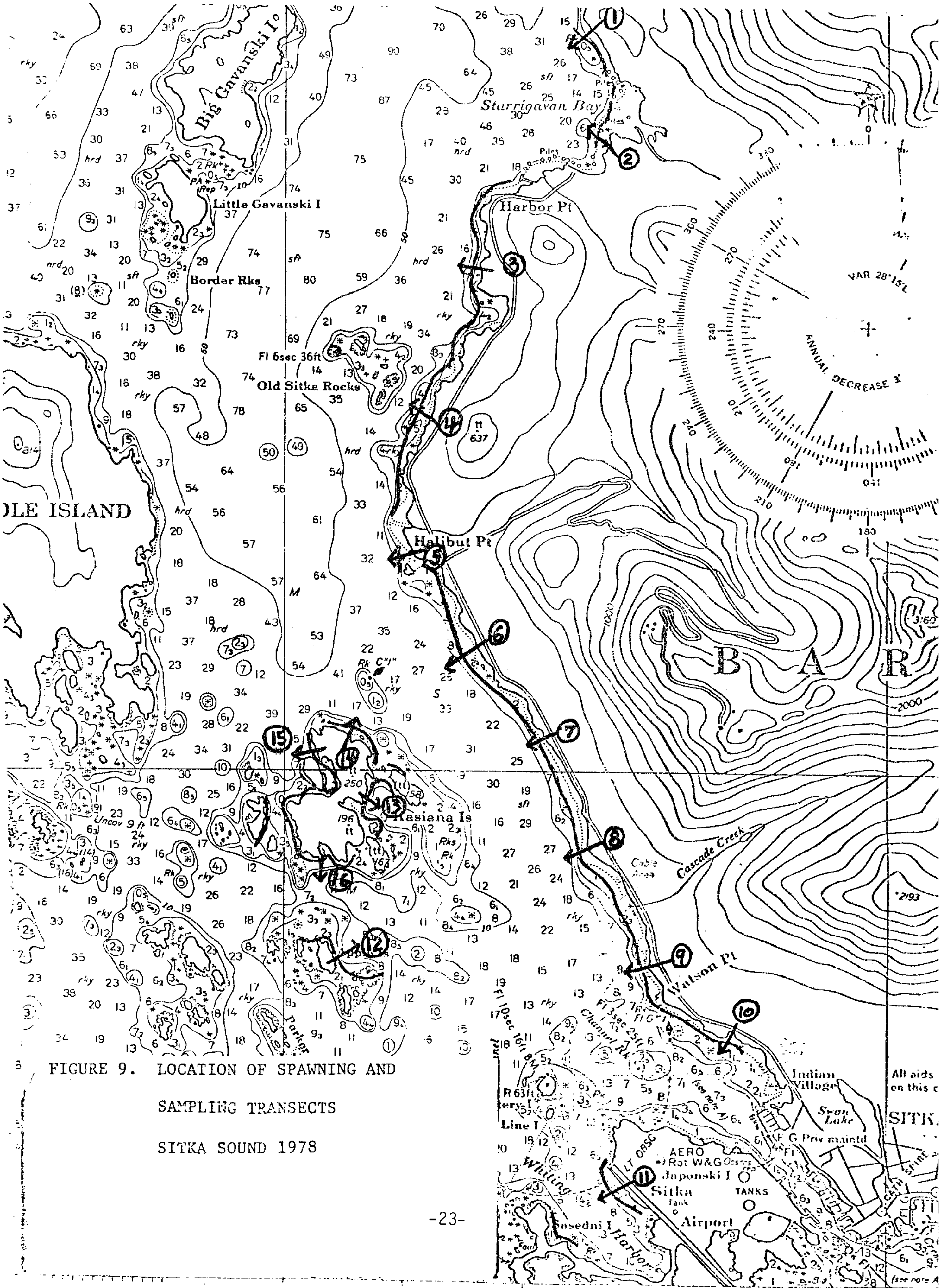


FIGURE 9. LOCATION OF SPAWNING AND SAMPLING TRANSECTS SITKA SOUND 1978

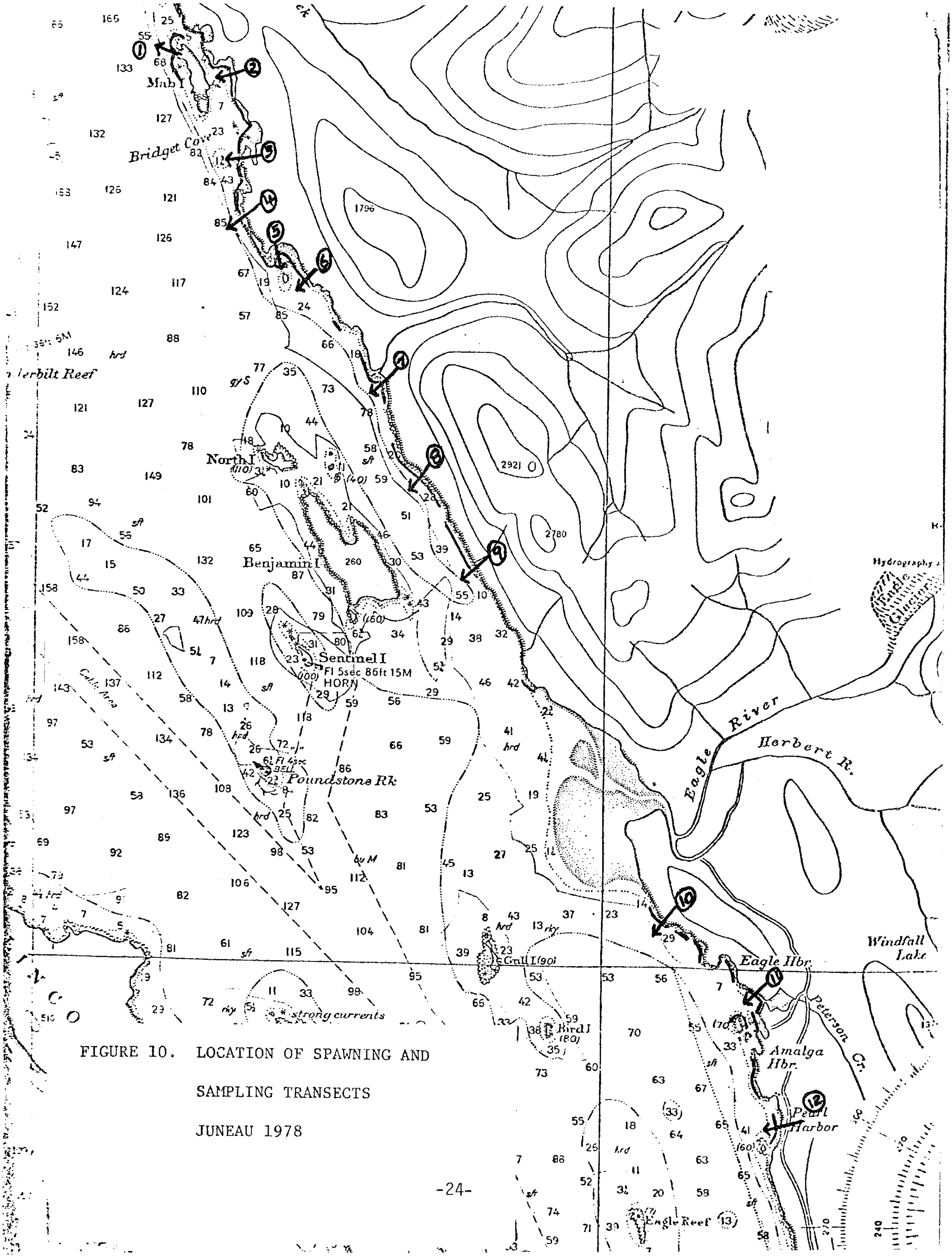


FIGURE 10. LOCATION OF SPAWNING AND SAMPLING TRANSECTS JUNEAU 1978

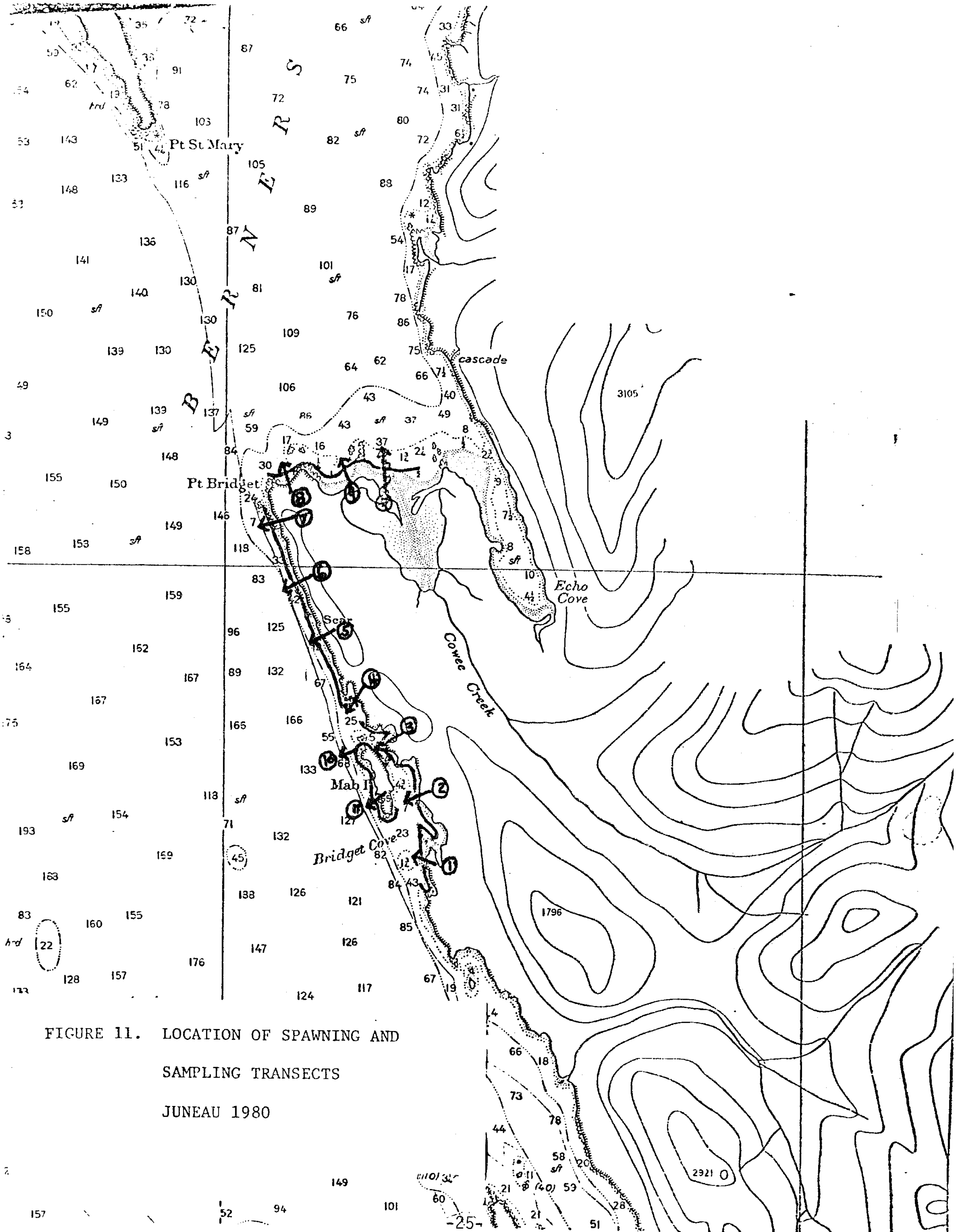


FIGURE 11. LOCATION OF SPAWNING AND SAMPLING TRANSECTS JUNEAU 1980

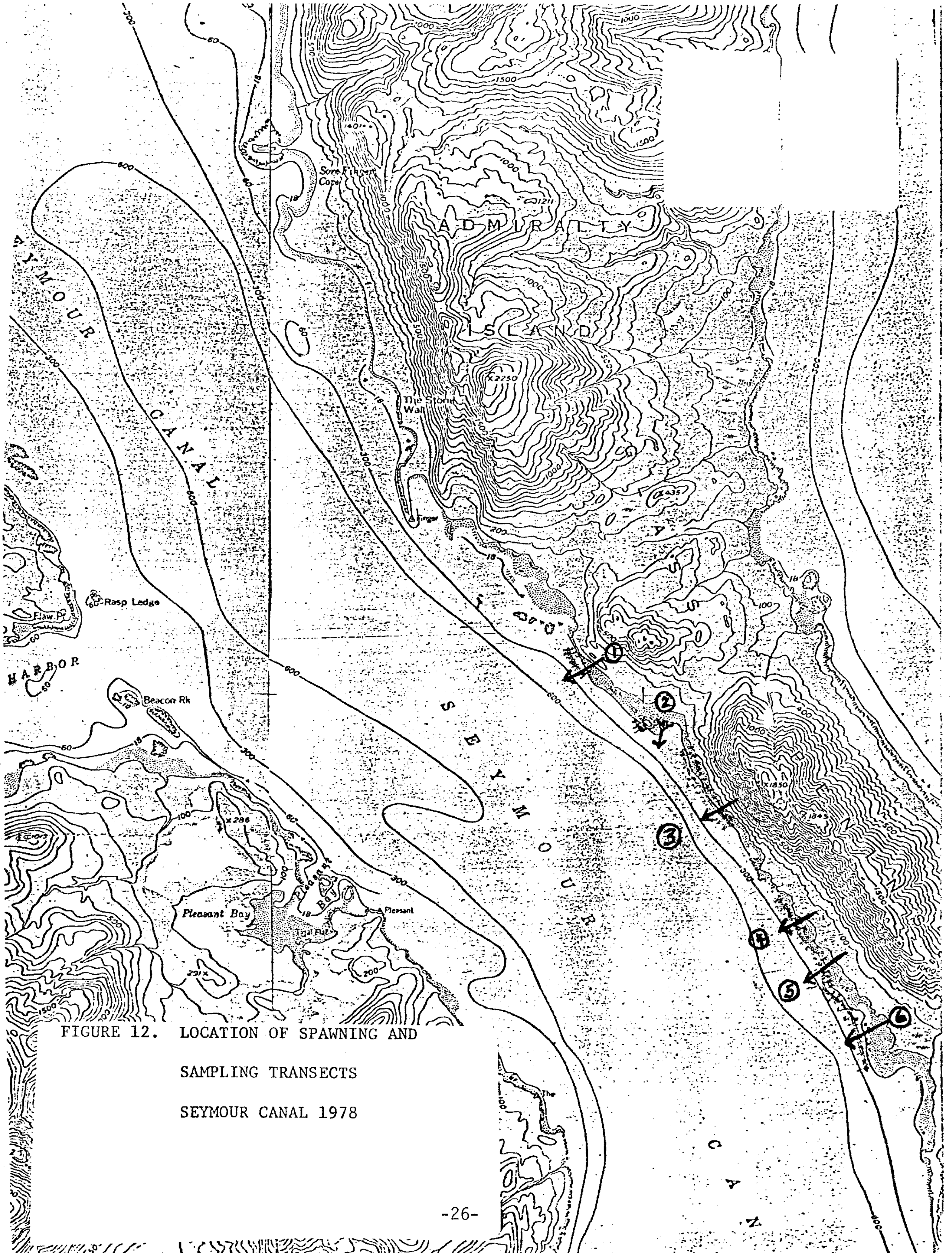


FIGURE 12. LOCATION OF SPAWNING AND SAMPLING TRANSECTS SEYMOUR CANAL 1978

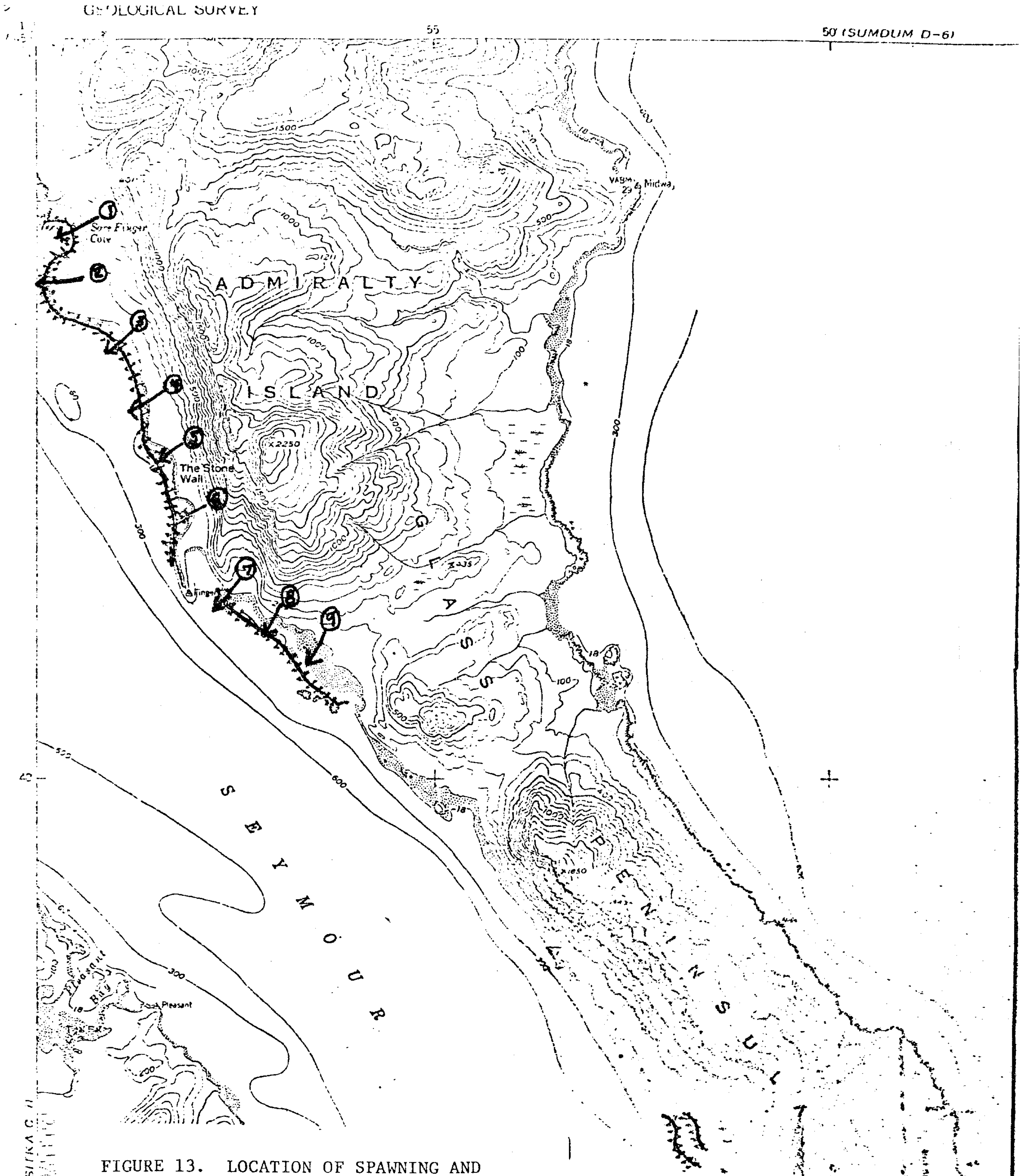


FIGURE 13. LOCATION OF SPAWNING AND SAMPLING TRANSECTS SEYMOUR CANAL 1980

Table 9. Summary of Southeastern herring fecundity by age class and length interval for years 1970, 1971, 1972, and 1973.

Length Interval (MM)	Frequency[1]	Fecundity Range	Average Fecundity
151 - 160	1		9,450
161 - 170	23	5,670 - 17,055	11,870
171 - 180	14	10,395 - 22,860	16,121
181 - 190	12	10,395 - 24,635	12,185
191 - 200	177	9,450 - 53,100	22,585
201 - 210	54	9,450 - 56,700	24,911
211 - 220	184	9,450 - 53,865	29,415
221 - 230	162	14,135 - 57,700	36,351
231 - 240	6	23,600 - 54,810	34,706
241 - 250	3	39,690 - 70,875	53,865

Age[2]	Frequency	Average Fecundity
II	1	9,450
III	51	15,552
IV	152	21,090
V	109	25,932
VI	114	27,801
VII	130	30,427
VIII	31	33,567
IX	23	35,772
X	18	36,157
XI	3	40,907
XII	3	56,385
XIII	1	54,810

[1] Based on samples collected at Auke Bay, Bridgett Cove, Helm Bay, Deer Island, Craig, Sitka Scow Bay, Seymour Canal, Farragut Bay and McFarland Island.

[2] The fish were assigned an anniversary date for each complete growing season. All samples collected were taken after growth had ceased in the fall and before growth had resumed in the spring. For example, if a fish was hatched in the spring of 1972 and collected in the fall of 1973, two growing seasons were assumed; and the fish recorded as age II.

8) Acoustical estimate of biomass.

An estimate of biomass computed from systematic acoustical surveys for comparison to spawning estimates.

9) Commercial harvest.

Harvest of herring in pounds from commercial gillnets and/or purse seines.

10) Total biomass available.

Total biomass is computed by adding the commercial harvest to the escapement.

11) Percent harvest of available biomass.

This figure reflects the percentage of the biomass available taken by the commercial fishery.

12) Pounds per linear mile.

Reflects the biomass variation per linear mile of beach receiving spawn.

13) Percent age composition.

Reflects the age composition to detect strong year classes and assess recruitment. For example Age III herring is defined as receiving three summers growth.

14) Depth in feet spawning observed.

Depth referenced to zero tide is documented where spawn observed.

15) Depth preference for spawning.

Percent of spawn recorded for upper intertidal, mid, lower, and subtidal level.

16) Temperature range during spawning.

Degree fahrenheit temperature recorded during sampling time period.

17) Plankton bloom observed.

Density of plankton bloom recorded as light [visibility greater than 6.1 m (20 ft)], medium [1.8 to 6.1 m (6 to 20 ft)] visibility, and heavy [less than 1.8 m (6 ft) visibility by divers.

18) Bird activity observed.

Predation by scoters and gulls was reported as heavy, medium, or light at the discretion of the observer. Numbers are in the thousands with scoters preying mainly on subtidal eggs and sea gulls on exposed eggs at low tide levels.

19) Weather conditions during incubation.

Presence of strong inshore winds was noted as an indicator of egg loss from dislodging of vegetation and spawn.

SPECIAL STUDIES

The following data for special studies conducted on Southeastern spawning grounds is as follows:

Herring Spawning Substrate Analysis

Substrate type observed with spawn is documented at comprehensive study areas. Substrate is typed as to vegetation as follows:

R = Bare rock

S = Sand

F = Includes upper intertidal kelp

FUCUS	- Rock weed	*CONSTATINCA*	- Cup and saucer
PORPHYRA	- Red laver	*ULUA*	- Sea lettuce
CODIUM	- Sea staghorn	*ENDOCLADIA*	- Nail brush
RHODOMELA	- Black pine	*RHODYMENIA*	- Dulse

EG = Includes midtide to lower tidal kelp.

ZOSTERA - Eel grass

LBK = Includes large brown kelp which occur in lower tidal and subtidal areas.

LAMINARIA - Sea girdle
- Sugar Wrack
- Blister Wrack

COSTARIA - Seersucker

CYAMATHERE - Triple rib

ALARIA - Wing kelp

AGARUM - Sea colander

MACROCYSTIS - Giant kelp

NEREOCYSTIC - Ribbon kelp or bull kelp

It should be noted that the vegetation utilized by Southeastern herring for spawning is not complete but serves as initial documentation.

Substrate occurrence with observed spawn is summarized including distance from the beach by area and transects in Table 10 through 20.

Density of eggs by substrate type is summarized for Boca de Quadra for 1979 and 1980 in Tables 21 and 22.

Percent contribution of substrate type in terms of total deposition for Boca de Quadra, Sitka, Juneau, and Seymour Canal is summarized in Table 23.

Visual Estimate Analysis

Visual estimates instead of laboratory counts were tested for accuracy to determine a rapid method of assessing herring spawning ground deposition. Visual estimates were compared to actual laboratory counts. Comparisons are summarized by years tested and observers in Table 24.

Photography Analysis

Photographs were taken of the sample frame to test feasibility of counting eggs to determine density. A series of photographs were taken at 10 m (32.8 ft) intervals systematically on the established transect lines at Boca de Quadra and Seymour Canal. The photographs were taken at approximately 53.3 cm (21 in) which covered the sample frame area. Pictures were taken with ASA 200 film at 1/30 of a second and bracketed over various camera settings. It was not possible to count number of eggs due to vegetation coverage and variability in quality of pictures.

An experiment using underwater television was conducted under an equipment lease agreement to determine the feasibility of using underwater television as a method to estimate egg densities and other life history information such as substrate type. The initial experiment was conducted prior to spawning in a shallow bay over an eel grass *(Zostera)* bed. The method utilized two divers and a technician aboard a support vessel. A hand held video camera traced the transect line along the bottom. The video signal was monitored by the support vessel with communication to the divers for direction to produce the best picture. The support vessel video taped the experiment for later playback and for a permanent record of the experiment. Due to a lack of clarity and poor quality of pictures, egg densities could not be calculated. Photography, however, would be valuable in documenting substrate and bottom conditions.

Table 10. Summary of substrate type utilized for spawning including (width) distance from beach for Boca de Quadra, 1978.

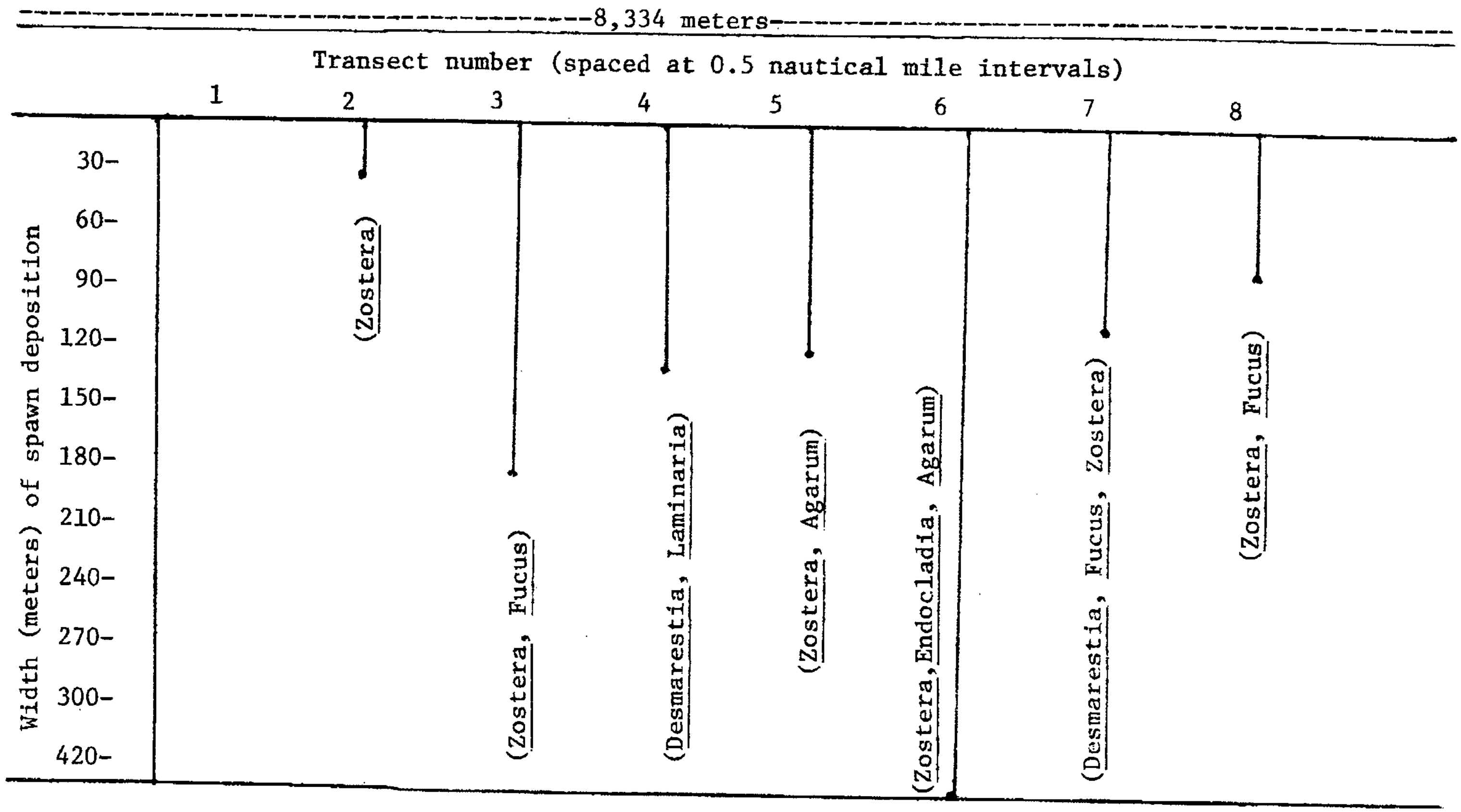


Table 11. Summary of substrate type utilized for spawning including (width) distance from beach for Boca de Quadra, 1979.

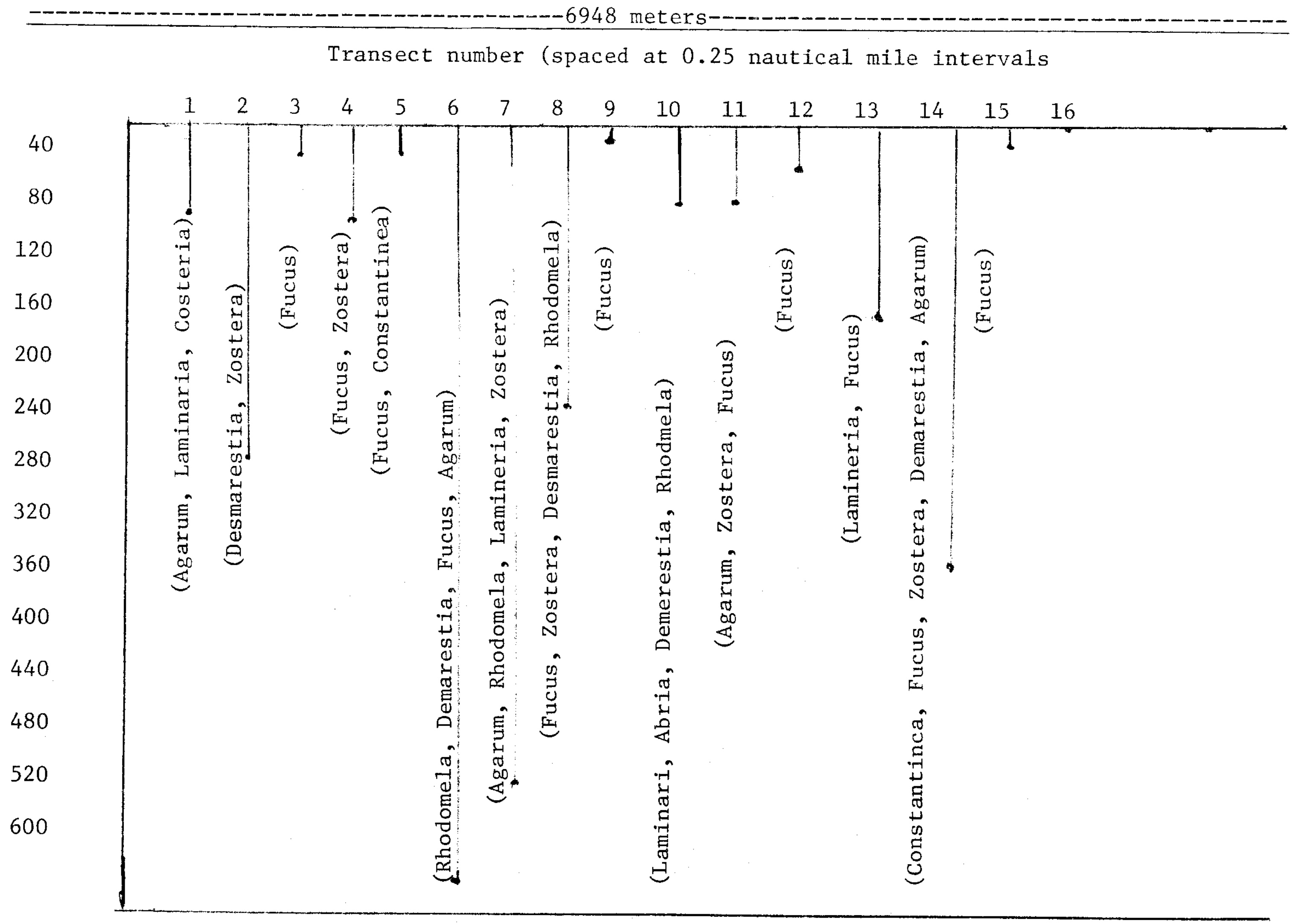


Table 12. Summary of substrate type utilized for spawning including (width) distance from beach for Boca de Quadra, 1980.

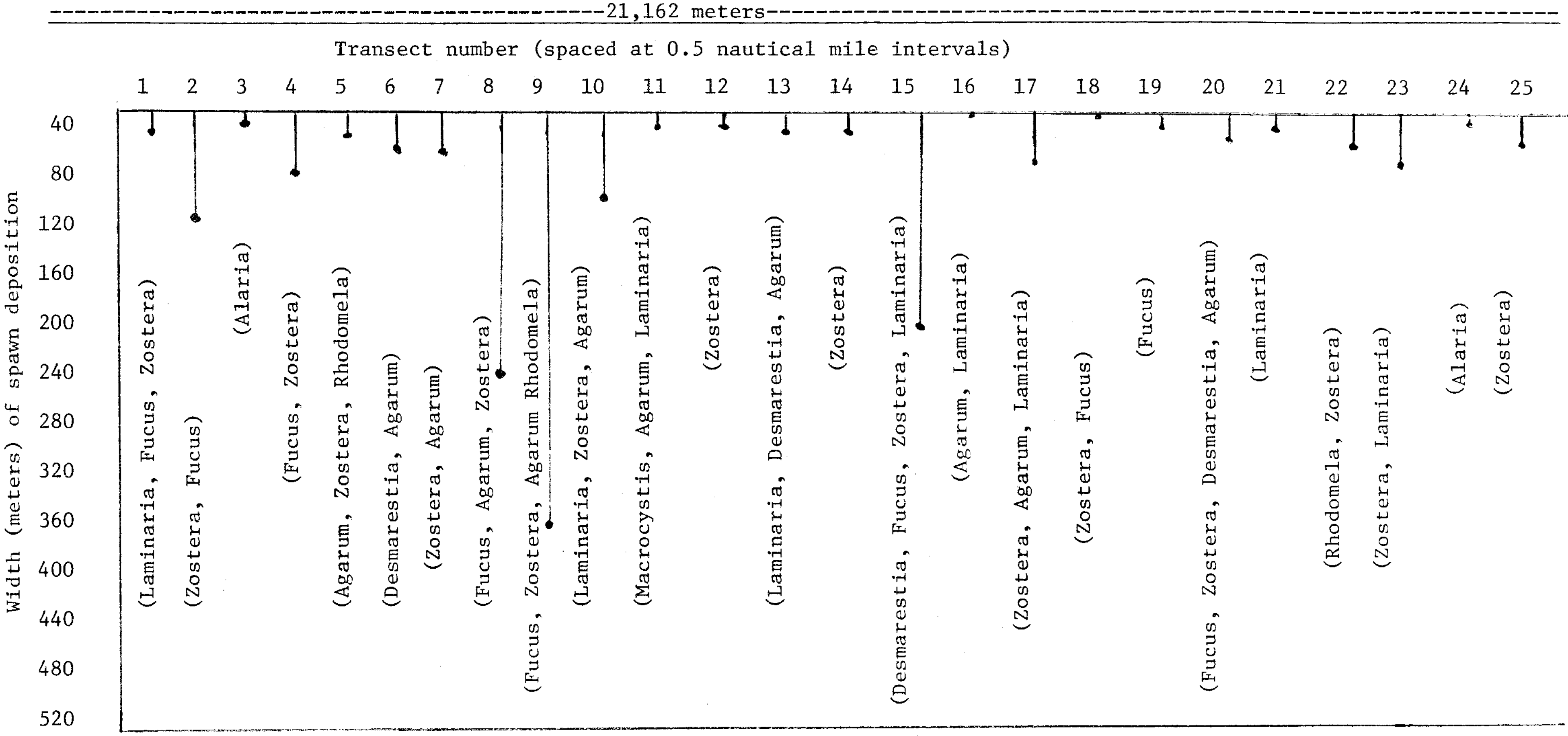


Table 13. Summary of substrate type utilized for spawning including (width) distance from beach for Helm Bay, 1979.

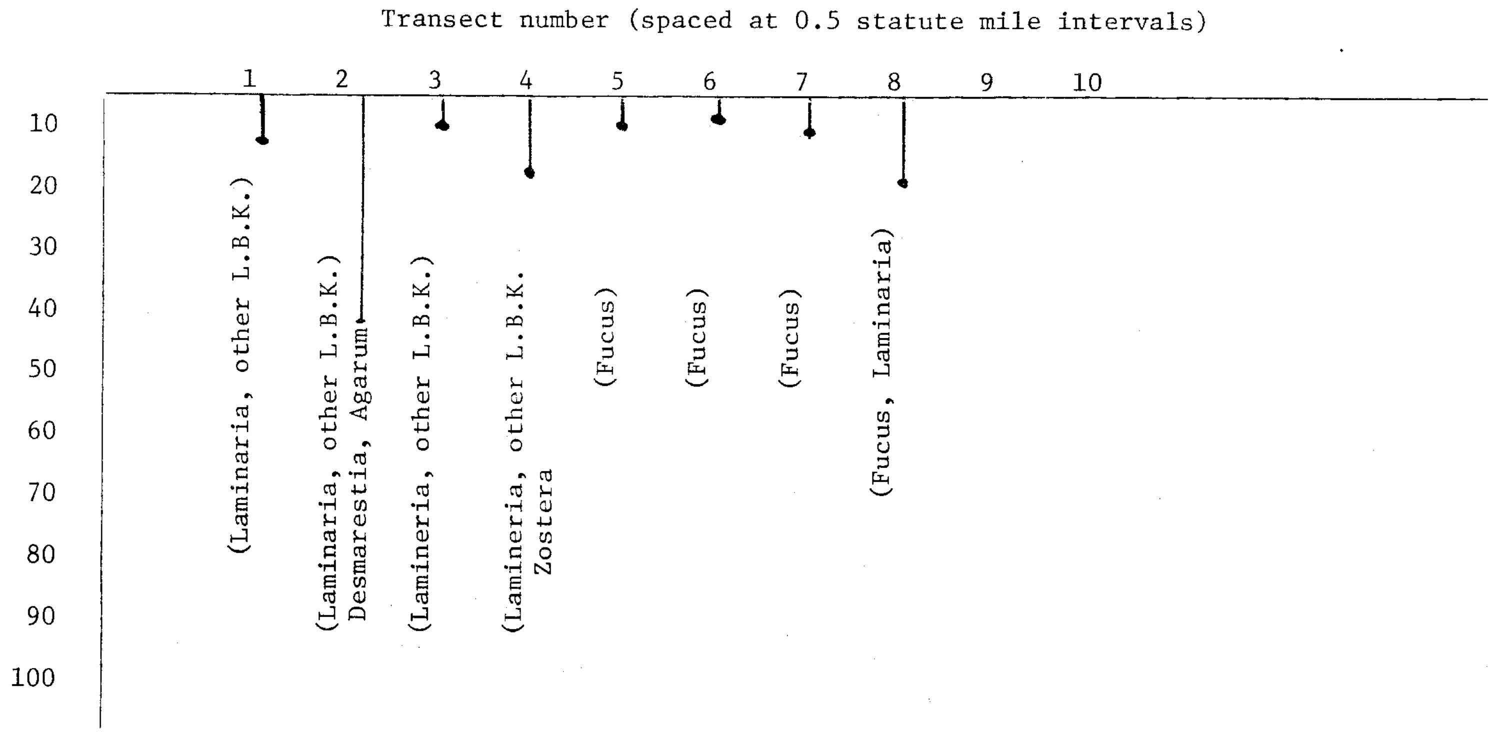


Table 14. Summary of substrate type utilized for spawning including (width) distance from beach for Kasaan Bay, 1979.

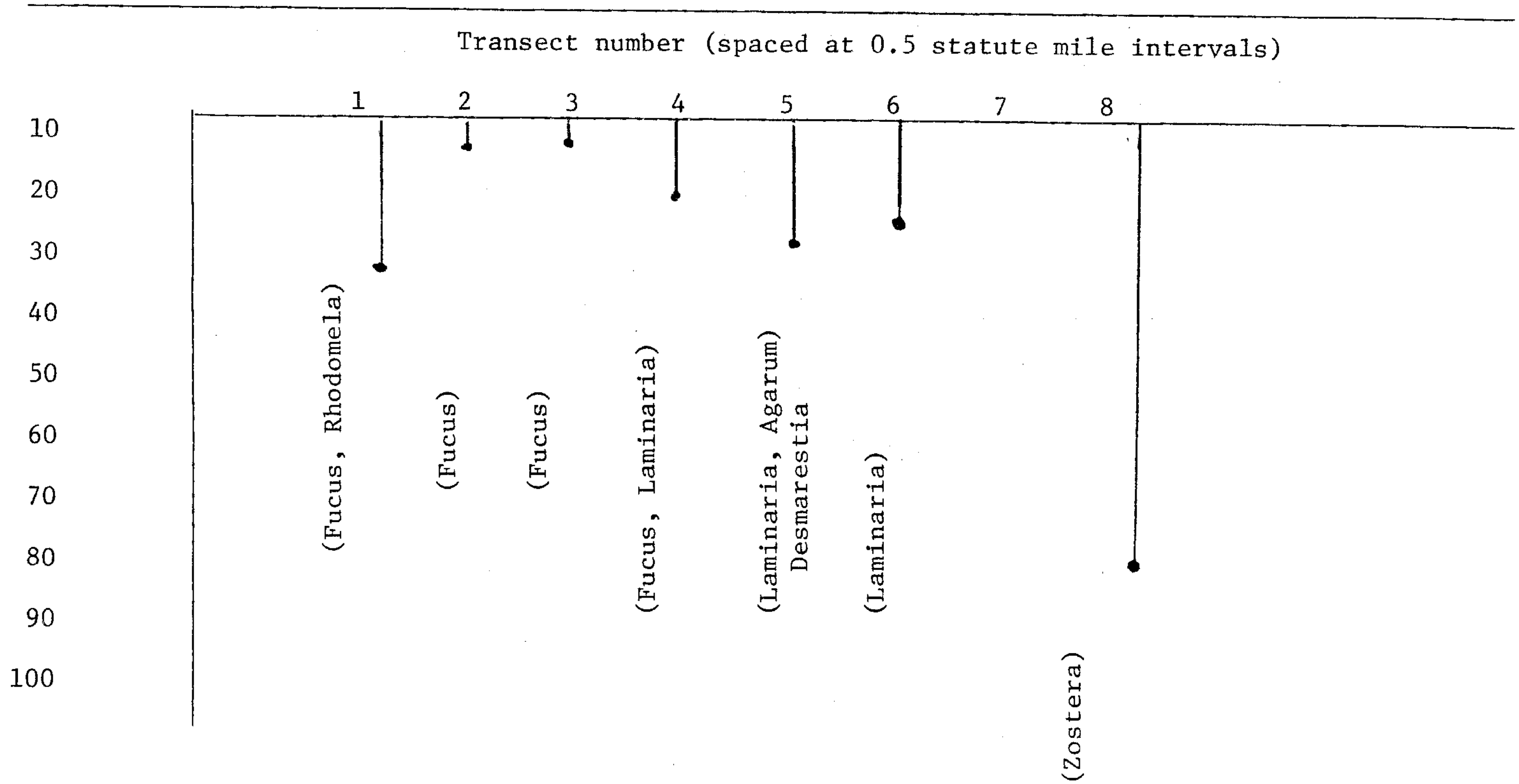
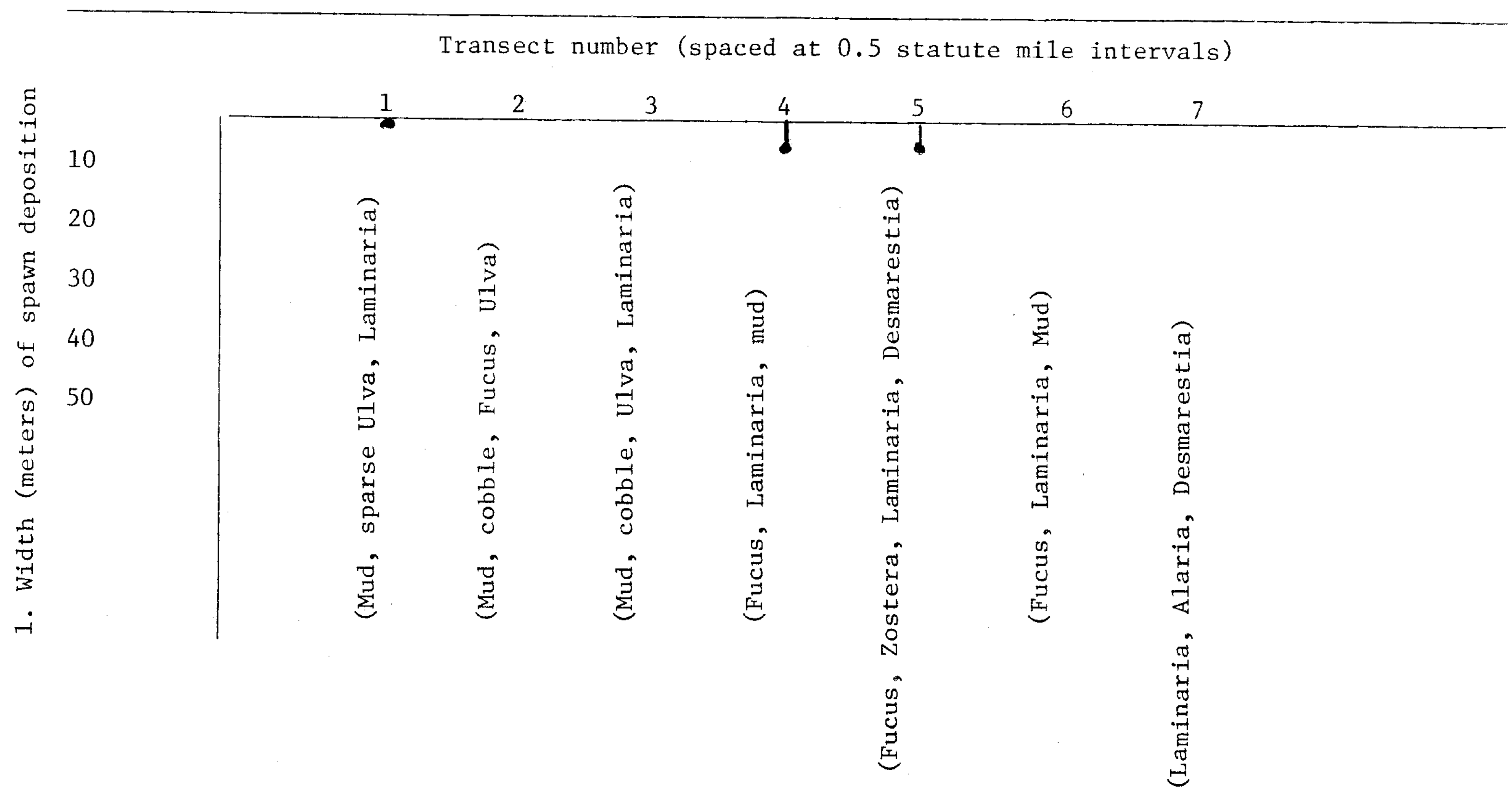


Table 15. Summary of substrate type utilized for spawning including (width) distance from beach Three Mile Arm, 1980.



1. Sampling conducted after hatching had started. Spawning potential limited to substrate (mud and sparse vegetation).

Table 16. Summary of substrate type utilized for spawning including (width) distance from beach Sitka, 1978.

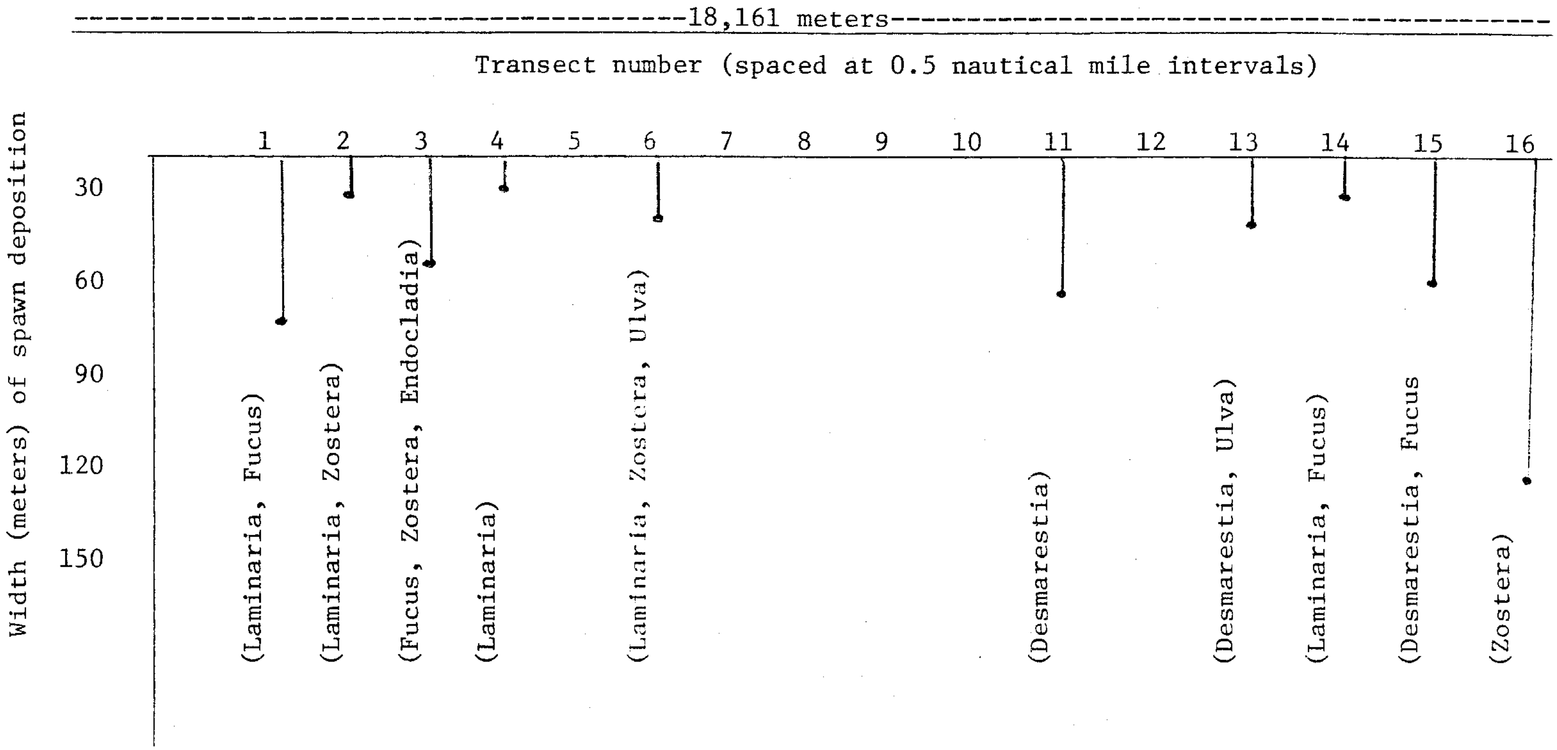


Table 17. Summary of substrate type utilized for spawning including (width) distance from beach Juneau, 1978.

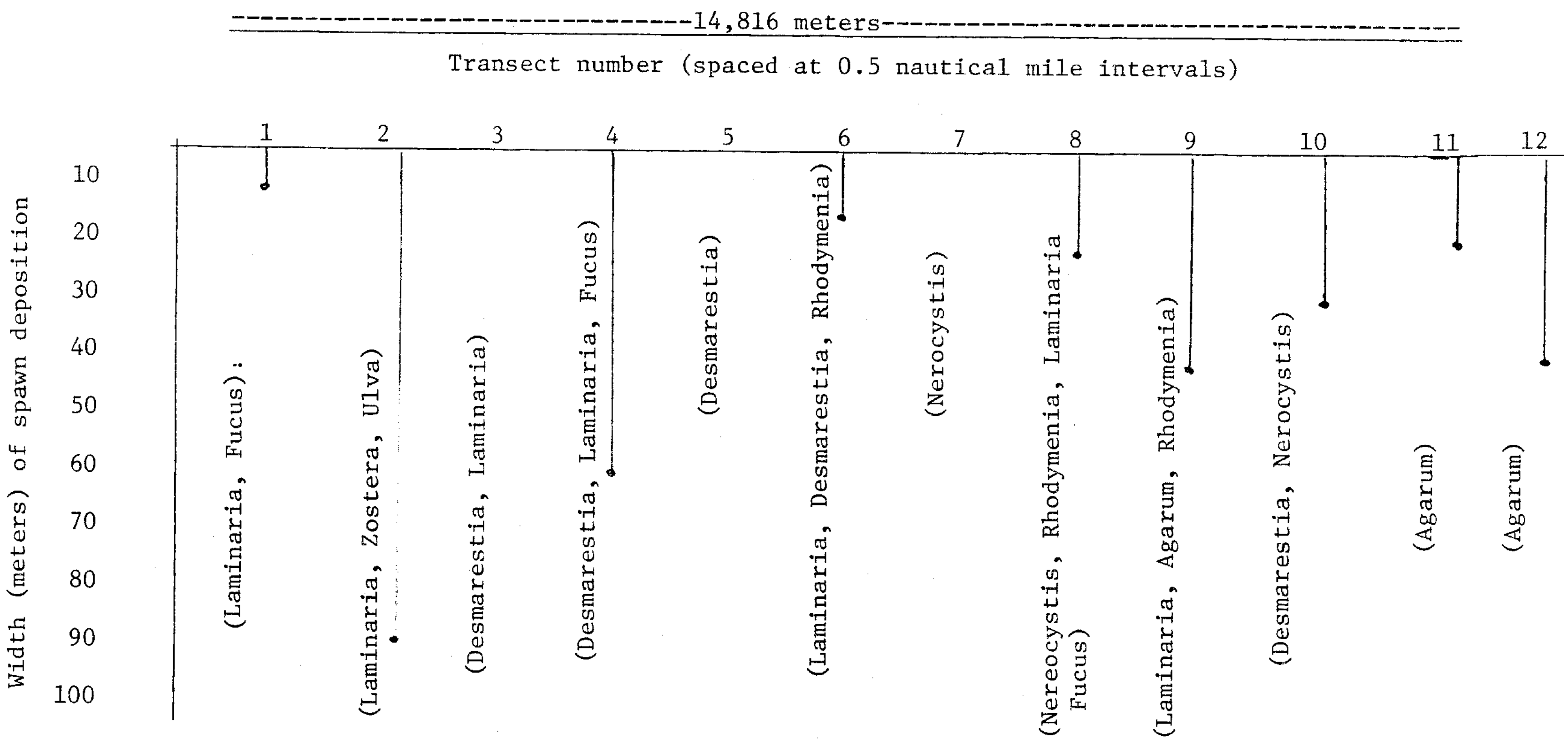


Table 18. Summary of substrate type utilized for spawning including (width) distance from beach Juneau, 1980.

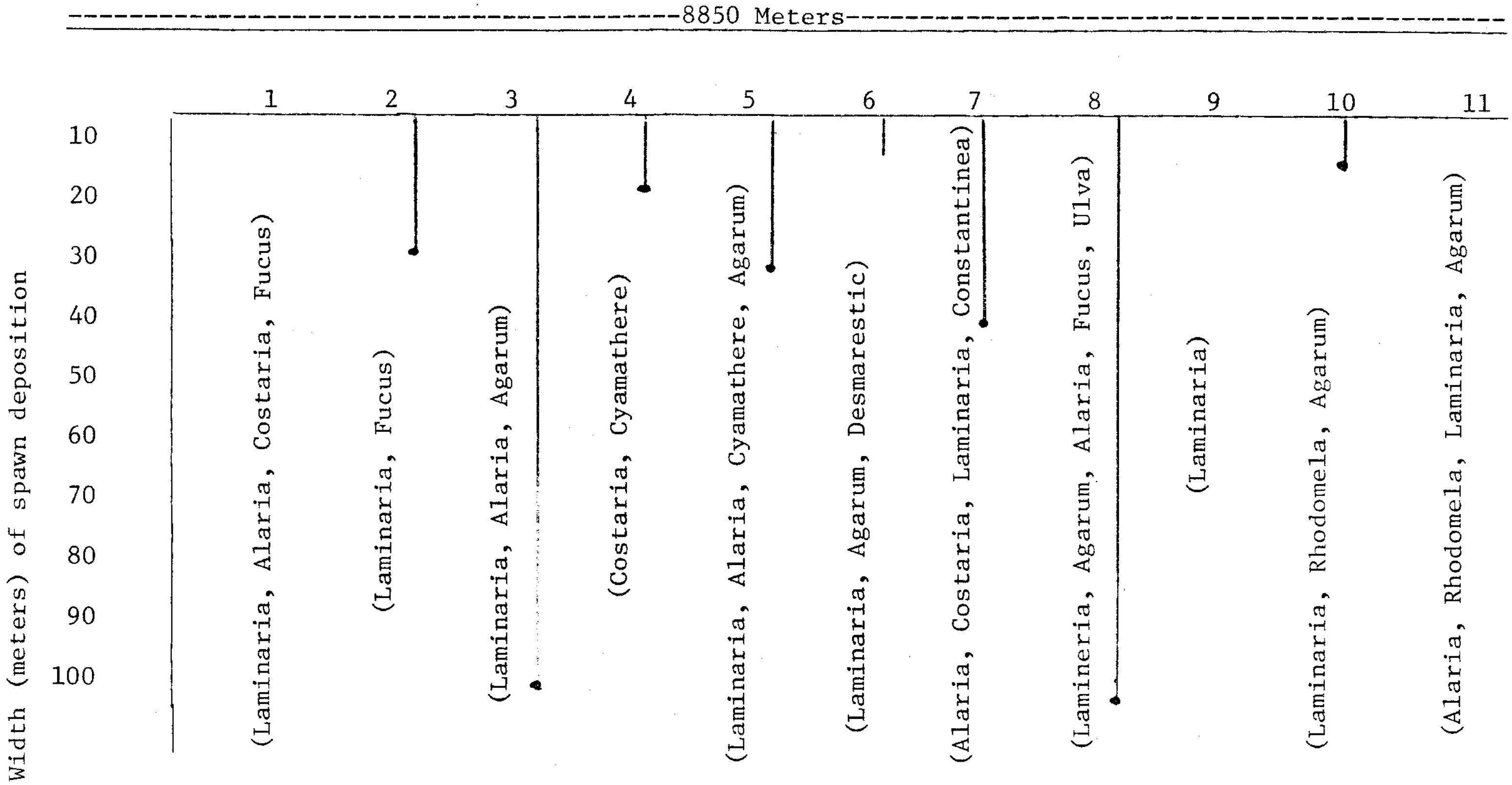


Table 19. Summary of substrate type utilized for spawning including (width) distance from beach Seymour, 1978.

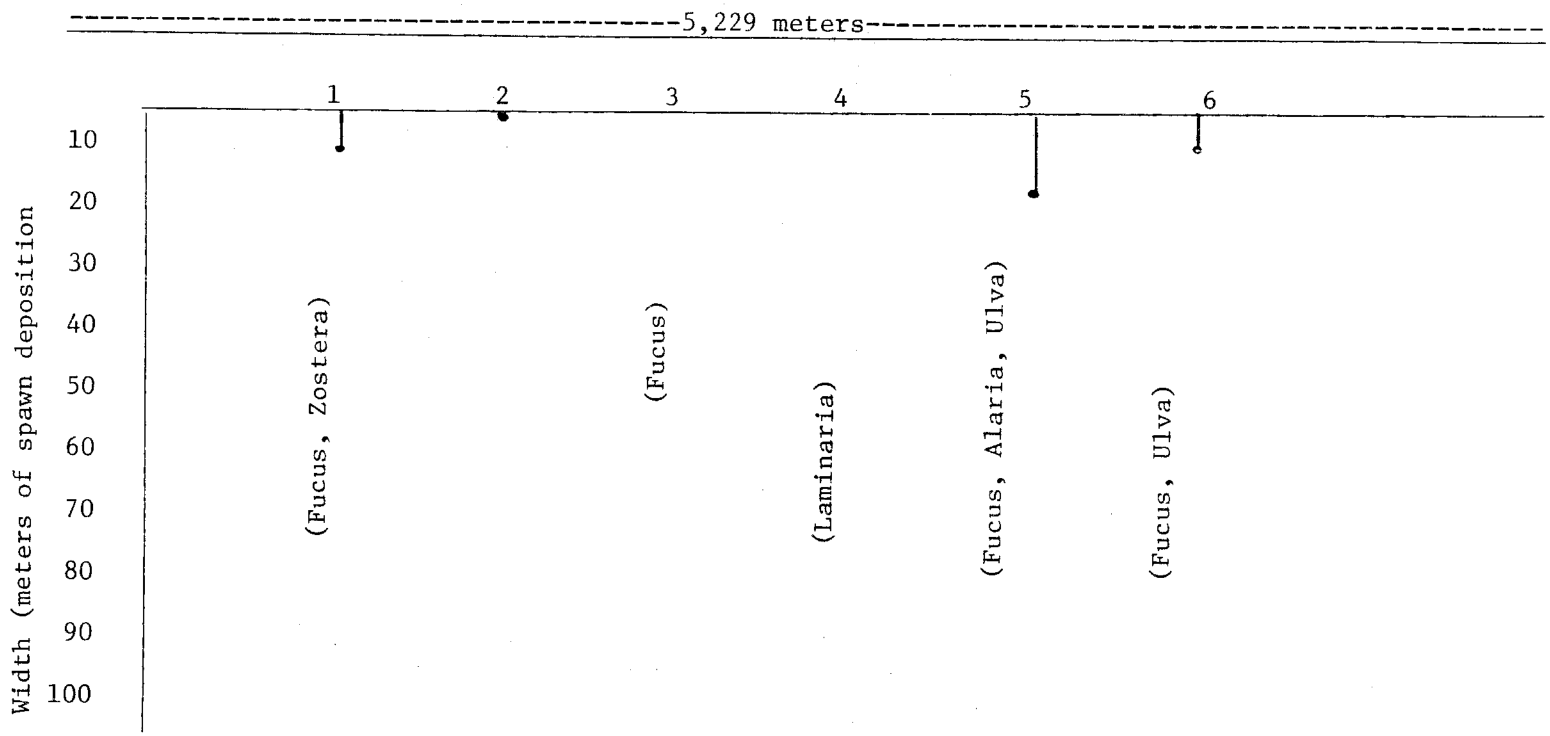


Table 20. Summary of substrate type utilized for spawning including (width) distance from beach Seymour, 1980.

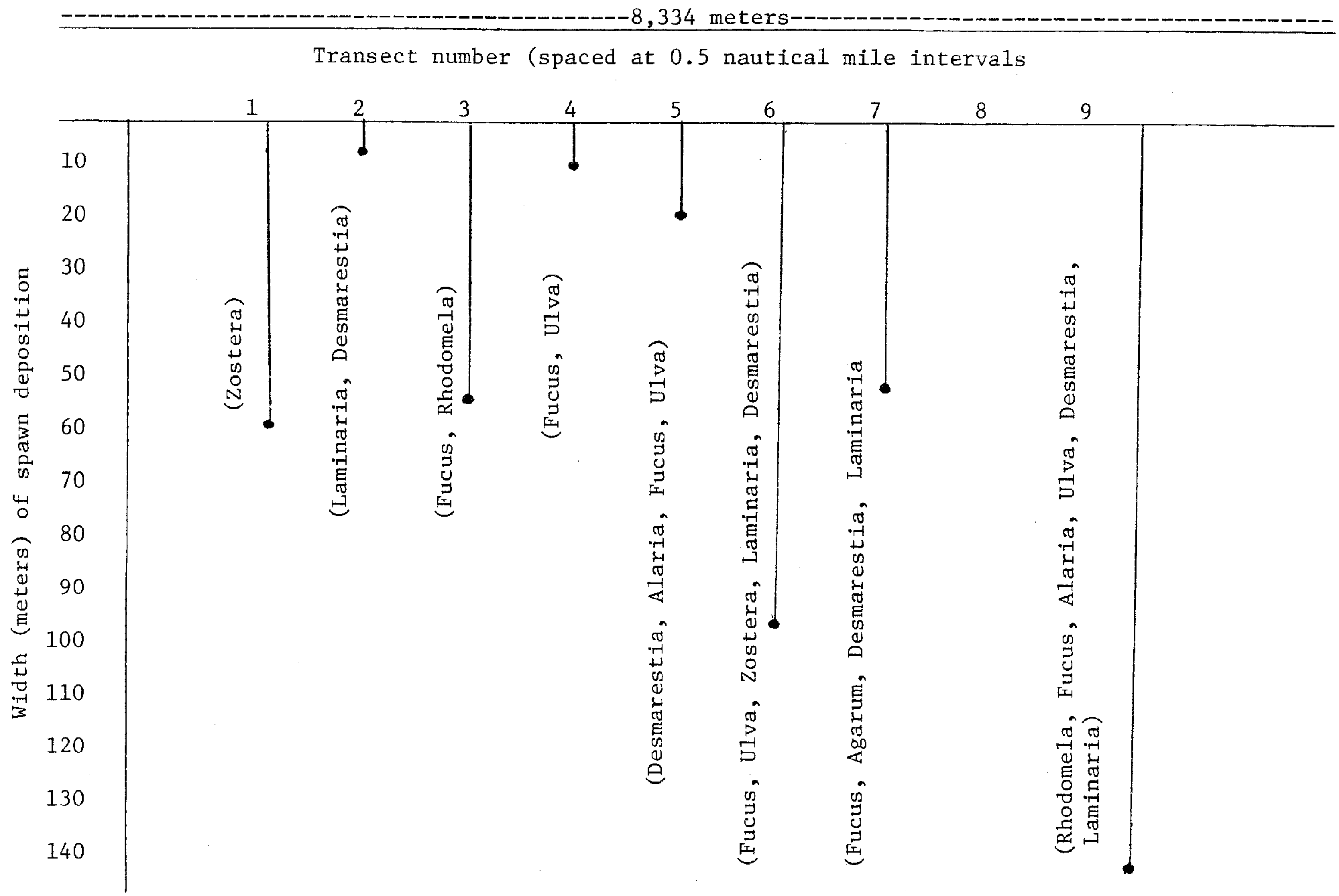


Table 21. Herring egg numbers computed from laboratory count by vegetative[1] type per sample and m^2 Boca de Quadra 1979.

	RANGE SAMPLE 1/10 m^2	METER^2	AVERAGE SAMPLE 1/10 m^2	METER^2	SAMPLES
F	299,871	2,998,710	74,807	748,070	29
EG	407,000	4,070,000	118,098	1,180,980	39
LBK	318,390	3,183,900	83,095	830,950	54
H	568,851	5,688,510	154,155	1,541,550	33
				Total	155

1. Vegetative Type

F - includes upper intertidal kelp
Fucus - rock weed
Porphyra - red laver
Codium - sea staghorn
Rhodomela - black pine
Constantinea - cup & saucer
Ulva - sea lettuce
Endocladia - nail brush
Rhodymenia - dulse

EG - includes midwater to lower tidal kelp
Zostera - eel grass

LBK - includes lower tidal large brown kelp.
Laminaria - sea girdle
Laminaria - sugar wreck
Laminaria - blister wreck
Costaria - seersucker
Cyamathere - triple rib
Alaria - wing kelp
Agarum - sea colander
Macrocystic - giant kelp
Nerocystis - ribbon kelp

H - includes lower tidal hair type kelp
Desmarestia - color changer
Odonthalia - brush kelp

Table 22. Herring egg numbers computed from laboratory count by vegetative[1] type per sample and meter^2 Boca de Quadra 1980.

	RANGE SAMPLE 1/10 m^2	METER^2	AVERAGE SAMPLE 1/10 m^2	METER^2	SAMPLES
F	264,570	2,645,700	51,912	519,120	35
EG	354,500	3,545,000	67,930	679,300	63
LBK	424,530	4,245,300	69,764	697,640	69
H	294,160	2,941,600	148,269	1,482,690	7
				Total	174

1. Vegetative Type

F - includes upper intertidal kelp dominated by Fucus.

Fucus - rock weed
Porphyra - red laver
Codium - sea staghorn
Rhodomela - black pine
Constantinea - cup & saucer
Ulva - sea lettuce
Endocladia - nail brush
Rhodymenia - dulse

EG - includes mid tidal to lower tidal kelp.

Zostera - eel grass

LBK - includes lower tidal large brown kelps.

Laminaria - sea girdle
Laminaria - sugar wreck
Laminaria - blister wreck
Costaria - seersucker
Cyamathere - triple rib
Alaria - wing kelp
Agarum - sea colander
Macrocystis - giant kelp
Nerocystis - ribbon kelp

H - includes lower tidal hair type kelp
Desmarestia - color changer
Odonthalia - brush kelp

Table 23. Contribution of substrate type by year sampled in terms of per cent of total deposition for Boca de Quadra, Sitka, Juneau, and Seymour Canal.

AREA	YEAR	PER CENT F.	PER CENT L.B.K.	PER CENT E.G.	PER CENT H.	PER CENT R.	PER CENT S.	TOTAL PER CENT
Boca de Quadra	1979	15	31	25	27	1	1	100
Boca de Quadra	1980	15	37	34	10	1	3	100
Sitka	1978	26	25	29	20	0	0	100
Juneau	1980	3	93	0	4	0	0	100
Seymour Canal	1980	40	25	11	24	0	0	100
Average		20	42	19	17	1	1	

1. Substrate types

F. - includes upper intertidal kelp

Fucus - rock weed
Porphyra - red laver
Codium - sea staghorn
Rhodomela - black pine
Constantinea - cup & saucer
Ulva - sea lettuce
Endocladia - nail brush
Rhodymenia - dulse

E.G.- includes mid to low tide levels

Zostera - eel grass

L.B.K.- includes low and subtidal kelp

Laminaria - sea girdle
- sugar wrack
- blister wrack
Costaria - seersucker
Cyamathere - triple rib
Alaria - wing kelp
Agarum - sea colander
Macrocystis - giant kelp
Nerocystis - ribbon kelp

H. - includes sub tidal hair type kelp

Desmarestia - color changer
Odonthalia - brush kelp

Table 24. Comparison of visual estimates versus laboratory counts from Boca de Quadra 1979-1980.

Observer David Street 1979

	Visual Estimate	Laboratory Count	Observations	Error % of Laboratory Count
F	320,000	472,387	6	67.7
EG	716,000	356,390	12	200.0
LBK	18,000	10,959	2	164.0
H	310,000	586,690	5	52.8
TOTAL	1,364,000	1,426,426	25	95.6

Observer Bob Larson 1979

	Visual Estimate	Laboratory Count	Observation	Error % of Laboratory Count
F	231,000	349,200	4	66.0
EG	425,000	628,138	2	67.6
LBK	207,000	487,189	3	42.5
H	412,000	519,111	5	79.3
TOTAL	1,275,500	1,983,638	14	64.3

Observer Dennis Blankenbeckler 1979

	Visual Estimate	Laboratory Count	Observations	Error % of Laboratory Count
F	232,500	248,751	8	93.4
EG	601,800	923,019	12	65.1
LBK	1,059,050	1,547,654	25	68.4
H	769,500	1,580,194	6	48.6
TOTAL	2,622,850	4,299,618	51	61.9

Observer Bob Larson 1980

	Visual Estimate	Laboratory Count	Observation	Error % of Laboratory Count
F	329,500	563,690	5	58.4
EG	1,971,300	1,533,385	21	128.5
LBK	1,438,700	1,978,968	17	72.6
H	170,000	174,450	2	97.4
TOTAL	3,909,500	4,250,493	45	91.9

Observer Dennis Blankenbeckler 1980

	Visual Estimate	Laboratory Count	Observation	Error % of Laboratory Count
F	700,000	958,151	1	75.0
EG	1,391,000	1,631,571	16	85.2
LBK	1,109,000	1,444,725	12	76.7
H	910,000	714,940	4	127.2
TOTAL	4,110,000	4,749,387	39	86.5

Predation and Egg Loss Study

Two permanent transects, 200 m in length, were established at Boca de Quadra immediately after spawning in April 1978. Three stations on each transect were covered with isolation cages to prevent bird predation yet allow egg removal from the influence of other exposure conditions. On each transect one cage was placed in the subtidal region, another at the low water mark, and the third at mid-tide. Sample stations at 10 m intervals were sampled on a repeated basis on the permanent transects to determine egg loss. Due to surge conditions and other project work commitments, subsequent sampling was only conducted once, 4 days after initial spawning. Inadequate sampling resulted in no data available to draw conclusions on Southeastern egg loss or predation. Predation and other egg mortalities has been estimated in Canada with varied rates. Egg mortality has been estimated at 25-40% in Southeastern Alaska by Montgomery (1958).

Tidal Conditions Versus Time of Spawning

Tidal conditions were compared to observed time of spawning at Boca de Quadra for the period 1976 to 1980. A summary of this data is illustrated in Figure 14. No correlation was observed between tide conditions and time of spawning.

Herring Gillnet Drop Out Analysis

Observations for herring loss from gillnet drop outs at Boca de Quadra have been documented during sampling by divers. Only a few areas have indicated herring mortality, suggesting no problems from drop outs.

CONCLUSIONS

1) The spawning time of Southeastern herring follows a specific time period (photoperiod) rather than related directly to temperature, tidal stage, etc.

2) Densities related to substrate type are as follows:

Substrate Type	High Estimate per M^2	Average Estimate per M^2	% Substrate Utilization Boca de Quadra 1979-1980
F.	2.6×10^6	519,120	15%
E.G.	3.5×10^6	679,300	30%
L.B.K.	4.2×10^6	697,640	34%
H.	2.9×10^6	1,500,000	19%
R.	N.A.	N.A.	1%
S.	N.A.	N.A.	1%
			100%

A large variation in density was observed because of the extent of egg deposition and substrate available. If suitable kelp beds extending far

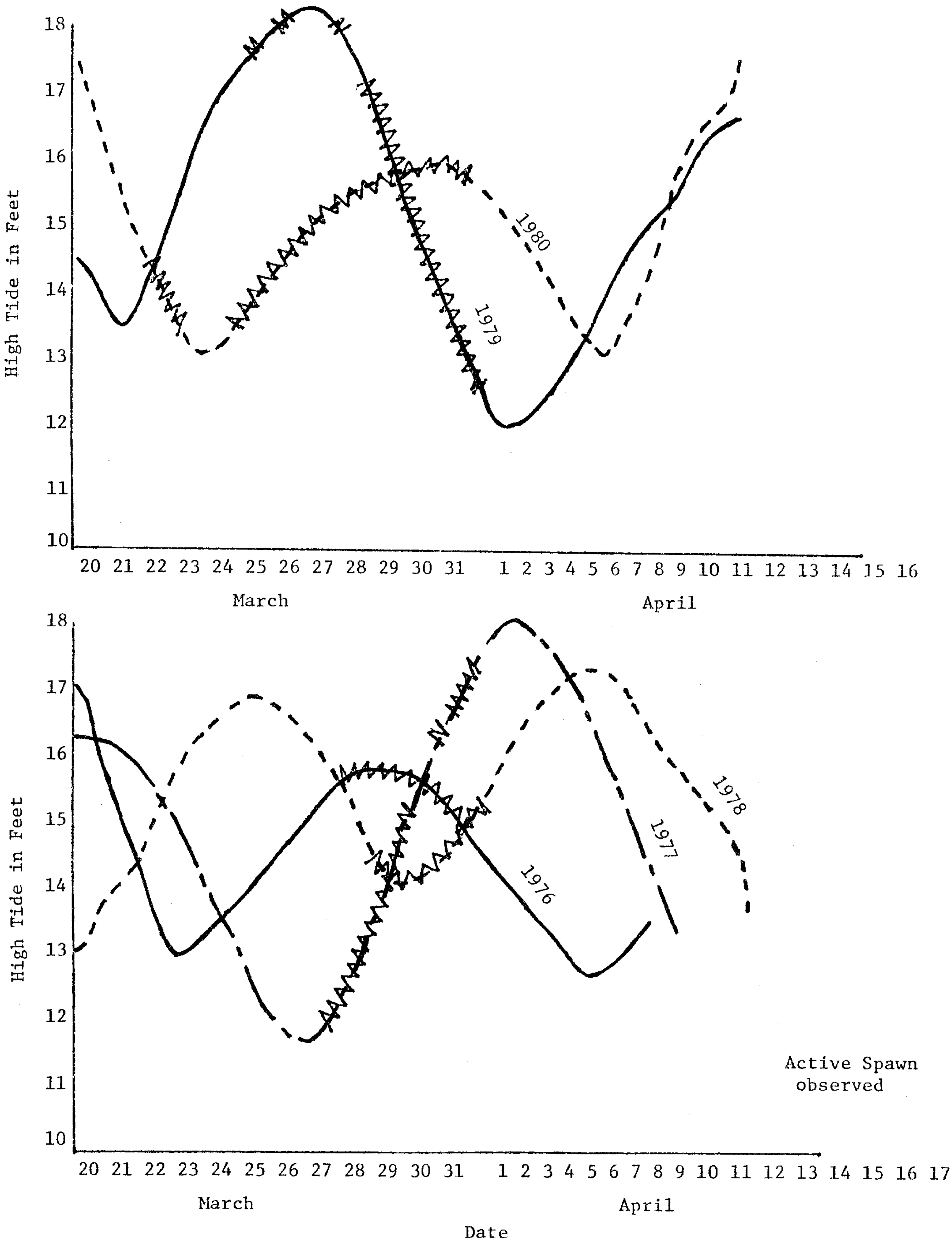


Figure 14. Comparison of tidal stage to time of spawning at Boca de Quadra, 1976-1980.

offshore are present, combined with heavy deposition, a small length of beach (linear miles) can represent a large biomass of herring spawners. For example, studies at Boca de Quadra for a 5-year period showed a range of 0.7 to 5.8 million lb (317.5 to 2,630.9 mt) of spawners per linear mile of beach receiving spawning.

3) A large variation in suitable substrate (kelp and sea grasses) available was documented. Boca de Quadra for example possesses kelp beds extending far offshore where other spawning grounds (e.g., Three Mile Arm) have only limited upper intertidal kelp present. Good substrate mapping reveals spawning potential.

4) Depth of spawnings was observed from +12 ft (3.66 m) tidal depth to -36 ft (11 m) depth. Spawning was not observed below this depth due to the lack of suitable habitat (kelp beds). In spawning area studies, usually at -40 ft (12.2 m), the bottom substrate changed to sand, mud, and isolated kelp. Depth preference for spawning varied from year to year and area to area studied. Depth preference referenced to tidal zones for areas studied are as follows:

Area and Year		Percent Upper Intertidal	Mid and Low Tidal	Sub Tidal	Total
Boca de Quadra	1979	15	27	58	100%
	1980	15	37	48	100%
Juneau	1980	3	0	97	100%
Sitka	1978	26	29	45	100%
Seymour	1980	40	11	49	100%

5) Southeastern herring spawned at temperatures ranging from 41° to 49° F (5 to 9.4 C).

6) Plankton blooms varied corresponding to cloud cover conditions. Plankton blooms were superficially documented only as an indicator to initial survival larva.

7) Predation studies were not adequate to draw any meaningful conclusions. Other studies conducted in British Columbia and Southeastern Alaska indicate 25% egg loss factor with high variability.

8) Photography was valuable for substrate and bottom condition documentation. Estimates of egg densities were difficult because of a lack of clarity of pictures and vegetative cover.

9) Visual estimates show promise in developing a fast method of evaluating spawning grounds. Accuracy varied among observers, but was consistent for individual observers. Observers tended to underestimate egg numbers, especially for high values. Need experienced divers year to year for comparable data.

10) Age composition and size computed from spawning ground sampling is valuable in documenting average length, fecundity, strong year classes, and indicator of recruitment.

11) Total biomass computed from surveys, including other collected data, is valuable for effective management of the resource. Total biomass can be computed from egg densities and area receiving spawn. A percentage of the biomass can be used as a harvest level for the next season. Actual spawning time can be predicted to aid in setting fishery seasons. Age composition and average size can be predicted to provide information on recruitment and general condition of stock.

12) Results from spawn surveys where acoustical estimates were made earlier were lower but reasonably close. Acoustical estimates made on the wintering stocks can include non-spawners resulting in higher estimates. Spawn estimates are invaluable especially in areas where herring are distributed but where accurate acoustical estimates cannot be made.

13) The spawning ground assessment function is the most important segment of the project. Data generated is valuable for management of the resource. Spawning ground biomass analysis eliminates problems in stock separation and separation of non-spawners. Spawning ground data can be a basis for developing escapement goals based on habitat and extent of deposition.

14) Collecting information on spawning ground utilizing SCUBA is very time consuming. Problems encountered include: cold temperatures, heavy seas, sea lion activity, and obtaining large vessel support for tendering divers.

RECOMMENDATIONS

1) Continue analysis on Southeastern spawning areas with priority given to sac roe commercial fishing areas where hydroacoustic biomass data is not available.

2) Continue studies on a fast reliable method of assessment, targeting on analysis of visual estimates of density.

3) Provide a support vessel to the project during April and May to conduct sampling.

4) Follow-up predation study for individual areas.

5) Develop vegetative mapping as a method of determining potential for Southeastern herring spawning grounds. Assistance from a kelp taxonomist to identify various species is recommended to establish baseline data of kelp present in Southeastern.

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