SITKA BOAT HARBOR HERRING SPAWN DEPOSITION STUDY

1994 SURVEY RESULTS

By

Robert Larson
and
Tim Minicucci

Regional Information Report[1] No. 1J94-24

Alaska Department of Fish and Game
Commercial Fisheries Management and Development Division
Juneau, Alaska

August 1994

---

[1] The Regional Information Report Series was established in 1987 to provide an information access system for all unpublished divisional reports. These reports frequently serve diverse ad hoc informational purposes or archive basic uninterpreted data. To accommodate timely reporting of recently collected information, reports in this series undergo only limited internal review and may contain preliminary data; this information may be subsequently finalized and published in the formal literature. Consequently, these reports should not be cited without prior approval of the author or the Commercial Fisheries Management and Development Division.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The Alaska Department of Fish and Game (ADF&G) entered into a cooperative agreement with the U.S. Fish and Wildlife Service (USF&WS), agreement COOP-93-065 number 1448-0007-93-7770, in the spring of 1993 to document the extent of herring spawning activities within the boundaries of the proposed small boat harbor at Sitka, Alaska. The monitoring study is part of the U.S. Army Corps of Engineers project plans for the harbor and will be used to determine if construction and operation of the harbor will have adverse effects on traditional spawning within this area. Construction of the harbor is scheduled to start during the summer of 1994. The first survey covered by this agreement occurred in April 1993. The 1994 survey should be the last pre-impact spawn survey.

OBJECTIVES

The study is designed to document the habitat and herring spawning patterns prior to the construction of the harbor and to provide post-construction monitoring. Aerial surveys will document herring spawn timing and spawn geographic distribution of the greater Sitka Sound herring population. Habitat within the proposed breakwater boundaries and herring egg densities will be described through examination of permanent experimental sites. Data collection will be possible for two years prior to construction, with at least two years of data collection after the harbor is completed.

METHODS

Aerial and Skiff Surveys

Aerial and skiff surveys are the standard method for documenting timing and location of herring spawning activities in Southeast Alaska. Surveys are conducted on a daily basis during the time herring are expected to be spawning in the area. Surveys are generally conducted with the aid of a small, fixed-wing aircraft, or skiff, by Department of Fish and Game employees. A daily log of herring distributions and spawning activities is maintained with shoreline lengths of herring spawning activities recorded on 1:40,000 scale NOAA navigation chart notes 17326 and 17324. The annual total miles of spawn is a sum of the amount of shore receiving spawn for the season without regard to the number of days spawning occurred.

Spawn Deposition Sampling

The spawn deposition survey technique for estimating numbers of herring eggs by spawning area has been used in Southeast Alaska since 1976. It has become the most common method of estimating herring escapements in recent years and is one of the major components of the age-structured analysis (ASA) method of projecting a subsequent year's return of spawning biomass.

The basic field sampling procedure entails 2-person SCUBA teams swimming along line transects and recording visual estimates of the number of eggs within a 0.10 m^2 sampling frame placed on the bottom at 5-meter distances along the transects. Because the frames (i.e., samples) are spaced equidistantly along transects, the record of the number of frames along a transect is also used to compute transect length. Along each transect, Diver 1 swims the specified inter-frame distance and places the frame on the bottom in a haphazard fashion (i.e., to minimize or avoid bias). Diver 2 then visually estimates the number of eggs within the frame boundary and records the number of eggs within the frame on a preprinted data form carried by Diver 2. Diver 2 records the sequential number of the sample along with data on depth, substrate and temperature. If time and conditions allow, Diver 1 also estimates the number of eggs for comparison with Diver 2's estimates and as a training exercise for Diver 1.

Starting points for transects in the control area are located randomly along the shore in areas where aerial or skiff surveys indicated probable spawn deposition. Transects are oriented perpendicular to the shoreline. Transects extend from the intertidal to either 15 meters of depth or until no further egg deposition is observed. The transect is extended above the waterline as far as egg deposition occurs. Dives are limited to 15 meters because deeper dives severely limit total bottom time for SCUBA divers and pose safety risks when conducted repetitively over several days. In addition, little if any herring egg deposition normally occurs deeper than 15 m. The number of transects for Sitka Sound was estimated from previous surveys to achieve a statistical objective of producing an estimate of mean egg density with a standard error within +/- 20% of the mean.

Visual Estimate Correction

Since visual estimates, rather than actual counts, of eggs within the 0.10 m^2 sampling frame are recorded, measurement error occurs. To minimize the influence of measurement error on final estimates of total egg deposition, diver-specific correction coefficients (c_i) are used to adjust estimates of egg density. Correction coefficients are estimated by visually estimating the number of eggs within a sampling frame and then collecting all of the eggs within the frame for later enumeration. To collect the eggs, divers either remove them from the substrate (e.g., rock) or collect the substrate (e.g., kelp) for later removal of the eggs.

Given the visual estimates and actual counts of eggs, the diver-specific correction factors are estimated as:

$$c_i = \frac{k_i}{v_i}$$

where: c_i = estimated correction factor for diver i.
k_i = mean laboratory count of egg numbers for diver i
v_i = mean visual estimate of egg numbers for diver i

Estimates of Total Egg Deposition

For each spawning area, total egg deposition is estimated as:

$$t = ad$$

where: t = estimated total deposition of eggs for the spawning area.
a = estimated total area (m^2) on which eggs have been deposited at the spawning area.
d = estimated mean density of eggs (eggs/m^2) at the spawning area.

The total area on which eggs have been deposited is estimated as:

$$a = lw$$

where: l = total meters of shoreline receiving spawn (determined from aerial/skiff surveys) at the spawning area.
w = mean length of transects conducted at the spawning area.

The mean density of eggs is estimated as:

$$d = \frac{\sum v_i c_i}{\sum n_i}$$

where: n_i = number of quadrants visually estimated by diver i.

Spawning Biomass Estimation

The total number of eggs per spawning area is the primary estimate used in forecasting herring spawning biomass. The estimate is used either with additional information such as age composition and growth information to calculate future returns, or in a simpler model which assumes that growth and recruitment are exactly balanced by natural mortality. The total Sitka Sound herring return and the subsequent forecast return for 1995 will be determined by ASA. A 1994 spawning biomass for the study area and control can be directly estimated from the number of eggs as:

$$b = \frac{t}{L * 100,000,000}$$

where: b = estimated total spawning biomass.
(100,000,000 is the standard eggs to spawning biomass conversion).

L = egg loss correction factor (=0.9) that accounts for an estimated 10% egg mortality between the time eggs are deposited and spawn deposition surveys are conducted.

RESULTS AND DISCUSSION

Aerial and Skiff Surveys

Aerial surveys to document herring activities in the Sitka Sound area were initiated March 16 and terminated April 17. The first active spawning in Sitka Sound occurred on March 26 in Leesofskaia Bay and ended on April 16 in the Goddard area. A total of 58.1 nautical miles of beach received spawn in

1994, slightly more than the 55 miles in 1993. The entire 1.0 nautical mile of shore within the boat harbor study area received spawn again in 1994. Due to a commitment to act as a management platform for the Cat Island commercial herring fishery, a department vessel was not available to support the boat harbor survey in 1994. The USF&WS supplied a local vessel to support the survey effort. Two USF&WS divers, Bill Hughes and Ed Grossman, assisted in the survey, as did ADF&G divers Bob Larson, Tim Minicucci, Bob DeJong and Bill Davidson.

Visual Estimate Correction

Twenty-five (25) pairs of visual estimates and laboratory egg counts were obtained from the four Department of Fish and Game divers that participated in the survey. Vegetative substrates included eelgrass, fucus and large brown kelp. Individual diver corrections, laboratory counts compared to visual estimates, ranged from 0.8 to 2.7. The calibration data used for these surveys was based on the sum of all samples taken since 1982; it is diver and substrate-specific (Table 1).

Estimates of Total Egg Deposition

The spawn deposition surveys began with the five permanent transects within the proposed small boat harbor on April 8 (Figure 1). Surveys continued north of town on April 9, 10 and 11, with the last 15 transects south of the bridge completed on April 12. A total of 39 randomly selected transects were completed (1.5 per nautical mile of beach) for the 57.1 nautical miles of spawn outside the boat harbor (Figure 2). The average transect width in the boat harbor (5 transects, 1 mile of beach) was 199 meters, with an average density of 167,752 eggs per square meter. The resultant boat harbor escapement estimate is 687 tons. For the area outside the boat harbor (39 transects, 57.1 nautical miles of spawn) the average transect width was 51 meters with an average density of 232,198 eggs per square meter. The resultant escapement estimate is 14,026 tons. The total egg-deposition-based biomass estimate for herring that spawned in Sitka Sound in 1994, including the proposed boat harbor area, is 14,713 tons (Table 2).

For comparison, the 1993 escapement estimate of 1,721 tons from inside the proposed boat harbor was computed using 276 meters width of spawn and a density of 313,086 eggs/m^2. The spawn deposition estimate for the control area was 31,076 tons, using a 91-meter width of spawn and a density of 349,086 eggs/m^2.

Individual transect data with the number of eggs per quadrant, vegetation type and depth is included for the boat harbor study (Table 3) and the Sitka Sound control area (Table 4). The daily aerial and vessel herring spawning activity survey log is also included (Table 5).

Table 1. Spawn deposition visual and laboratory estimates.

SITKA AREA SPAWN DEPOSITION VISUAL AND LABORATORY ESTIMATES

Date	Observer	Substrate	Eggs/ml	Visual Est.	Lab Est.	Lab/Visual
11-Apr-94	BD	elg	233	80,000	159,256	2.0
11-Apr-94	BD	lbk	222	65,000	63,285	1.0
11-Apr-94	BD	fuc	124	13,000	18,251	1.4
11-Apr-94	BDJ	elg	233	60,000	159,256	2.7
11-Apr-94	BDJ	elg	269	25,000	27,856	1.1
11-Apr-94	BDJ	lbk	205	20,000	17,313	0.9
11-Apr-94	BDJ	fuc	184	25,000	28,519	1.1
11-Apr-94	BDJ	fuc	179	35,000	38,324	1.1
11-Apr-94	BDJ	lbk	243	25,000	34,991	1.4
11-Apr-94	BDJ	fuc	118	35,000	32,522	0.9
11-Apr-94	RL	lbk	196	10,000	15,484	1.5
11-Apr-94	RL	lbk	199	75,000	92,336	1.2
11-Apr-94	RL	fuc	123	33,000	36,408	1.1
11-Apr-94	RL	fuc	204	35,000	35,559	1.0
11-Apr-94	RL	fuc	162	25,000	36,490	1.5
11-Apr-94	RL	lbk	232	75,000	61,374	0.8
11-Apr-94	TM	elg	233	110,000	159,256	1.4
11-Apr-94	TM	elg	269	15,000	27,856	1.9
11-Apr-94	TM	lbk	205	20,000	17,313	0.9
11-Apr-94	TM	fuc	184	20,000	28,519	1.4
11-Apr-94	TM	fuc	179	40,000	38,324	1.0
11-Apr-94	TM	lbk	222	70,000	63,285	0.9
11-Apr-94	TM	lbk	243	40,000	34,991	0.9
11-Apr-94	TM	fuc	118	35,000	32,522	0.9
11-Apr-94	TM	fuc	124	15,000	18,251	1.2

1994 SOUTHEAST HERRING SPAWN DEPOSTION DIVER CALIBRATIONS

	SUBSTRATE			
DIVER	Eel Grass	Fucus	Hair Kelp	Large Brown Kelp
B. Davidson	1.05	1.14	1.24	0.85
B. DeJong	1.01	1.15	1.03	0.95
R. Larson	1.03	1.02	1.22	1.08
T. Minicucci	1.24	1.13	1.03	0.86

Note: Estimates based on 1982-88, 1993 and 1994 data with each year weighted equally. Several extreme data points excluded.

Table 2. Sitka Area spawn deposition survey results, 1994.

SITKA SOUND HERRING SPAWN DEPOSITION SURVEY RESULTS 1994

SITKA BOAT HARBOR

Number of estimates	199	Divers with estimates	TM	BDJ	RL
		Corrected sum of estimates	1163.63	560.15	1614.48
Total number of eggs/.1meter quadrant (1,000s)	3338.26				
Average length of transects in meters	199	(total samples*5 meters/total [5] transects)			
Lineal meters of shoreline receiving spawn	1852	(1.0 nautical miles of shore* 1852 meters/nmile)			
Area of survey in square meters	368548	(length of shoreline * average width of transects)			
Average density of quadrant samples (1,000s)	17	(total eggs[1,000s] / total number of observations)			
Average density of eggs per square meter	167,752	(average .1 meter quadrant sample*1,000 eggs*10 meters)			
Total number of eggs in survey area	61,824,575,200	(total survey area in meters * total eggs per meter)			
Unadjusted escapement estimate in tons	618	(total number of eggs / 100,000,000 eggs per ton of spawners)			
Corrected escapement using 10% egg loss	687	(adjustment to account for 10% egg loss prior to survey)			

REMAINDER SITKA SOUND

Number of estimates	401	Divers making estimates	TM	BD	BDJ	RL
		Corrected sum of estimates	1616.43	826.56	1592.51	5275.65
Total number of eggs/.1meter quadrant (1,000s)	9,311.15					
Average length of transects in meters	51	(total samples*5 meters/total [39] transects)				
Lineal meters of shoreline receiving spawn	105,749	(57.1 nautical miles of shore* 1852 meters/nmile)				
Area of survey in square meters	5,436,593	(length of shoreline * average width of transects)				
Average density of quadrant samples (1,000s)	23	(total eggs[1,000s] / total number of observations)				
Average density of eggs per square meter	232,198	(average .1 meter quadrant sample*1,000 eggs*10 meters)				
Total number of eggs in survey area	1,262,367,517,410	(total survey area in meters * total eggs per meter)				
Unadjusted escapement estimate in tons	12,624	(total number of eggs / 100,000,000 eggs per ton of spawners)				
Corrected escapement using 10% egg loss	14,026	(adjustment to account for 10% egg loss prior to survey)				

SITKA SOUND AND BOAT HARBOR TOTAL

Sitka small boat harbor corrected escapement	687	Tons
Remainder Sitka Sound corrected escapement	14,026	Tons
Total Sitka Sound herring escapement	14,713	Tons

Table 3. Sitka Boat Harbor spawn deposition raw data 1994.

SITKA BOAT HARBOR HERRING SPAWN SURVEY 1994

DIVERS: Bill Davidson (BD), Bob DeJong (BDJ), Ed Grossman (EG), Bill Hughes (BH), Robert Larson (RL), Tim Minicucci (TM), Linda Perkins (LP)

BOTTOM TYPE: boulder=bld, cobble=cbl, fir=fir, gravel=gvl, mud=mud, mussels-mus, rock= rck, sand=snd, shell or shell hash=shl, woody debris=wdy

VEGETATION: alaria=ala, agarum=agm, coraline algae=cor, eelgrass=elg, fillamentous=fil, fucus=fuc, hairkelp=hir, laminaria=lam, large brown kelp=lbk, leafy red=red, loose=los, macrocystis=mac ulva=ulv

DATE	TRANSECT #	TIME IN	TIME OUT	TOTAL TIME	MAX DEPTH	DIVER #1	DIVER #2	INCREMENT (Meters)	DEPTH (Feet)	BOTTOM TYPE	VEGETATION	TM EYE	BDJ EYE	RL EYE	TM CORRECTION	BDJ CORRECTION	RL CORRECTION	COMMENTS
08-Apr-94	P-1	1616	1650	34	32	RL	LP	5	0	rck	fuc			30	0	0	31	
								5	7	rck	lbk			80	0	0	86	
								5	9	rck	lbk			5	0	0	5.4	
								5	11	rck	lbk			5	0	0	5.4	
								5	13	rck	lbk			9	0	0	9.7	
								5	15	rck	lbk			75	0	0	81	
								5	17	rck	lbk			10	0	0	11	
								5	20	gvl	lbk			7	0	0	7.6	
								5	23	gvl	lbk			3	0	0	3.2	
								5	25	gvl	lbk			15	0	0	16	
								5	26	gvl	lbk			1	0	0	1.1	
								5	25	gvl	lbk			6	0	0	6.5	
								5	28	mud	shl			0	0	0	0	
								5	29	mud	lbk			2	0	0	2.2	
								5	30	mud				0	0	0	0	
								5	31	mud	lbk			3	0	0	3.2	
								5	32	mud				0	0	0	0	2' visibility
08-Apr-94	P-2	1105	1158	53	39	BDJ	BD	5	3	rck			0		0	0	0	
								5	6	rck	hir		1		0	1	0	
								5	7	rck	hir		0		0	0	0	
								5	7	rck	red		20		0	22	0	
								5	7	rck	red		15		0	16	0	
								5	7	rck	red		2		0	2.2	0	
								5	8	rck	hir		60		0	62	0	
								5	9	rck	hir		20		0	21	0	
								5	9	rck	hir		30		0	31	0	
								5	9	rck	lbk		10		0	9.5	0	
								5	9	rck	lbk		10		0	9.5	0	
								5	10	rck	lbk		8		0	7.6	0	
								5	10	rck	hir		2		0	2.1	0	
								5	11	rck	hir		4		0	4.1	0	
								5	11	rck	hir		60		0	62	0	
								5	12	rck	lbk		40		0	38	0	
								5	12	snd	lbk		80		0	76	0	
								5	13	snd	lbk		7		0	6.7	0	
								5	13	snd	lbk		25		0	24	0	
								5	14	snd	lbk		7		0	6.7	0	
								5	15	snd	lbk		4		0	3.8	0	
								5	15	snd	hir		1		0	1	0	

Table 3. cont.

								5	16	snd	hir	5		0	5.2	0		
								5	17	snd	hir	4		0	4.1	0		
								5	18	snd	hir	5		0	5.2	0		
								5	19	snd		0		0	0	0		
								5	20	snd	hir	4		0	4.1	0		
								5	21	snd	lbk	8		0	7.6	0		
								5	22	snd	lbk	30		0	29	0		
								5	23	snd	lbk	25		0	24	0		
								5	25	snd	lbk	20		0	19	0		
								5	31	snd	lbk	30		0	29	0		
								5	33	snd	lbk	30		0	29	0		
								5	36	mud		1		0	1	0		
								5	37	mud		0		0	0	0		
								5	39	mud		0		0	0	0		
08-Apr-94	P-3	1600	1635	35	30	TM	EG	5	6	cbl		0		0	0	0		
								5	6	cbl	elg	60		74	0	0		
								5	6	cbl	hir	50		52	0	0		
								5	6	rck	hir	120		124	0	0		
								5	6	rck	lbk	70		60	0	0		
								5	6	rck	lbk	110		95	0	0		
								5	6	rck	lbk	50		43	0	0		
								5	6	rck	hir	40		41	0	0		
								5	6	rck	lbk	1		0.9	0	0		
								5	11	snd	lbk	1		0.9	0	0		
								5	12	snd	hir	1		1	0	0		
								5	13	rck	ala	10		11	0	0		
								5	14	snd	hir	1		1	0	0		
								5	15	rck	hir	3		3.1	0	0		
								5	16	rck	hir	0		0	0	0		
								5	17	rck		4		5	0	0		
								5	18	rck	lbk	50		43	0	0		
								5	18	rck		20		25	0	0		
								5	19	rck	lbk	35		30	0	0		
								5	19	rck	lbk	50		43	0	0		
								5	20	rck	lbk	40		34	0	0		
								5	20	rck	lbk	50		43	0	0		
								5	21	rck	lbk	60		52	0	0		
								5	21	rck	lbk	20		17	0	0		
								5	22	rck		0		0	0	0		
								5	22	cbl		0		0	0	0		
								5	22	snd		0		0	0	0		
								5	22	snd		0		0	0	0		
								5	23	snd		0		0	0	0		
								5	24	snd		0		0	0	0		
								5	24	snd		0		0	0	0		
								5	24	snd		0		0	0	0		
								5	24	snd		0		0	0	0		
								5	25	snd		0		0	0	0		
								5	25	snd		0		0	0	0		
								5	25	snd		0		0	0	0		
								5	26	snd		0		0	0	0		no vis.
								5	26	snd		0		0	0	0		
								5	27	snd		0		0	0	0		
								5	28	snd		0		0	0	0		
								5	30	snd		0		0	0	0		
08-Apr-94	P-4	1400	1447	47	33	RL	BH	5	4	cbl			0	0	0	0		
								5	6	cbl			0	0	0	0		
								5	6	cbl			0	0	0	0		

Table 3. cont.

								5	7	snd	red		0	0	0	0	
								5	7	snd			0	0	0	0	
								5	7	snd			6	0	0	6.2	
								5	7	cbl	red		15	0	0	16	
								5	7	cbl	red		90	0	0	95	
								5	7	cbl	red		150	0	0	159	
								5	8	cbl	fir		60	0	0	64	
								5	9	cbl	fir		110	0	0	117	
								5	9	cbl	fir		35	0	0	37	
								5	10	cbl	red		20	0	0	21	
								5	10	snd	elg		80	0	0	82	
								5	11	snd	elg		110	0	0	113	
								5	11	snd	elg		100	0	0	103	
								5	11	snd	elg		50	0	0	52	
								5	11	snd	elg		70	0	0	72	
								5	11	snd	elg		60	0	0	62	
								5	11	snd	elg		50	0	0	52	
								5	12	snd	elg		35	0	0	36	
								5	12	snd	elg		30	0	0	31	
								5	13	snd	elg		10	0	0	10	
								5	13	snd	elg		20	0	0	21	
								5	13	snd	elg		15	0	0	15	
								5	13	snd	elg		10	0	0	10	
								5	14	snd	elg		5	0	0	5.2	
								5	14	snd	elg		5	0	0	5.2	
								5	14	snd	ala		5	0	0	5.3	
								5	14	snd	ala		3	0	0	3.2	
								5	15	cbl	ala		2	0	0	2.1	
								5	15	cbl	lbk		5	0	0	5.4	
								5	15	cbl	lbk		1	0	0	1.1	
								5	16	cbl	lbk		4	0	0	4.3	
								5	16	cbl	lbk		1	0	0	1.1	
								5	17	gvl	lbk		0	0	0	0	
								5	17	gvl	lbk		10	0	0	11	
								5	18	rck	lbk		15	0	0	16	
								5	19	gvl	lbk		2	0	0	2.2	
								5	20	gvl	lbk		1	0	0	1.1	
								5	21	gvl	lbk		2	0	0	2.2	
								5	21	gvl	lbk		40	0	0	43	
								5	23	gvl	lbk		0	0	0	0	
								5	23	gvl	lbk		20	0	0	22	
								5	24	gvl	lbk		2	0	0	2.2	
								5	26	gvl	lbk		0	0	0	0	
								5	27	gvl	lbk		35	0	0	38	
								5	29	gvl	lbk		1	0	0	1.1	
								5	33	mud			0	0	0	0	
								5	33	mud			0	0	0	0	
08-Apr-94	P-5	1105	1158	53	30	TM	EG	5	4	rck		0		0	0	0	15 m to top of rock
								5	5	rck		0		0	0	0	
								5	5	rck		0		0	0	0	
								5	7	rck		0		0	0	0	
								5	7	snd		0		0	0	0	
								5	7	snd		0		0	0	0	
								5	7	snd	elg	1		1.2	0	0	
								5	8	snd	elg	0		0	0	0	
								5	8	snd	hir	90		93	0	0	
								5	9	snd	hir	15		15	0	0	
								5	9	snd	elg	30		37	0	0	
								5	9	snd	ulv	0		0	0	0	
								5	9	snd	ulv	0		0	0	0	

Table 3. cont.

	5	9	snd	elg	20	25	0	0	
	5	10	snd	elg	15	19	0	0	
	5	10	snd	elg	30	37	0	0	
	5	10	snd	elg	30	37	0	0	
	5	10	snd	elg	35	43	0	0	
	5	10	snd		0	0	0	0	
	5	10	snd		0	0	0	0	
	5	10	snd	elg	1	1.2	0	0	
	5	10	snd		0	0	0	0	
	5	11	snd		0	0	0	0	
	5	12	snd	hir	2	2.1	0	0	
	5	12	snd	lam	3	3.2	0	0	
	5	14	snd	elg	2	2.5	0	0	
	5	15	snd	hir	1	1	0	0	
	5	18	snd	lbk	1	0.9	0	0	
	5	18	snd	lbk	1	0.9	0	0	
	5	19	snd	lbk	1	0.9	0	0	
	5	20	snd	lbk	0	0	0	0	
	5	20	snd		0	0	0	0	
	5	21	snd		0	0	0	0	
	5	22	snd		0	0	0	0	
	5	22	snd	lbk	0	0	0	0	
	5	22	snd		0	0	0	0	
	5	22	snd	hir	0	0	0	0	
	5	23	snd	lbk	0	0	0	0	
	5	23	snd		0	0	0	0	
	5	23	snd	lam	0	0	0	0	
	5	24	snd	lam	2	2.1	0	0	
	5	24	snd	lam	0	0	0	0	
	5	24	snd	lam	15	16	0	0	
	5	24	snd	lam	20	21	0	0	
	5	24	snd	lam	0	0	0	0	visibility <1'
	5	25	cbl		0	0	0	0	
	5	25	cbl	lbk	2	1.7	0	0	
	5	26	cbl	lbk	5	4.3	0	0	
	5	26	cbl	lbk	0	0	0	0	
	5	27	cbl		0	0	0	0	
	5	27	cbl		0	0	0	0	
	5	28	cbl		0	0	0	0	
	5	28	cbl		0	0	0	0	
	5	30	snd		0	0	0	0	
	5	30	snd		0	0	0	0	

Table 4. Sitka Sound spawn deposition study control sites.

SITKA SOUND HERRING SPAWN DEPOSITION SURVEY 1994

DIVERS: Bill Davidson (BD), Bob DeJong (BDJ), Ed Grossman (EG), Bill Hughes (BH), Robert Larson (RL), Tim Minicucci (TM)

BOTTOM TYPE: boulder=bld, cobble=cbl, fir=fir, gravel=gvl, mud=mud, mussels-mus, rock= rck, sand=snd, shell or shell hash=shl, woody debris=wdy

VEGETATION: alaria=ala, agarum=agm, coraline algae=cor, eelgrass=elg, fillamentous=fil, fucus=fuc, hairkelp=hir, laminaria=lam, large brown kelp=lbk, leafy red=red, loose=los, macrocystis=mac ulva=ulv

DATE	TRANSECT #	TIME IN	TIME OUT	TOTAL TIME	MAX DEPTH	DIVER #1	DIVER #2	INCREMENT (Meters)	DEPTH (Feet)	BOTTOM TYPE	VEGETATION	TM EYE	BD EYE	BDJ EYE	RL EYE	TM CORRECTION	BD CORRECTION	BDJ CORRECTION	RL CORRECTION	COMMENTS
########	1	1518	1522	4	40	TM	BD	5	0	rck		70				74.2	0	0		
									5	rck		140				148.4	0	0	0	
									16	rck		60				63.6	0	0	0	
									27	rck		0				0	0	0	0	red urchins
									34	rck		0				0	0	0	0	cucumbers
									40	rck		0				0	0	0	0	steep, many sea lions
########	2	1527	1540	13	47	TM	BD	5	2	rck			30			0	31.8	0	0	
									11	rck			25			0	26.5	0	0	
									21	rck			50			0	53	0	0	
									29	rck			20			0	21.2	0	0	
									38	rck			0			0	0	0	0	
									47	rck			0			0	0	0	0	
########	3	1320	1330	10	36	RL	EG	5	1	rck	fuc				0	0	0	0	0	
									4	rck	fir				15	0	0	0	15.9	
									9	cbl	red				20	0	0	0	21.2	
									14	cbl	lbk				45	0	0	0	48.6	
									20	rck	lbk				25	0	0	0	27	
									28	rck	lbk				0	0	0	0	0	
									36	shl					0	0	0	0	0	
########	4	1348	1355	7	35	RL	EG	5	4	rck	fuc				130	0	0	0	132.6	
									14	rck	lbk				110	0	0	0	118.8	
									23	rck	lbk				80	0	0	0	86.4	
									35	rck	lbk				0	0	0	0	0	
########	5	1440	1452	12	32	BD	BDJ	5	0	bld				40		0	0	43.2	0	
									2	bld	fuc			50		0	0	57.5	0	
									5	rck	fuc			50		0	0	57.5	0	
									9	cbl	fir			17		0	0	18.36	0	
									12	cbl	red			30		0	0	32.4	0	
									13	snd	hir			15		0	0	15.45	0	
									20	snd	lbk			2		0	0	1.9	0	horse clams
									32	snd	lbk			4		0	0	3.8	0	
########	6	1410	1422	12	32	BD	BDJ	5	0	rck				0		0	0	0	0	
									2	rck	fuc			17		0	0	19.55	0	

Table 4. cont.

								4	rck	fuc		1	0	0	1.15	0	
								7	rck	fuc		0	0	0	0	0	
								9	rck	fuc		5	0	0	5.75	0	
								9	mud	elg		25	0	0	25.25	0	
								9	mud	elg		40	0	0	40.4	0	
								9	mud	elg		20	0	0	20.2	0	
								9	mud	elg		25	0	0	25.25	0	
								9	mud	elg		2	0	0	2.02	0	
								9	mud	elg		5	0	0	5.05	0	
								10	mud	elg		1	0	0	1.01	0	
								10	mud			0	0	0	0	0	
								13	mud			0	0	0	0	0	
								19	mud			0	0	0	0	0	
								25	rck			0	0	0	0	0	
								32	mud	lbk		0	0	0	0	0	
########	7	1153	1208	15	47	TM	BD	5	0	rck	fuc	12	0	13.68	0	0	
									8	rck	lbk	100	0	85	0	0	
									16	rck		45	0	47.7	0	0	
									21	rck	los	30	0	31.8	0	0	
									24	rck	lbk	50	0	42.5	0	0	
									33	rck		7	0	7.42	0	0	
									43	snd	los	3	0	3.18	0	0	
									47	snd	los	2	0	2.12	0	0	
########	8	1108	1122	14	37	TM	BD	5	1	rck	fuc	55	62.15	0	0	0	5m to mhw
									2	rck	hir	38	39.14	0	0	0	
									3	rck	hir	2	2.06	0	0	0	
									11	rck	lbk	30	25.8	0	0	0	
									14	mud	lbk	1	0.86	0	0	0	
									16	mud	los	2	2.12	0	0	0	
									18	mud	lbk	5	4.3	0	0	0	
									19	mud	lbk	5	4.3	0	0	0	
									21	mud	lbk	1	0.86	0	0	0	
									22	mud	lbk	30	25.8	0	0	0	
									22	mud	lbk	0	0	0	0	0	
									24	mud	lbk	0	0	0	0	0	
									26	mud	lbk	0	0	0	0	0	
									28	mud	lbk	0	0	0	0	0	
									30	mud		0	0	0	0	0	
									32	mud		0	0	0	0	0	
									34	mud		0	0	0	0	0	
									37	mud		0	0	0	0	0	
########	9	1016	1025	9	2	BDJ	TM	5	-2	gvl	fuc	20	22.6	0	0	0	
									2	gvl	lbk	5	4.3	0	0	0	
									2	gvl	elg	15	18.6	0	0	0	
									2	mud		0	0	0	0	0	
									2	mud		0	0	0	0	0	
									2	mud		0	0	0	0	0	
									2	mud		0	0	0	0	0	1/2 way across flats
########	10	955	1004	9	38	BDJ	TM	5	-1	gvl	fuc	60	67.8	0	0	0	
									1	gvl	fuc	30	33.9	0	0	0	
									3	gvl	lbk	5	4.3	0	0	0	
									8	gvl	lbk	0	0	0	0	0	
									13	mud	lbk	0	0	0	0	0	
									16	mud	lbk	0	0	0	0	0	

Table 4. cont.

									19	mud		0		0	0	0	0	
									21	mud		0		0	0	0	0	
									24	mud		0		0	0	0	0	
									26	mud		0		0	0	0	0	
									28	mud		0		0	0	0	0	
									30	mud		0		0	0	0	0	
									32	mud		0		0	0	0	0	
									34	mud		0		0	0	0	0	
									36	mud		0		0	0	0	0	
									37	mud		0		0	0	0	0	
									38	mud		0		0	0	0	0	
########	11	1012	1025	13	21	RL	BH	5	1	rck	fuc		15	0	0	0	15.3	
									3	rck	fir		125	0	0	0	132.5	
									6	rck	lbk		95	0	0	0	102.6	
									12	rck	lbk		15	0	0	0	16.2	
									14	snd	fil		1	0	0	0	1.06	
									17	snd	los		1	0	0	0	1.06	
									19	snd	fil		0	0	0	0	0	
									21	snd			0	0	0	0	0	
########	12	1101	1110	9	30	RL	BH	5	-1	rck	fuc		50	0	0	0	51	
									2	rck	fuc		140	0	0	0	142.8	
									7	rck	lbk		45	0	0	0	48.6	
									10	shl	lbk		40	0	0	0	43.2	
									13	rck	lbk		40	0	0	0	43.2	
									20	snd			0	0	0	0	0	
									26	snd			0	0	0	0	0	
									23	rck			0	0	0	0	0	
									25	rck			0	0	0	0	0	
									30	rck			0	0	0	0	0	
########	13	1155	1215	20	36	RL	EG	5	1	rck	fuc		90	0	0	0	91.8	
									6	rck	red		85	0	0	0	90.1	
									8	rck	red		40	0	0	0	42.4	
									15	rck	lbk		140	0	0	0	151.2	
									23	rck	lbk		25	0	0	0	27	
									31	rck			0	0	0	0	0	
									36	snd			0	0	0	0	0	
########	14	1227	1237	10	31	RL	EG	5	1	rck			0	0	0	0	0	
									6	rck	fuc		5	0	0	0	5.1	
									12	rck			0	0	0	0	0	
									19	rck			0	0	0	0	0	
									23	rck			0	0	0	0	0	
									31	cbl	shl		0	0	0	0	0	
########	15	1222	1226	4	22	TM	BD	5	0	rck	fuc	0		0	0	0	0	
									10	cbl	lbk	0		0	0	0	0	cuc present
									14	mud		0		0	0	0	0	
									16	mud		0		0	0	0	0	
									18	mud		0		0	0	0	0	
									19	mud		0		0	0	0	0	
									19	mud		0		0	0	0	0	
									20	mud		0		0	0	0	0	
									21	mud		0		0	0	0	0	
									22	mud		0		0	0	0	0	

Table 4. cont.

8-Apr-94	16	1240	1250	10	40	BDJ	BD	5	3	rck		0	0	0	0	0	
									19	rck	lbk	0	0	0	0	0	
									29	rck	hir	0	0	0	0	0	
									35	rck		0	0	0	0	0	
									40	rck	lbk	0	0	0	0	0	poor visibility
9-Apr-94	17	1026	1043	17	26	RL	BH	5	7	rck	fir	120	0	0	0	127.2	
									9	rck	hir	25	0	0	0	30.5	
									10	snd	elg	150	0	0	0	154.5	
									11	snd	lbk	20	0	0	0	21.6	
									12	gvl	lbk	2	0	0	0	2.16	
									13	gvl	lbk	0	0	0	0	0	
									14	gvl	lbk	1	0	0	0	1.08	
									16	gvl	lbk	0	0	0	0	0	
									18	gvl	lbk	1	0	0	0	1.08	
									17	gvl	lbk	0	0	0	0	0	
									19	gvl	lbk	0	0	0	0	0	
									23	snd	lbk	0	0	0	0	0	
									26	gvl		0	0	0	0	0	
									26	gvl		0	0	0	0	0	
9-Apr-94	18	1101	1125	24	25	RL	BH	5	3	gvl		0	0	0	0	0	
									6	rck		50	0	0	0	53	
									7	rck	fuc	100	0	0	0	102	
									8	rck	fuc	120	0	0	0	122.4	
									8	rck	fuc	130	0	0	0	132.6	
									8	rck	elg	220	0	0	0	226.6	
									9	rck	los	40	0	0	0	42.4	
									9	rck	los	30	0	0	0	31.8	
									10	snd	elg	70	0	0	0	72.1	
									10	rck	lbk	20	0	0	0	21.6	
									11	snd	elg	110	0	0	0	113.3	
									11	rck	lbk	30	0	0	0	32.4	
									12	snd	elg	100	0	0	0	103	
									12	snd	elg	40	0	0	0	41.2	
									12	snd	elg	90	0	0	0	92.7	
									13	snd	elg	125	0	0	0	128.8	
									15	snd	elg	50	0	0	0	51.5	
									17	gvl	lbk	0	0	0	0	0	
									18	snd	hir	0	0	0	0	0	
									18	snd	lbk	0	0	0	0	0	
									18	snd		0	0	0	0	0	
									21	snd		0	0	0	0	0	
									22	snd	lbk	0	0	0	0	0	
									25	snd		0	0	0	0	0	
9-Apr-94	19	1144	1157	13	24	RL	BH	5	2	gvl	lbk	0	0	0	0	0	
									3	gvl	lbk	0	0	0	0	0	
									6	gvl	lbk	0	0	0	0	0	
									8	cbl	lbk	1	0	0	0	1.08	
									9	snd	elg	30	0	0	0	30.9	
									10	snd	elg	160	0	0	0	164.8	
									12	snd	elg	250	0	0	0	257.5	
									14	snd	elg	50	0	0	0	51.5	
									15	snd	elg	75	0	0	0	77.25	
									16	snd	elg	1	0	0	0	1.03	

Table 4. cont.

									18	snd	elg			1	0	0	0	1.03
									19	snd	elg			1	0	0	0	1.03
									20	snd				0	0	0	0	0
									19	snd				0	0	0	0	0
									20	snd	lbk			0	0	0	0	0
									21	snd				0	0	0	0	0
									22	snd				0	0	0	0	0
									23	snd				0	0	0	0	0
									24	snd				0	0	0	0	0
9-Apr-94	20	1214	1228	14	30	RL	BH	5	4	rck				0	0	0	0	0
									6	cbl				0	0	0	0	0
									7	cbl	fuc			65	0	0	0	66.3
									9	cbl	elg			130	0	0	0	133.9
									10	cbl	lbk			45	0	0	0	48.6
									11	cbl				10	0	0	0	10.6
									12	gvl	lbk			0	0	0	0	0
									15	gvl	lbk			2	0	0	0	2.16
									17	gvl	lbk			4	0	0	0	4.32
									20	gvl	lbk			5	0	0	0	5.4
									23	snd				0	0	0	0	0
									26	snd				0	0	0	0	0
									30	snd				0	0	0	0	0
########	21	1116	1127	11	28	BD	BDJ	5	5	mud	fuc		1		0	1.14	0	0
									6	mud	elg		0		0	0	0	0
									6	mud			0		0	0	0	0
									6	mud			0		0	0	0	0
									7	mud			0		0	0	0	0
									7	mud			0		0	0	0	0
									12	mud	fuc		4		0	4.56	0	0
									16	mud	fuc		4		0	4.56	0	0
									28	mud			0		0	0	0	0
########	22	1159	1205	6	40	BD	TM	5	13	rck	lbk	1			0.86	0	0	0
									21	rck	lbk	0			0	0	0	0
									28	mud	lbk	0			0	0	0	0
									34	mud	lbk	0			0	0	0	0
									40	mud		0			0	0	0	0
########	23	1236	1245	9	35	RL	EG	5	3	cbl	fuc			0	0	0	0	0
									8	cbl	fil			0	0	0	0	0
									14	shl	elg			5	0	0	0	5.15
									21	shl	lbk			0	0	0	0	0
									26	shl	lbk			0	0	0	0	0
									35	shl	lbk			0	0	0	0	0
########	24	1215	1222	7	28	RL	EG	5	2	cbl	fuc			0	0	0	0	0
									4	cbl	fuc			0	0	0	0	0
									8	cbl	fil			0	0	0	0	0
									12	snd	elg			15	0	0	0	15.45
									21	snd	elg			0	0	0	0	0
									28	mud				0	0	0	0	0
########	25	1148	1156	8	31	RL	EG	5	5	rck	fuc			25	0	0	0	25.5
									9	rck	fil			250	0	0	0	265

Table 4. cont.

								15	cbl	los			10	0	0	0	10.6	
								22	cbl	lbk			0	0	0	0	0	
								31	snd	lbk			0	0	0	0	0	
########	26	1112	1125	13	29	RL	EG	5	3	rck	fuc			30	0	0	0	30.6	
									7	rck	fuc			50	0	0	0	51	
									10	rck	lbk			20	0	0	0	21.6	
									18	rck	lbk			25	0	0	0	27	
									29	cbl	lbk			0	0	0	0	0	
9-Apr-94	27	1438	1449	11	40	TM	BD	5	8	snd	fuc	1			1.13	0	0	0	60 meters to 8' 0 cbl
									10	snd	elg	10			12.4	0	0	0	
									12	snd	elg	7			8.68	0	0	0	
									17	mud	elg	0			0	0	0	0	
									24	mud	elg	0			0	0	0	0	
									30	mud		0			0	0	0	0	
									36	mud		0			0	0	0	0	
									40	mud		0			0	0	0	0	
9-Apr-94	28	1521	1529	8	36	BDJ	TM	5	0	rck	fuc		0		0	0	0	0	
									8	rck	hir		25		0	0	25.75	0	
									19	rck	lbk		50		0	0	47.5	0	
									26	cbl			1		0	0	1.08	0	
									30	snd			0		0	0	0	0	
									36	snd			0		0	0	0	0	
9-Apr-94	29	1700	1710	10	42	TM	EG	5	1	rck	fuc	15			16.95	0	0	0	5 m. to mhw
									8	rck	lbk	25			21.5	0	0	0	
									14	rck	lbk	5			4.3	0	0	0	
									20	rck		0			0	0	0	0	
									30	rck		0			0	0	0	0	
									35	rck	lbk	1			0.86	0	0	0	
									40	rck		0			0	0	0	0	
									42	rck		0			0	0	0	0	
9-Apr-94	30	1637	1648	11	20	TM	EG	5	3	rck	hir	90			92.7	0	0	0	
									4	rck	lbk	70			60.2	0	0	0	
									9	rck	lbk	35			30.1	0	0	0	
									10	rck	lbk	80			68.8	0	0	0	
									14	rck	lbk	3			2.58	0	0	0	
									17	rck	lbk	15			12.9	0	0	0	
									19	rck	lbk	2			1.72	0	0	0	
									20	cbl		0			0	0	0	0	20 m to 30' cbl/mud 0
9-Apr-94	31	1556	1615	19	35	RL	EG	5	2	rck	fil			30	0	0	0	31.8	
									5	rck	fir			125	0	0	0	132.5	
									13	rck				150	0	0	0	159	
									17	rck	lbk			65	0	0	0	70.2	
									24	rck				30	0	0	0	31.8	
									28	rck	los			20	0	0	0	21.2	
									29	shl	los			1	0	0	0	1.06	
									31	shl	los			3	0	0	0	3.18	
									32	shl	los			4	0	0	0	4.24	
									34	shl	lbk			0	0	0	0	0	

Table 4. cont.

									34	shl			0	0	0	0	0	
									35	shl			0	0	0	0	0	
									35	shl			0	0	0	0	0	
########	32	1006	1011	5	39	BD	TM	5	1	snd		0		0	0	0	0	
									2	snd		0		0	0	0	0	
									3	rck		90		0	95.4	0	0	
									4	snd	fir	30		0	31.8	0	0	
									6	snd	los	2		0	2.12	0	0	clams
									9	snd		0		0	0	0	0	clams
									15	snd	hir	0		0	0	0	0	clams
									21	snd	lbk	0		0	0	0	0	cucumbers
									31	snd		0		0	0	0	0	
									39	snd		0		0	0	0	0	
########	33	1025	1038	13	46	BD	TM	5	6	rck	lbk	3		2.58	0	0	0	5 m to mhw
									7	rck		0		0	0	0	0	
									9	rck	lbk	0		0	0	0	0	
									13	rck		0		0	0	0	0	
									19	rck		0		0	0	0	0	
									21	rck	lbk	3		2.58	0	0	0	
									23	rck	lbk	1		0.86	0	0	0	
									25	rck		1		1.06	0	0	0	
									28	rck	lbk	18		15.48	0	0	0	
									31	rck	lbk	1		0.86	0	0	0	
									35	rck	lbk	5		4.3	0	0	0	
									36	rck	lbk	25		21.5	0	0	0	
									42	rck	lbk	100		86	0	0	0	
									46	rck		0		0	0	0	0	
9-Apr-94	34	1336	1350	14	49	TM	EG	5	3	rck	fuc	30		33.9	0	0	0	
									10	rck	lbk	100		86	0	0	0	
									11	rck	lbk	140		120.4	0	0	0	
									15	rck	lbk	110		94.6	0	0	0	
									21	rck	lbk	50		43	0	0	0	
									26	rck	lbk	80		68.8	0	0	0	
									32	rck	lbk	90		77.4	0	0	0	
									38	snd	lbk	15		12.9	0	0	0	
									45	snd	lbk	2		1.72	0	0	0	
									49	snd	lbk	2		1.72	0	0	0	stop at 50', steep
9-Apr-94	35	1452	1510	18	44	RL	EG	5	3	rck	fuc		40	0	0	0	40.8	
									9	rck	fil		100	0	0	0	106	
									16	rck			140	0	0	0	148.4	
									26	rck	agm		30	0	0	0	32.4	
									33	rck	agm		1	0	0	0	1.08	
									37	shl	agm		20	0	0	0	21.6	
									44	shl			0	0	0	0	0	
9-Apr-94	36	1158	1212	14	38	BD	BDJ	5	0	rck			0		0	0	0	0
									6	rck	fuc		35		0	0	40.25	0
									12	rck	lbk		100		0	0	95	0
									13	rck	lbk		80		0	0	76	0
									17	rck	lbk		60		0	0	57	0
									20	snd	lbk		60		0	0	57	0
									24	snd	lbk		22		0	0	20.9	0
									27	snd	lbk		5		0	0	4.75	0
									32	cbl	lbk		25		0	0	23.75	0

Table 4. cont.

									34	mud	lbk	4	0	0	3.8	0		
									37	gvl		0	0	0	0	0	cucumbers	
									38	gvl		0	0	0	0	0		
9-Apr-94	37	1126	1137	11	8	BDJ	BD	5	0	bld		0	0	0	0	0		
									2	cbl	fuc	5	0	5.7	0	0		
									5	cbl	ulv	0	0	0	0	0		
									8	snd	ulv	0	0	0	0	0		
									7	mud	elg	1	0	1.05	0	0		
									8	mud	elg	3	0	3.15	0	0		
									8	shl		0	0	0	0	0		
									8	mud	elg	0	0	0	0	0		
8-Apr-94	38	1314	1338	24	37	BDJ	BD	5	3	cbl		0	0	0	0	0		
									5	rck	fuc	100	0	0	115	0		
									7	snd	hir	35	0	0	36.05	0		
									9	rck	hir	60	0	0	61.8	0		
									11	cbl	lbk	35	0	0	33.25	0		
									11	rck	lbk	55	0	0	52.25	0		
									12	rck		10	0	0	10.8	0		
									12	rck	lbk	5	0	0	4.75	0		
									13	rck	lbk	20	0	0	19	0		
									14	snd		260	0	0	280.8	0		
									14	snd	crl	3	0	0	3.24	0		
									15	gvl	hir	80	0	0	82.4	0		
									17	snd	hir	50	0	0	51.5	0		
									18	snd	lbk	2	0	0	1.9	0		
									20	snd	hir	10	0	0	10.3	0		
									22	snd	lbk	1	0	0	0.95	0		
									25	snd		0	0	0	0	0		
									26	snd		0	0	0	0	0		
									29	snd		0	0	0	0	0		
									30	snd		0	0	0	0	0		
									34	snd	shl	0	0	0	0	0		
									37	snd	shl	0	0	0	0	0		
9-Apr-94	39	1015	1045	30	44	BDJ	BD	5	0	rck		0	0	0	0	0		
									11	rck		0	0	0	0	0		
									14	rck	lbk	1	0	0.85	0	0		
									14	rck	lbk	3	0	2.55	0	0		
									15	bld	lbk	4	0	3.4	0	0		
									17	bld	lbk	40	0	34	0	0		
									18	snd	lbk	2	0	1.7	0	0		
									19	snd	lbk	12	0	10.2	0	0		
									20	snd	lbk	30	0	25.5	0	0		
									21	snd	lbk	45	0	38.25	0	0		
									22	bld	lbk	3	0	2.55	0	0		
									23	snd	lbk	6	0	5.1	0	0		
									25	snd	lbk	8	0	6.8	0	0		
									26	rck	lbk	10	0	8.5	0	0		
									27	rck		50	0	53	0	0		
									29	rck		3	0	3.18	0	0		
									30	gvl	lbk	2	0	1.7	0	0		
									31	snd		0	0	0	0	0		
									33	rck	lbk	45	0	38.25	0	0		
									36	snd	lbk	8	0	6.8	0	0		
									37	snd	lbk	50	0	42.5	0	0		

Table 4. cont.

39	snd	lbk	15	0	12.75	0	0
42	snd	lbk	13	0	11.05	0	0
43	snd	lbk	3	0	2.55	0	0
44	snd	lbk	0	0	0	0	0

Table 5. Sitka Sound Herring Spawning Activity Surveys, 1994.

AERIAL AND VESSEL HERRING SURVEYS, SITKA SOUND 1994

3/16/94	No sign of life to indicate any herring in the area.
3/17/94	Skiff survey Eastern Channel to Nakwasina Sound with sounder on the 28' whaler; no herring seen.
3/19/94	From Nakwasina to Burunof, no herring or herring predators seen.
3/21/94	Northend - sea lions near Halibut Point, Cove and mouth of Nakwasina Sound and off Sea Mart. Southend - Herring flipping on the surface and a whale feeding in Aleutkina Bay. Few sea lions in Dorothy Narrows.
3/22/94	Northend - looks very quiet; sea lions disappeared. Southend - big changes in Eastern Channel; large concentration of sea lions and gulls and four whales. Several pods of sea lions in Aleutkina Bay.
3/23/94	Northend - no change. Very quiet. Southend - no change. Large concentration of gulls and sea lions in Eastern Channel. Fewer sea lions in SamSing/Aleutkina area. Skiff survey - fish are moving out of Eastern Channel.
3/24/94	Northend - very quiet, few sea lions off Cove. Southend - considerably less birds in Eastern Channel. Large pod of sea lions off Cape Burunof. Skiff survey - north to south, nothing seen.
3/25/94	Southend - one whale and large pod (150) sea lions off Cape Burunof. Northend - Continues to be very quiet. Few sea lions off Old Sitka Rocks.
3/26/94	Northend - very foggy. No activity. Southend - big change. Many large pods of sea lions have moved into Eastern Channel toward Silver Bay. Whales and birds have also moved into this area. **First spawn** of the season in Leesofskaia Bay (1/2 - 1 mile). First fish on the beach. Several large schools observed in the shallows here also. R/V Sundance surveyed south including Aleutkina/SamSing Cove and Eastern Channel. Very little seen during survey; appears that fish have moved out again.
3/27/94	Northend - no change, still very quiet. Southend - much less predator activity in Eastern Channel and Aleutkina Bay than seen yesterday. Spawn in Leesofskaia Bay has completely dissipated. No spawn seen anywhere. Large concentration of sea lions in Camp Coogan.

Table 5. Cont.

3/28/94	Southend - approximately 1/4 miles of **active spawn** outside Sandy Cove. Several large schools seen in Sandy Cove and Aleutkina Bay in the shallows. Large concentration of sea lions in Camp Coogan. Nothing seen between 3 Entrance Bay and Goddard. Northend - first big change on northend. First fish on the beach on north. Approximately 2 miles of fish heavily schooled upshallow at Halibut Pt., all mostly around Middle Island, Crow Island and Kasiana Islands. Large concentrations of gulls in Parker Islands. Sundance survey north reported scattered schools on the surface in the Sitka Channel (moving north from Eastern Channel) and off Halibut Pt.
3/29/94	Southend - **active spawn** on Indian River Flats and Leesofskaia and Aleutkina Bay. Lots of fish up shallow in bight in Aleutkina; nothing seen W of Sandy Cove to SamSing. Northend - **major spawn** from Watson Pt. to Halibut Pt. and around Kasiana Island. **Spot spawn** at the head of Katlian Bay, Big Gavanski and around Middle Island. Sundance reported no schools were seen deep and only small schools in the shallows in the northend. Fish heavily banded at Halibut Pt. and throughout Katlian Bay.
3/30/94	Southend - **major spawning** from bridge to Dangel's Island. **Spot spawns** in Jamestown Bay to Entrance Pt. Several large schools in Silver Bay. Large pods of sea lions in Camp Coogan, **spot spawn** in Leesofskaia Bay, lots of fish in the bay. **Major spawn** in Aleutkina Bay. Several 30 to 100 tons schools along the beach in Deep Inlet. Nothing seen south of Cape Burunof to Goddard. 4 miles of spawn south to date. Northend - **major spawn** along HPR from Thompsen Harbor to Halibut Pt, around Middle, Kasiana Island, and Whiting Harbor. 14 miles of spawn north to date. Katlian looks bleak; Sundance reported very little fish. Fish heavily banded in the shallow from Lisianski Pt. to Dog Pt. Many large schools and ribbons up toward the head of Nakwasina Sound, mostly above Allan Pt. and in the pass. Some schools at the head of Nakwasina Passage. Southend - a lot less fish seen in Deep Inlet this afternoon compared to this morning when several large schools were seen. Solid thick band in Leesofskaia and Aleutkina Bays to Silver Pt. Fish have moved out of Silver Bay.
3/31/94	Northend - **major spawn** in Katlian Bay, Kasiana Island, Whiting Harbor. **Spawn** along road system but is beginning to disappear; a lot of herring still at the head of Nakwasina Sound. Southend - **major spawn** from bridge through Jamestown Bay and Thimbleberry Bay to Entrance Pt., Aleutkina Bay and Deep Bay.
4/1/94	Southend - **major spawn** in Aleutkina Bay and Deep Inlet, nothing W of Sandy Cove yet. Spawning has subsided between bridge and Entrance Pt. Northend - Spawning almost done in the northend. Some **spawn**, 2 miles, in Nakwasina and Signaka Islands. No herring seen in Nakwasina. Approximately 50 miles of spawn; 30 north and 20 south.

Table 5 Cont.

4/2/94	Southend - good **spawning** in Sandy Cove and Deep Bay. Some **spots** in Aleutkina. Nothing in Goddard or Redoubt. Northend - few **spot spawns** in Nakwasina Sound, Signaka Island and west Middle Island but other than that the spawn on northend is done. Nothing seen in Salisbury Sound.
4/3/94	Bill Burgess flew and reported only about 1/4 miles of **spawn.**
4/4/94	Three spots north for 1/2 mile of **active spawn** in Katlian and Nakwasina.
4/5/94	Aerial survey to West Crawfish. No herring or spawn.
4/7/94	Flew south to Whale Bay Crawfish mouth of Necker. Fifty to sixty sea gulls at Dorothy Narrows otherwise nothing in small and great arms of Whale, nothing at mouth of Necker. One hundred sea otters at Viesokoi Rock.
4/11/94	Flew Goddard and reported no spawn and only a few sea lions.
4/16/94	Five small **spot spawns** in Goddard area.
4/17/94	Spawn in Goddard completely dissipated.

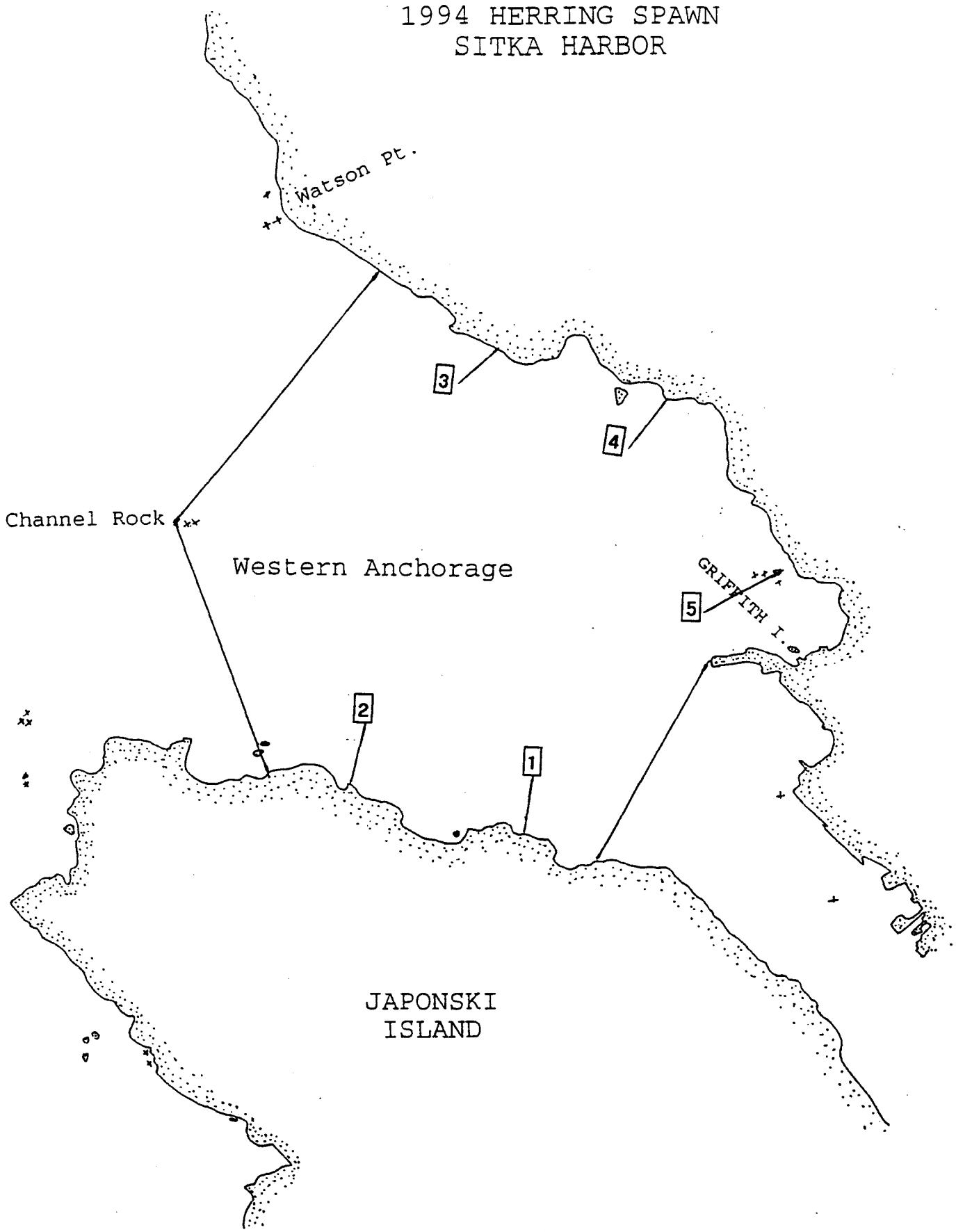

Figure 1. 1994 Herring Spawn Sitka Harbor.

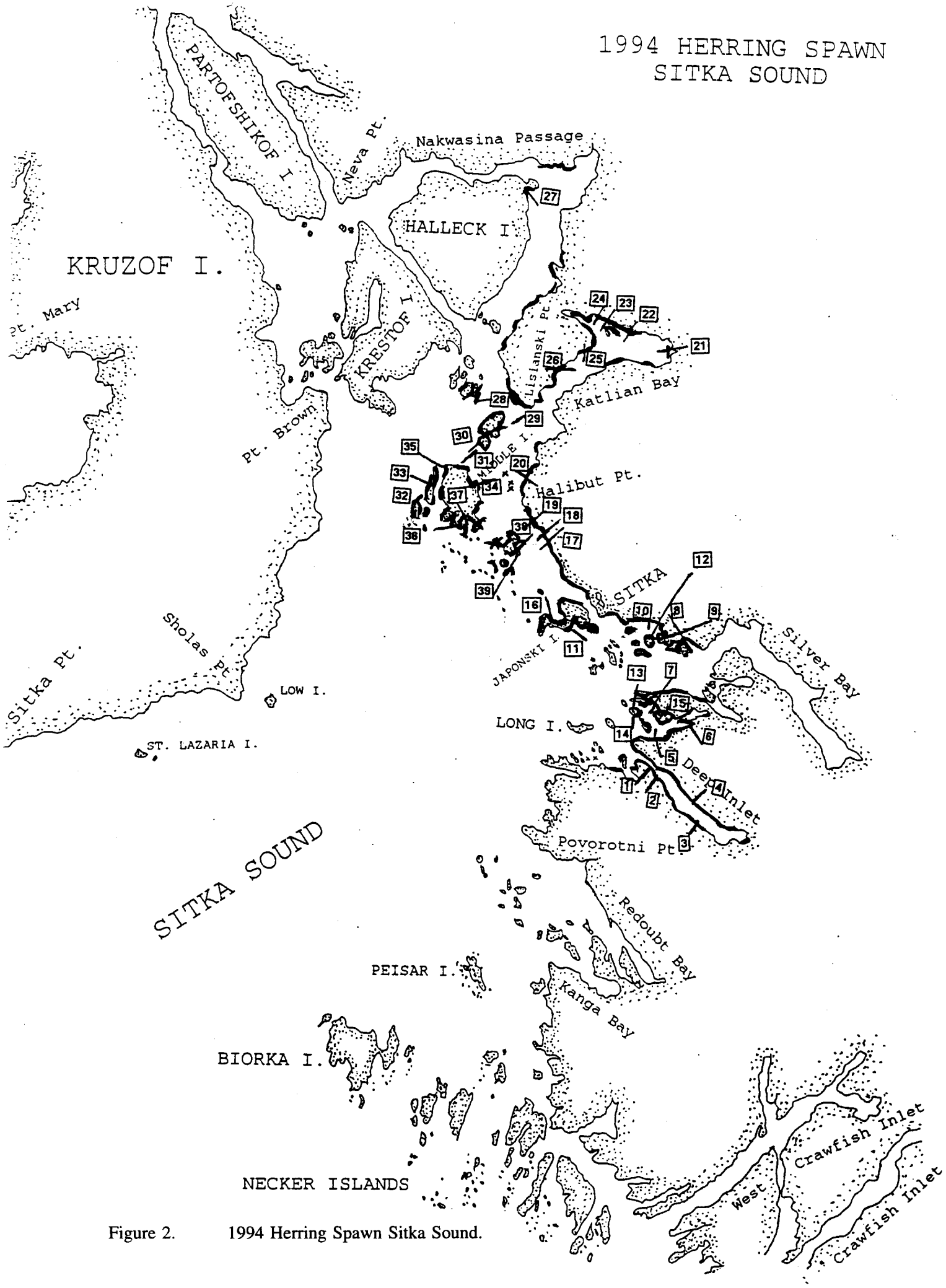

Figure 2. 1994 Herring Spawn Sitka Sound.