Assessment of 1979 Herring Spawnings in the Meares Island Section of Clayoquot Sound, British Columbia

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ASSESSMENT OF 1979 HERRING SPAWNINGS IN THE MEARES ISLAND SECTION OF CLAYOQUOT SOUND, BRITISH COLUMBIA

by

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ABSTRACT

Haegele, C. W., and D. C. Miller. 1979. Assessment of 1979 herring spawnings in the Meares Island section of Clayoquot Sound, British Columbia. Fish. Mar. Serv. MS Rep. 1547: 27 p.

In the Meares Island section of Clayoquot Sound, herring spawn mostly on extensive beds of eelgrass. A diver survey of herring spawnings was conducted in this area in 1979 to obtain the best possible estimate of egg deposition because estimates obtained from surface surveys seemed unrealistic. The survey showed that 3.7859×10^{12} eggs were deposited on 4.0028×10^{6} m^2 area. The large Elbow Bank had 50% of this spawn on 35% of the area. Sea grasses occupied 94% of the spawn area. Most of the spawn was subtidal.

Key words: Pacific herring, spawn, diver survey.

RÉSUMÉ

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Dans la région de l'île Meares, à l'intérieur de la baie Clayoquot, le hareng fraye principalement sur de vastes bancs de zostère. On a effectué en 1979 un levé par plongées des frayères de hareng de la région afin d'obtenir une estimation aussi précise que possible du dépôt d'oeufs: en effet, les estimations obtenues par des levés effectués à partir de la surface semblaient irréalistes. L'étude a montré que $3,7859 \times 10^{12}$ oeufs ont été déposés sur une superficie de $4,0028 \times 10^{6}$ m^2. Le grand banc Elbow portait 50% du frai sur 35% de la surface étudiée. Les plantes marines occupaient 94% de la surface de fraye. La plus grande partie du frai se trouvait à l'étage subtidal.

Mots clés: hareng du Pacifique, fraye, levé par plongées.

INTRODUCTION

The Meares Island section of Clayoquot Sound (Section 245 in Fig. 1) is one of the major herring roe fishing and herring spawning areas on the west coast of Vancouver Island. A unique feature of this area are the large beds of eelgrass (Zostera marine) on the banks and shallow shorelines (Haegele and Hamey 1979). Herring deposit their adhesive eggs on this extensive vegetation. As a result of the extreme widths and the suspected patchiness and variability in percent cover of the vegetation, confidence in egg deposition estimates, which are used in stock assessment (Humphreys and Hourston 1978), from surface surveys has been low. A diver survey of herring spawnings in this area was seen as a means of obtaining the best possible estimate of egg deposition. Initially, a thorough two-week survey of spawnings was planned but as a result of a fire aboard the first survey vessel, the survey was curtailed to the one week preceding the hatching of the eggs (March 25, 1979).

METHODS

The approximate locations of herring spawnings in the study area (Fig. 2) were identified by surface grappling, diver spot checks and the towing of divers on a sled behind a power boat. Locations for diver transects were then chosen to give the best coverage in the time available. Of necessity, major and heavier egg depositions received better coverage than smaller and lighter egg depositions.

Transects consisted of graduated gillnet leadline set approximately perpendicular to the shoreline from a power boat under radio direction from a surveyor on the beach. The surveyor used a Theodolite to survey and position the transect. Divers swam along the transect leadline making observations of spawn substrate (vegetation) type, percent cover of vegetation, patchiness of vegetation and layers of eggs. They recorded the distance along the leadline for each set of observations. Whenever any changes in any of these observations occurred, a 0.25 m^2 (0.5 m x 0.5 m) sample was taken. It consisted of all the rooted vegetation and attached eggs within the 0.25 m^2 sample quadrat. The depth at which samples were obtained was also measured and later corrected to chart datum.

The samples were transported in burlap sacs to the shipboard laboratory, where the sample was separated into fractions by vegetation species according to Widdowson (1973 and 1974) and Scagel (1967). Each fraction was weighed wet to the nearest gram. Samples were classified into vegetation types based on the percent by weight of species. These vegetation types are grasses, rockweed, kelp, other brown algae, foliose red algae and filamentous red algae (Haegele et al. 1979). The number of layers of eggs for each sample was determined independently by 2 to 4 raters and the ratings averaged.

Zones of spawn were identified on the basis of this survey information and vegetation maps prepared from aerial photographs (Haegele and Hamey 1979). The area of each zone was measured. Using keys relating vegetation type, percent cover of vegetation and layers of eggs to eggs per unit area (Haegele et al. 1979), the number of eggs in each zone was calculated.

RESULTS AND DISCUSSION

Thirty-one spawn zones were identified and plotted on vegetation maps for the study area (Figs. 3A to 7B). Detailed calculations of egg numbers for each zone are contained in Table 1 and are summarized by map in Table 2 and Table 3. There were 17 transects with 118 stations at which samples were taken. These are identfied on the maps.

Since time did not permit complete transect coverage of all the spawnings, information for some of the zones (zones 6, 7, 12, 15, 20, and 25 to 31) came from grappling or spot diving information. These zones accounted for 12.6% of the 3.7859×10^{12} eggs deposited and 18.2% of the 4.0028×10^{6} m^2 area of spawn. Of the two large banks in the area, Elbow Bank (zones 17, 18, and 19 in Fig. 5B) had 50% of the eggs on 35% of the area while Yellow Bank (zones 1, 2, and 3 in Fig. 3B) had only 6.7% of the spawn on 12.7% of the area because of low percent cover vegetation. The other major spawning was at Yarksis (zone 23 in Fig. 6B) where 19% of the eggs were deposited on 10.8% of the area.

Sea grasses occupied 93.7% of the spawn area (Table 4). Foliose red algae, kelp, rockweed, and filamentous red algae accounted for the remainder in that order. Grasses at 70% cover and 1 egg layer and 80% cover and 7 egg layers were the largest substrate type-percent cover-egg layer category, occupying 8.5% and 8.3% of the total area respectively. Grasses at 70% cover were the largest substrate type-percent cover category at 22.5% of total area and grasses at 5 egg layers was the largest substrate type-egg layer category at 15.5% of total area.

Of the 91 samples for which depths were recorded, 66% were collected between -0.6 to -2.5 m while the total range was from +1.4 to -8.0 m (Table 5). The average percent cover ($\pm$ 1 S.E.) of vegetation was also highest between -0.6 and -2.5 m at 56($\pm$4) (Table 5). Above -0.6 m, average percent cover was 53($\pm$9) and below -2.5 m it was 34($\pm$5).

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Table 1. Spawn deposition data by map and zone.

Map	Transect no.	Zone	Substrate type	No. of samples	Percent cover	Layers of eggs	Eggs/m^2 ($x10^3$)	Area (m^2x10^3)	Total no. of eggs ($x10^9$)
1. Ritchie Bay	T1A	1	Grasses	3	100	8	3,439	6.6	22.7
	T1B		Grasses	4	80	6	2,027	13.1	26.6
	T2		Grasses	2	70	6	1,740	6.6	11.5
			Grasses	3	20	4	304	65.6	19.0
			Grasses	2	10	3	120	39.4	4.7
				14				131.3	85.4
	T1A	2	Grasses	1	50	5	1,008	42.3	42.6
	T1B		Grasses	1	40	5	785	42.3	33.2
	T2		Grasses	2	30	6	664	84.6	56.2
			Grasses	1	20	6	421	42.3	17.8
				5				211.5	149.8
	T1A	3	Grasses	1	30	3	378	16.7	6.3
	T1B		Grasses	2	10	2	94	33.4	3.1
	T2		Grasses	1	10	1	67	33.4	2.2
			Grasses	2	10	<0.25	42	50.0	2.1
			Kelp	2	10	1	105	16.7	1.8
			Fil. red algae	1	10	1	162	16.7	2.7
				9				166.9	18.2
	T1A	4	Grasses	1	40	1	246	2.6	0.6
			Kelp	1	70	3	911	2.6	2.4
			Fil. red algae	1	90	3	1,457	3.5	5.1
				3				8.7	8.1

Table 1 (cont'd)

Map	Transect no.	Zone	Substrate type	No. of samples	Percent cover	Layers of eggs	Eggs/m^2 ($x10^3$)	Area ($m^2 x10^3$)	Total no. of eggs ($x10^9$)
	T12	5	Grasses	1	70	2	686	11.7	8.0
			Grasses	1	60	2	584	4.7	2.7
			Grasses	1	10	0.5	54	7.0	0.4
				3				23.4	11.1
	-	6	Grasses	0	70	0.5	288	91.7	26.4
	-	7	Fol. red algae	0	50	0.5	244	22.9	5.6
2. Robert Point	T10	8	Fol. red algae	1	70	0.5	329	3.0	1.0
	T10	9	Grasses	1	80	3	1,089	32.8	35.7
			Grasses	1	60	2	584	32.8	19.2
				2				65.6	54.9
	T10	10	Fol. red algae	1	60	2	833	31.4	26.2
			Fol. red algae	2	40	1	314	39.2	12.3
			Fol. red algae	1	20	0.5	144	7.8	1.1
				4				78.4	39.6
	T10	11	Grasses	1	90	8	3,042	11.3	34.4
	T11		Grasses	1	80	3	1,089	15.1	16.4
			Grasses	2	60	2	584	11.3	6.6
			Fol. red algae	2	60	2	833	18.8	15.7
			Fol. red algae	3	40	0.5	207	18.8	3.9
				9				75.3	77.0

Table 1 (cont'd)

Map	Transect no.	Zone	Substrate type	No. of samples	Percent cover	Layers of eggs	Eggs/m^2 ($x10^3$)	Area (m^2x10^3)	Total no. of eggs ($x10^9$)
	-	12	Grasses	0	90	8	3,042	3.0	9.1
			Grasses	0	80	3	1,089	4.0	4.4
			Grasses	0	60	2	584	3.0	1.8
			Fol. red algae	0	60	2	833	5.1	4.2
			Fol. red algae	0	40	0.5	207	5.1	1.0
				0				20.2	20.5
	T13	13	Grasses	1	70	<0.25	181	90.0	16.3
	T13	14	Grasses	1	70	0.5	288	22.1	6.4
3. Elbow Bank	-	15	Grasses	0	60	2	584	19.1	11.2
			Rockweed	0	70	1.5	902	6.4	5.8
			Kelp	0	60	1	318	25.5	8.1
			Fol. red algae	0	70	2	1,010	12.8	12.9
				0				63.8	38.0
	T8	16	Grasses	1	90	8	3,042	7.8	23.7
			Grasses	1	30	6	664	54.4	36.1
			Grasses	1	20	1	127	15.5	2.0
				3				77.7	61.8
	T3A	17	Grasses	3	90	7	2,680	91.5	245.2
	T3B		Grasses	12	80	7	2,340	305.0	713.7
	T4A		Grasses	3	70	7	2,006	91.5	183.5
	T4B		Grasses	1	50	2	483	61.0	29.5
	T5A		Grasses	2	20	2	188	61.0	11.5
				21				610.0	1,183.4

Table 1 (cont'd)

Map	Transect no.	Zone	Substrate type	No. of samples	Percent cover	Layers of eggs	Eggs/m^2 ($x10^3$)	Area (m^2x10^3)	Total no. of eggs ($x10^9$)
	T3A	18	Grasses	1	80	5	1,714	79.0	135.4
	T3B		Grasses	3	70	5	1,474	79.0	116.4
	T4A		Grasses	8	60	5	1,238	197.5	244.5
	T4B		Grasses	5	50	5	1,008	118.5	119.4
	T5A		Grasses	4	40	3	515	79.0	40.7
	T5B		Grasses	2	30	3	378	79.0	29.9
	T9		Grasses	2	20	2	188	79.0	14.9
			Grasses	2	10	1	67	79.0	5.3
				27				790.0	706.5
	T5B T9	19	Grasses	2	10	<0.05	42	110.0	4.6
	-	20	Grasses	0	60	5	1,238	45.0	55.7
	T3A	21	Grasses	2	80	7	2,340	28.8	67.4
	T4A	22	Grasses	2	80	6	2,027	15.6	31.6
	T5A		Grasses	2	20	5	363	15.6	5.7
			Grasses	1	10	1	67	15.6	1.0
			Rockweed	1	90	2	1,442	15.6	22.5
				6				62.4	60.8
4. Yarksis	T6	23	Grasses	1	90	8	3,042	86.6	263.4
			Grasses	1	80	6	2,027	43.3	87.8
			Grasses	1	70	2	686	21.6	14.8
			Grasses	1	60	8	1,900	129.9	246.8
			Grasses	1	60	3	798	129.9	103.7
			Grasses	1	50	0.5	214	21.6	4.6
				6				432.9	721.1

Table 1 (cont'd)

Map	Transect no.	Zone	Substrate type	No. of samples	Percent cover	Layers of eggs	Eggs/m^2 ($x10^3$)	Area (m^2x10^3)	Total no. of eggs ($x10^9$)
5. Stubbs Is.	T7	24	Grasses	2	10	0.5	54	142.2	7.7
			Grasses	4	10	<0.25	42	142.2	6.0
				6				284.4	13.7
	-	25	Grasses	0	70	2	686	27.8	19.1
	-	26	Grsses	0	70	2	686	23.9	16.4
	-	27	Grasses	0	70	4	1,208	60.3	72.8
	-	28	Grasses	0	70	1	420	305.8	128.4
	-	29	Grasses	0	70	0.5	288	22.6	6.5
	-	30	Grasses	0	70	<0.25	181	13.6	75.3
	-	31	Grasses	0	70	1	420	32.8	13.8

Table 2. Summary of 1979 spawn distribution by area in the Meares Island section of Clayoquot Sound (by substrate type and map number).

Map	No. of transects	No. of samples	Zones	Area ($m^2 x 10^3$)					
				Grasses	Rockweed	Kelp	Fol. red algae	Fil. red algae	All
1. Ritchie Bay	4	34	1-7	594.0		19.3	22.9	20.2	656.4
2. Robert Point	3	11	8-14	225.4			129.2		354.6
3. Elbow Bank	8	61	15-22	1,727.4	22.0	25.5	12.8		1,787.7
4. Yarksis	1	6	23	432.9					432.9
5. Stubbs Is.	1	6	24-31	771.2					771.2
All	17	118		3,750.9	22.0	44.8	164.9	20.2	4,002.8

Table 3. Summary of 1979 spawn distribution by number of eggs in the Meares Island section of Clayoquot Sound (by substrate type and map number).

Map	No. of transects	No. of samples	Zones	No. of eggs ($x10^9$)					
				Grasses	Rockweed	Kelp	Fol. red algae	Fil. red algae	All
1. Ritchie Bay	4	34	1-7	307.2		4.2	5.6	7.8	324.8
2. Robert Point	3	11	8-14	150.3			65.4		215.7
3. Elbow Bank	8	61	15-22	2,128.9	28.3	8.1	12.9		2,178.3
4. Yarksis	1	6	23	721.1					721.1
5. Stubbs Is.	1	6	24-31	346.0					346.0
All	17	118		3,653.6	28.3	12.3	83.9	7.8	3,785.9

Table 4. Distribution of spawn (% of total area) by percent cover, layers of eggs and substrate type.

Layers of eggs	Substrate type	Percent cover										
		10	20	30	40	50	60	70	80	90	100	All
<0.25	Grasses	7.55						2.59				10.14
0.5	Grasses	3.73				0.54		3.41				7.67
	Fol. red algae		0.19		0.60	0.57		0.07				1.44
	All	3.73	0.19		0.60	1.11		3.48				9.11
1	Grasses	3.20	0.39		0.06			8.46				12.11
	Kelp	0.42					0.64					1.05
	Fol. red algae				0.98							0.98
	Fil. red algae	0.42										0.42
	All	4.03	0.39		1.04		0.64	8.46				14.56
1.5	Rockweed							0.16				0.16
2	Grasses	0.83	3.50			1.52	1.77	2.12				9.75
	Rockweed									0.39		0.39
	Fol. red algae						1.38	0.32				1.70
	All	0.83	3.50			1.52	3.15	2.44		0.39		11.84
3	Grasses	0.98		2.39	1.97		3.24		1.30			9.89
	Kelp							0.06				0.06
	Fil. red algae									0.09		0.09
	All	0.98		2.39	1.97		3.24	0.06	1.30	0.09		10.04
4	Grasses		1.64					1.51				3.14

Table 4 (cont'd)

Layers of eggs	Substrate type	Percent cover										
		10	20	30	40	50	60	70	80	90	100	All
5	Grasses		0.39		1.06	4.02	6.06	1.97	1.97			15.47
6	Grasses		1.06	3.47				0.16	1.80			6.49
7	Grasses							2.28	8.34	2.28		12.91
8	Grasses						3.24			2.72	0.16	6.12
All	Grasses	16.29	6.97	5.86	3.10	6.08	14.32	22.51	13.41	5.00	0.16	93.71
	Rockweed							0.16		0.39		0.55
	Kelp	0.42					0.64	0.06				1.12
	Fol. red algae		0.19		1.58	0.57	1.38	0.39				4.12
	Fil. red algae	0.42								0.09		0.50
	All	17.13	7.16	5.86	4.67	6.65	16.34	23.13	13.41	5.48	0.16	100.00

Table 5. Average percent cover and no. of samples (in parenthesis) at depth for spawn substrate types.

Depth	Grasses	Rockweed	Kelp	Fol. red algae	Fil. red algae	All
+1.4 to +1.0	43(3)				90(1)	55(4)
+0.9 to +0.5	60(1)					60(1)
+0.4 to 0.0	70(1)			70(1)		70(2)
-0.1 to -0.5	30(2)					30(2)
-0.6 to -1.0	53(18)					53(18)
-1.1 to -1.5	58(19)					58(19)
-1.6 to -2.0	57(11)					57(11)
-2.1 to -2.5	59(10)				10(1)	54(11)
-2.6 to -3.0	50(3)		10(1)	10(1)		34(5)
-3.1 to -3.5	38(5)		10(1)			33(6)
-3.6 to -4.0	60(1)					60(1)
-4.1 to -4.5	25(2)					25(2)
-4.6 to -5.0	20(2)					20(2)
-5.1 to -5.5	10(1)			20(1)		15(2)
-5.6 to -6.0	60(1)				10(1)	35(2)
-6.1 to -6.5			70(1)			70(1)
-7.1 to -7.5				60(1)		60(1)
-7.6 to -8.0				40(1)		40(1)
Unknown	54(24)	90(1)		50(2)		55(27)
All	52(104)	90(1)	30(3)	43(7)	37(3)	51(118)

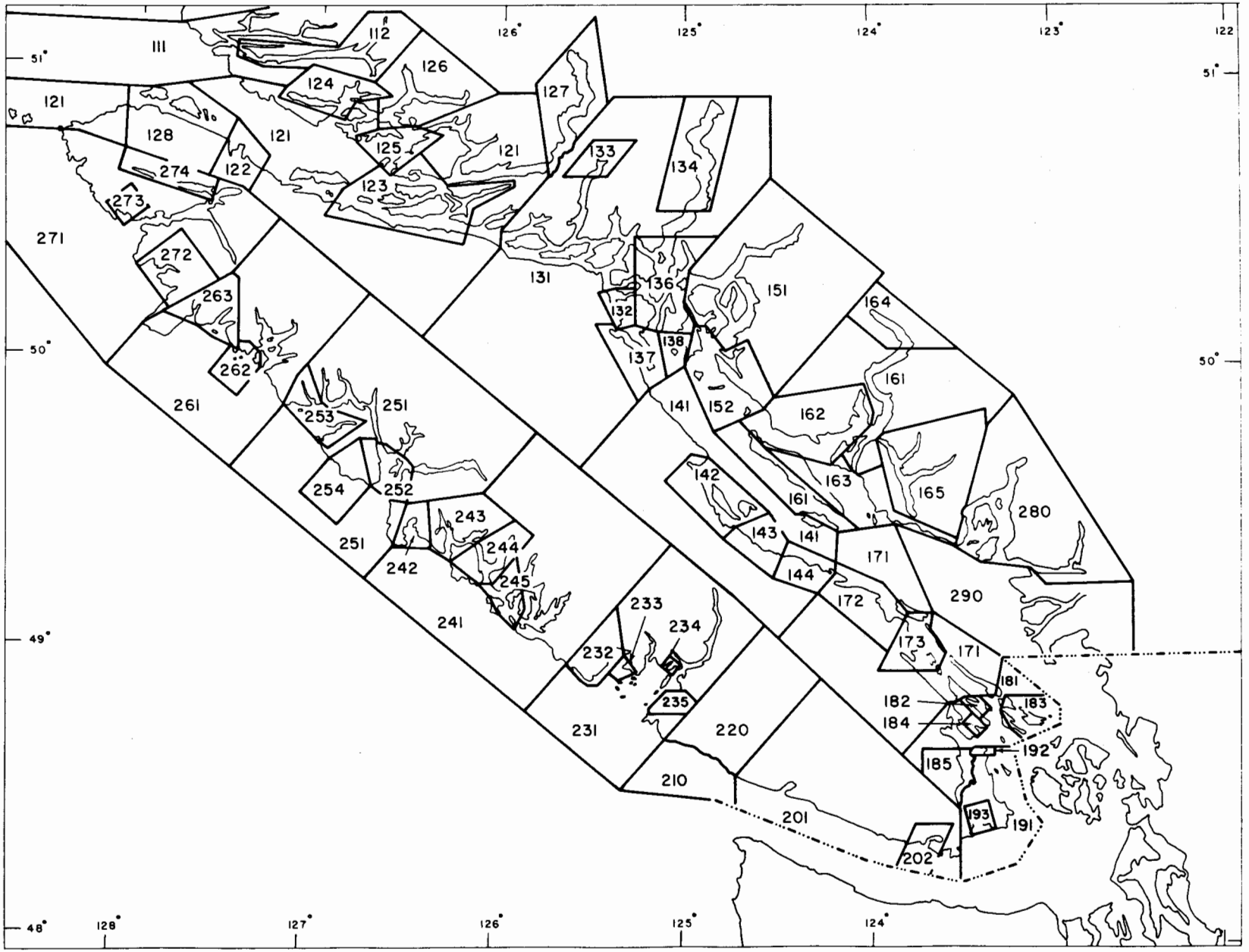

Fig. 1. Herring sections in southern British Columbia.

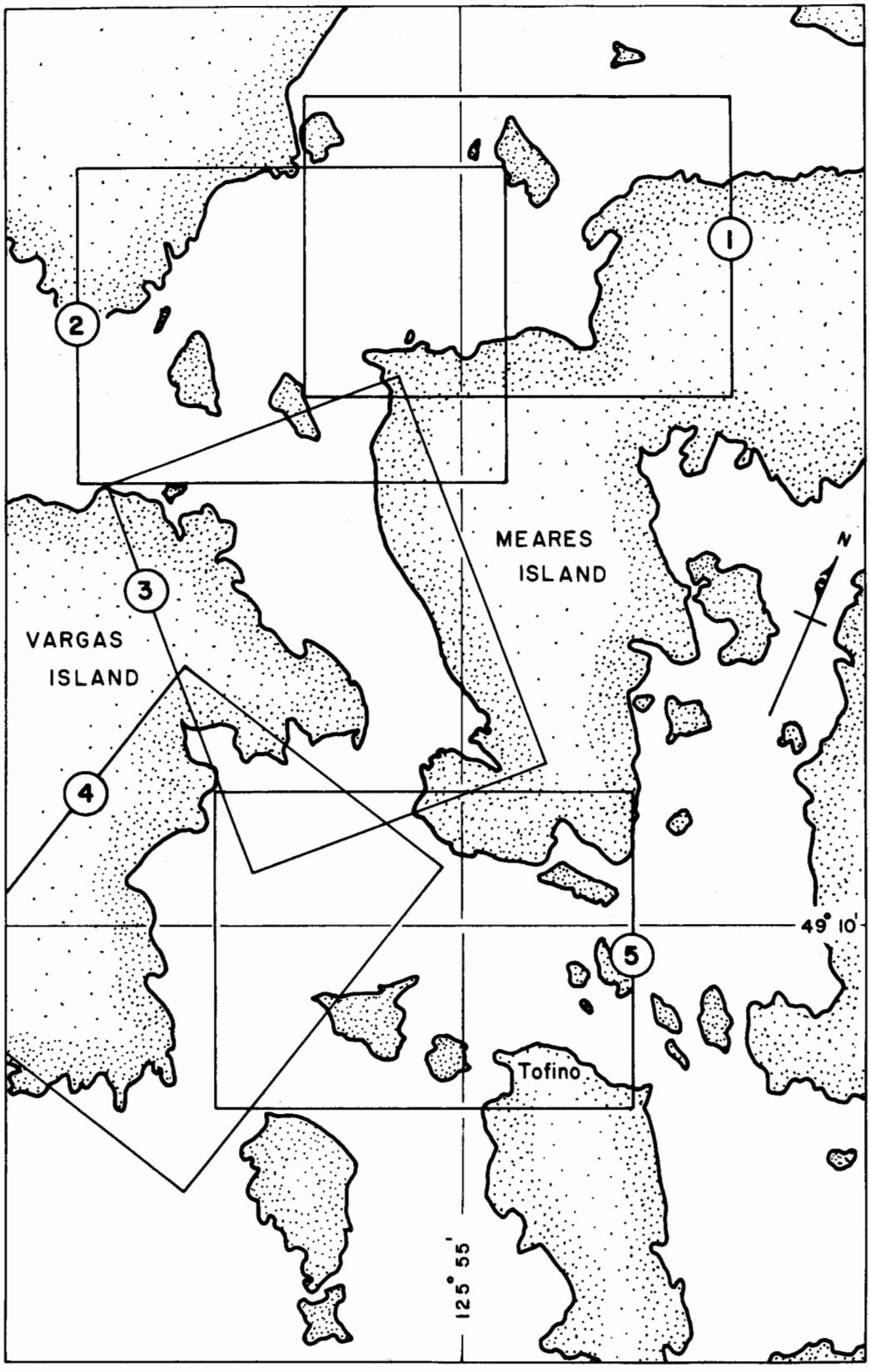

Fig. 2. Map showing study area and its division into large-scale maps.

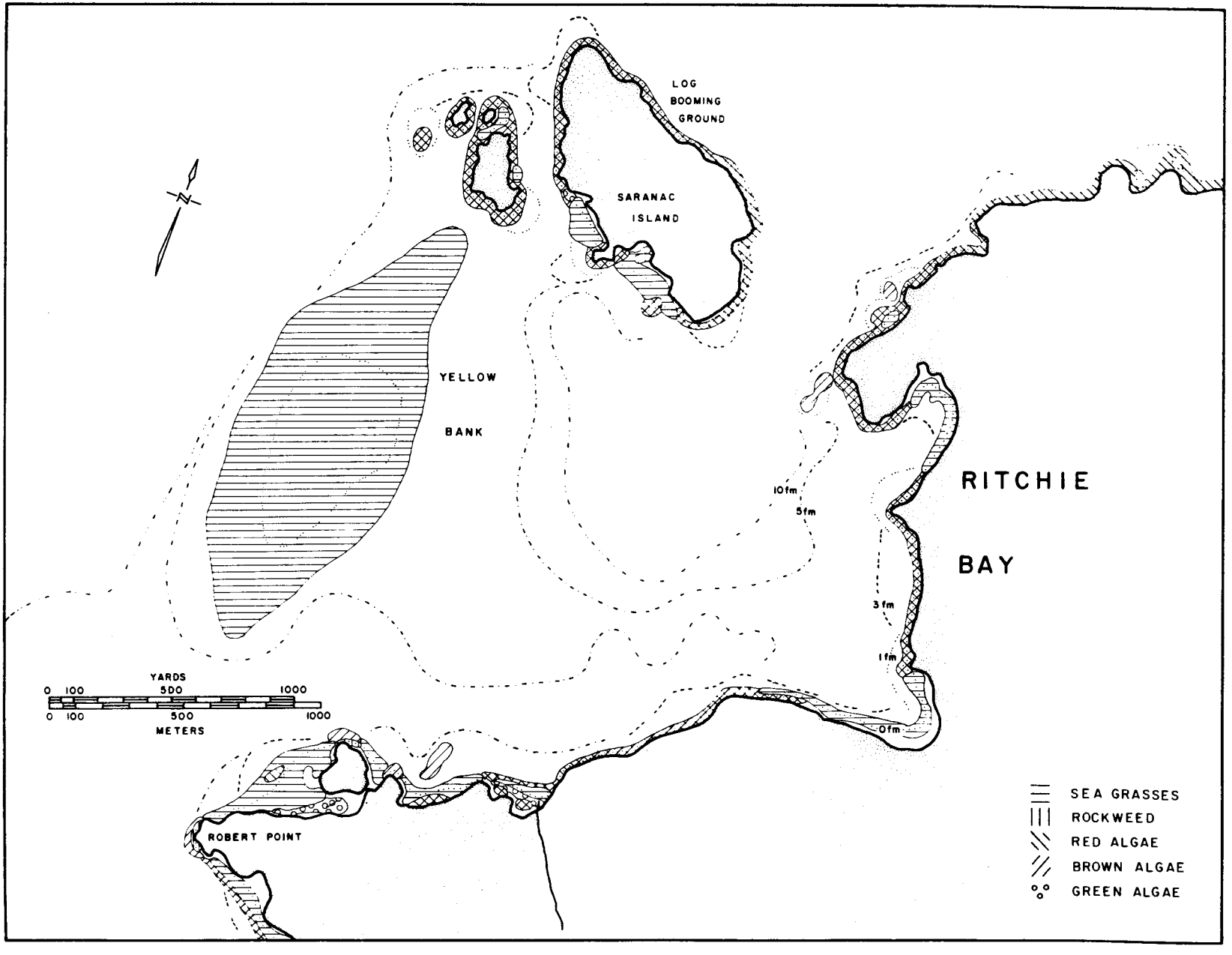

Fig. 3A. Shoreline vegetation from aerial photographs for Richie Bay (map 1 in Fig. 2).

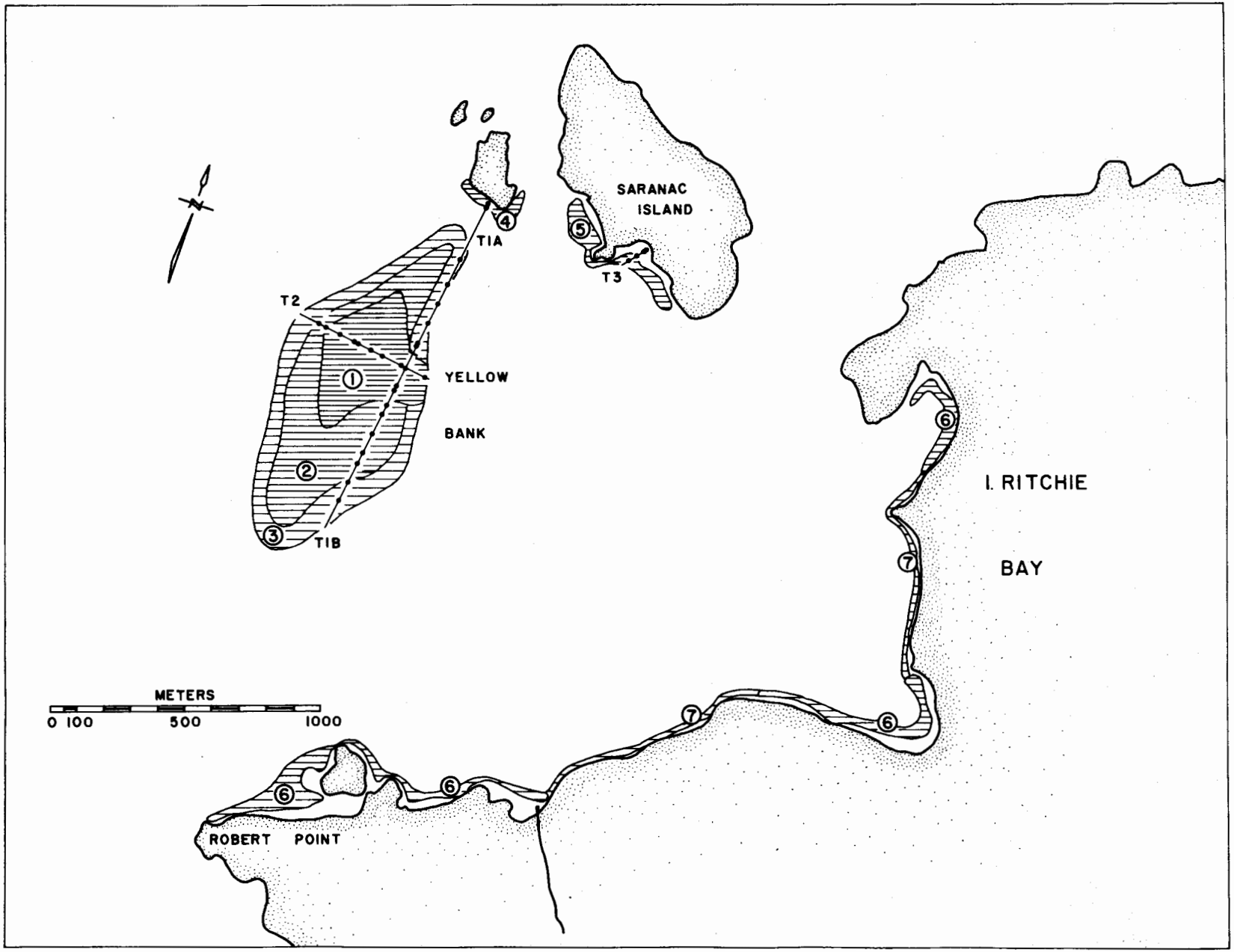

Fig. 3B. Herring spawn zones in 1979 for Ritchie Bay (map 1 in Fig. 2). Diver survey transects and sampling stations are indicated.

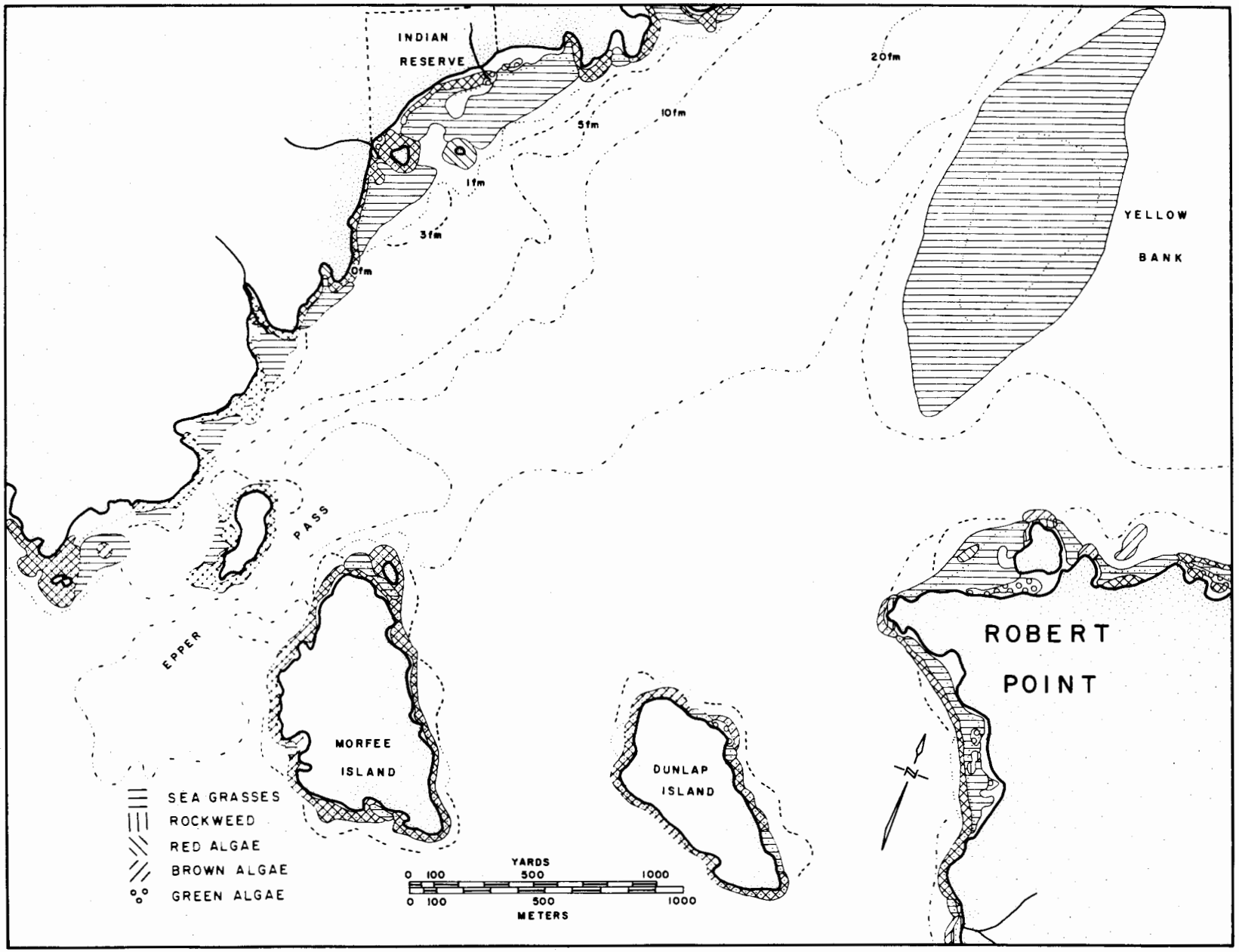

Fig. 4A. Shoreline vegetation from aerial photographs for Robert Point (map 2 in Fig. 2).

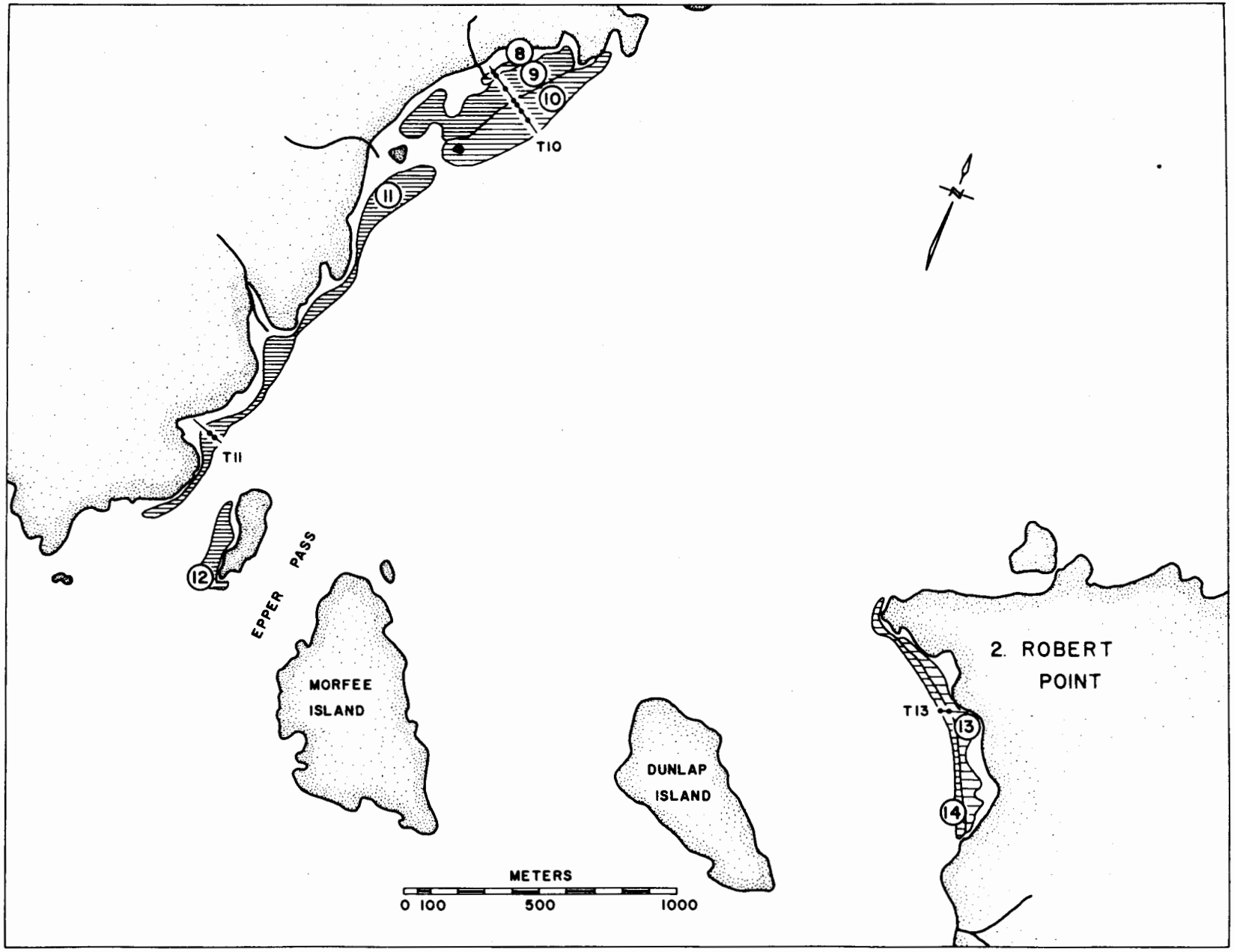

Fig. 4B. Herring spawn zones in 1979 for Robert Point (map 2 in Fig. 2). Diver survey transects and sampling stations are indicated.

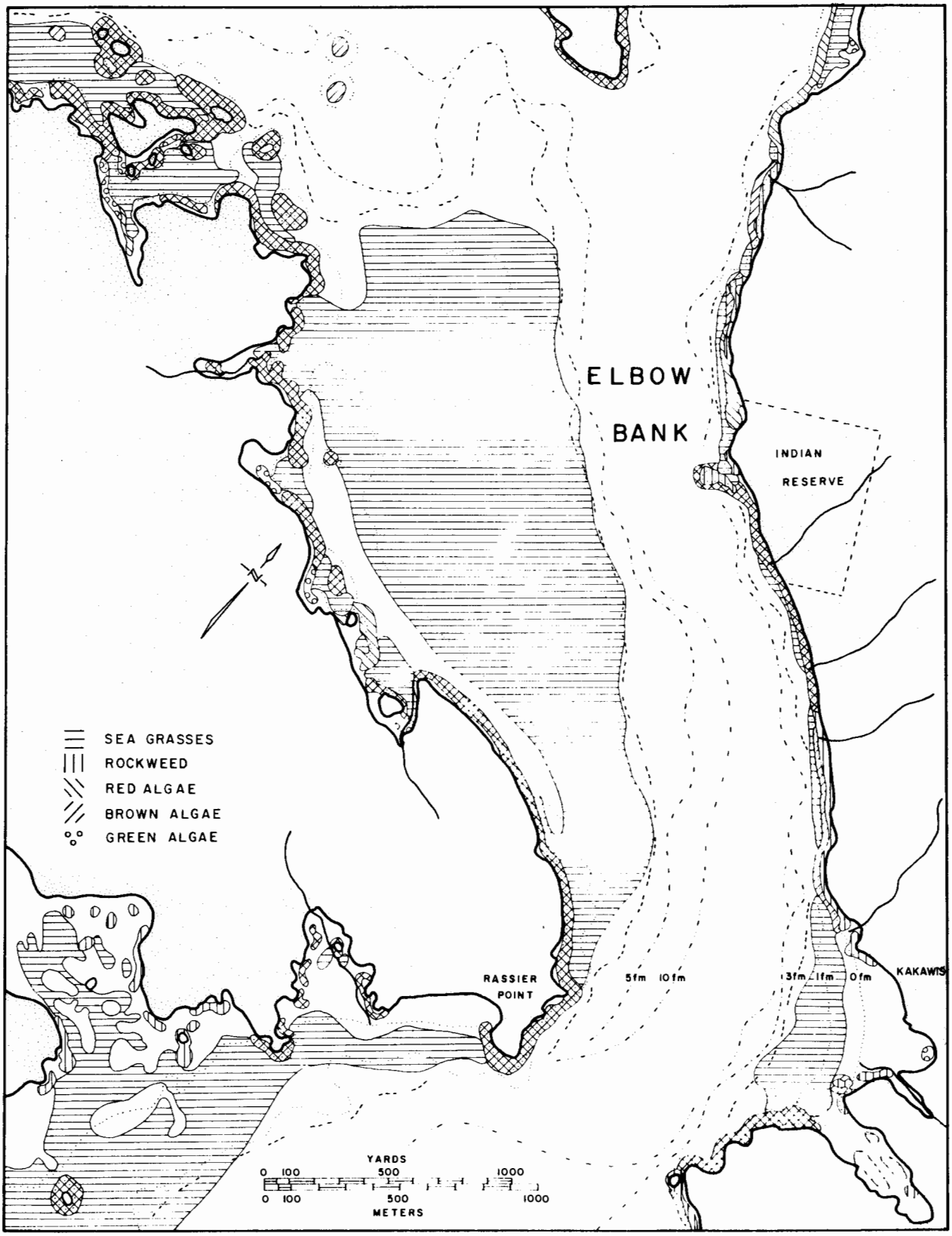

Fig. 5A. Shoreline vegetation from aerial photographs for Elbow Bank (map 3 in Fig. 2).

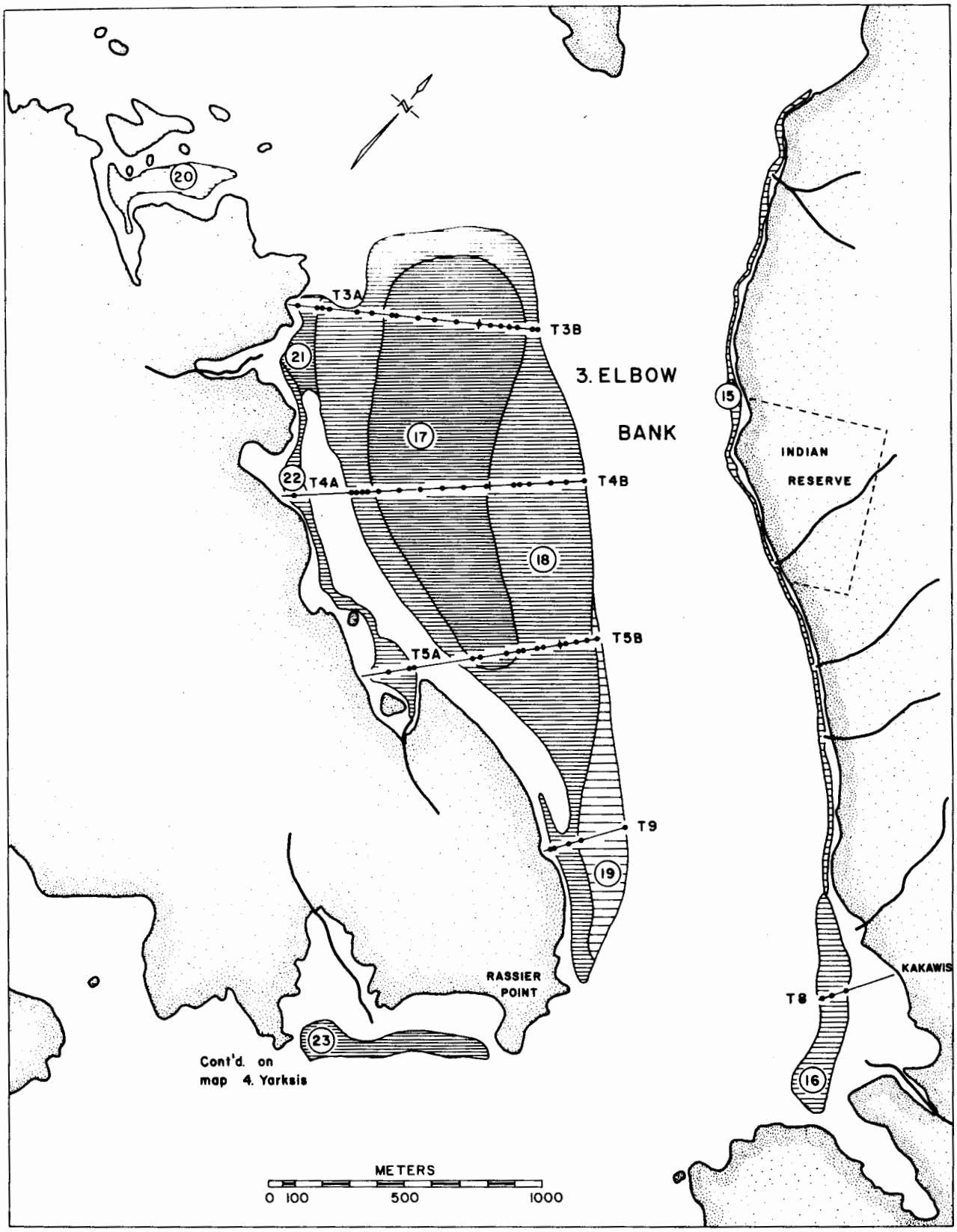

Fig. 5B. Herring spawn zones in 1979 for Elbow Bank (map 3 in Fig. 2). Diver survey transects and sampling stations are indicated.

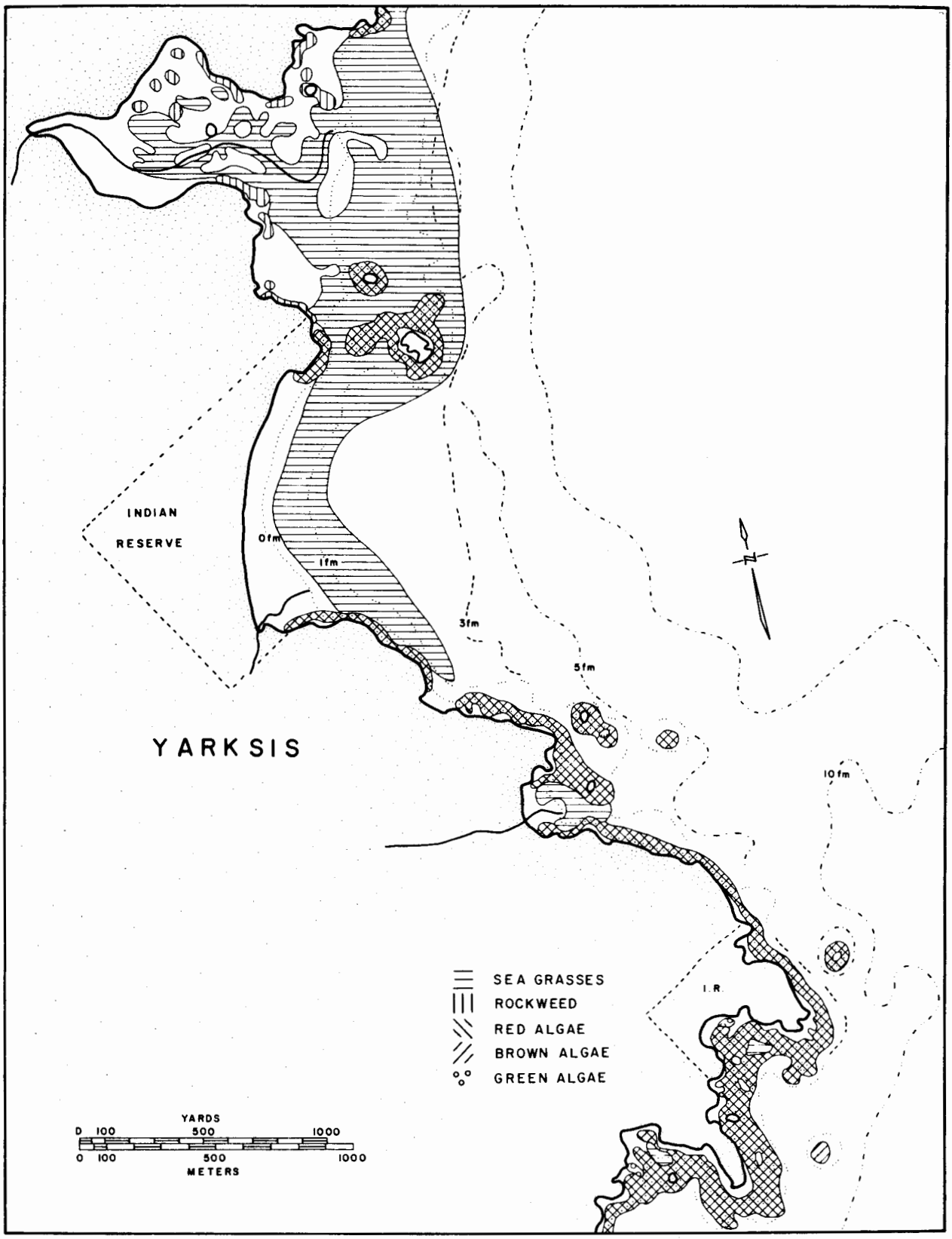

Fig. 6A. Shoreline vegetation from aerial photographs for Yarksis (map 4 in Fig. 2).

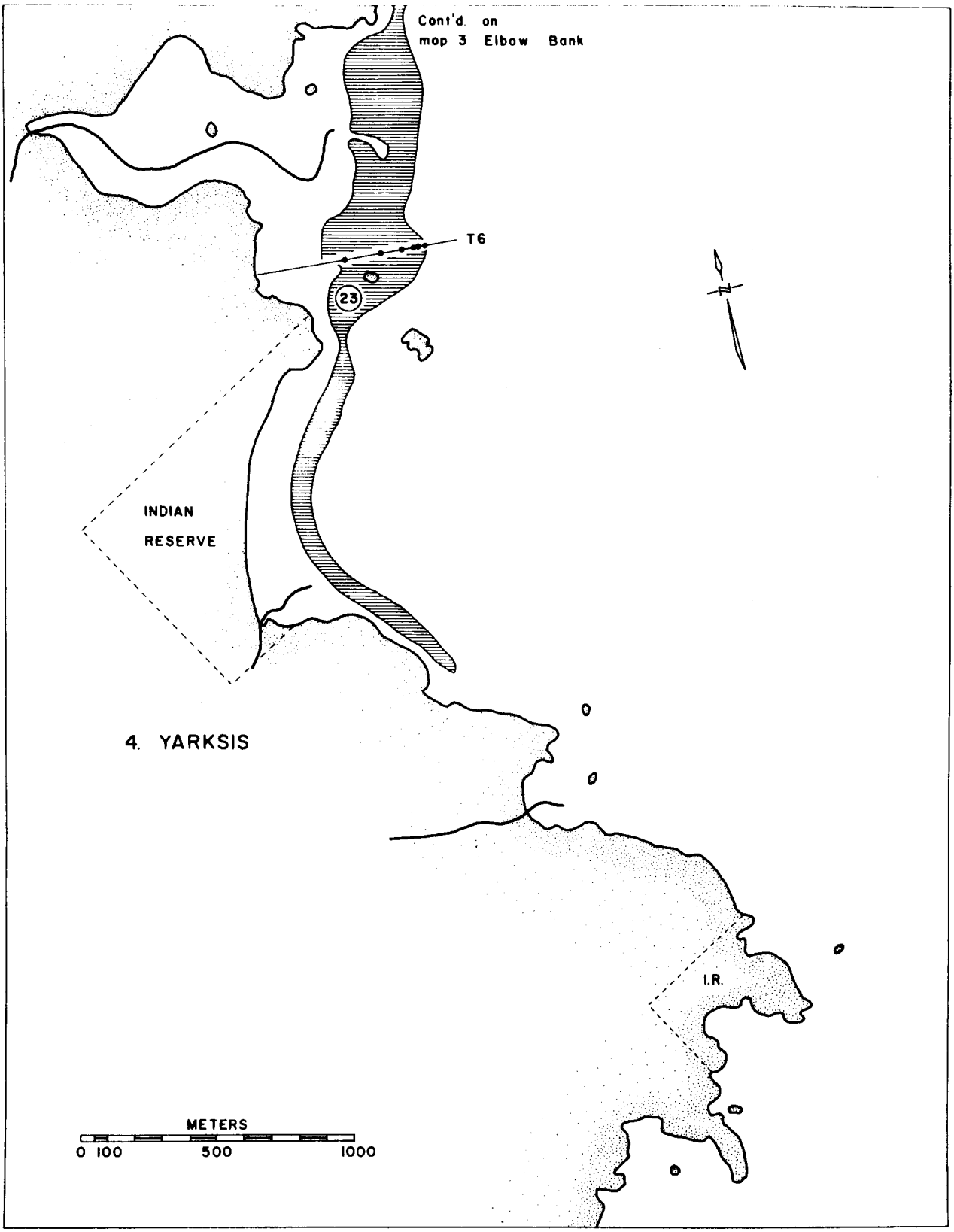

Fig. 6B. Herring spawn zones in 1979 for Yarksis (map 4 in Fig. 2). Diver survey transects and sampling stations are indicated.

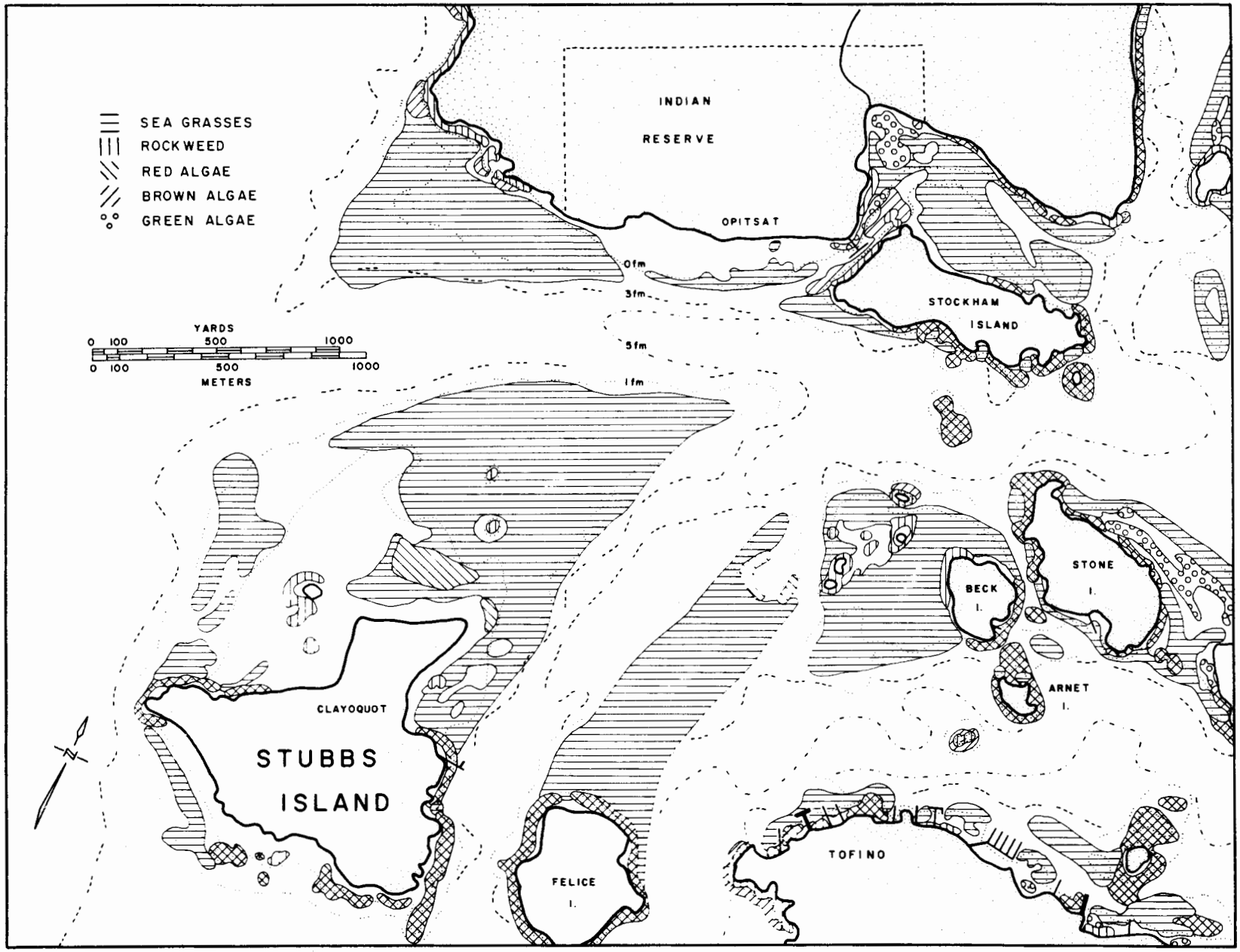

Fig. 7A. Shoreline vegetation from aerial photographs for Stubbs Island (map 5 in Fig. 2).

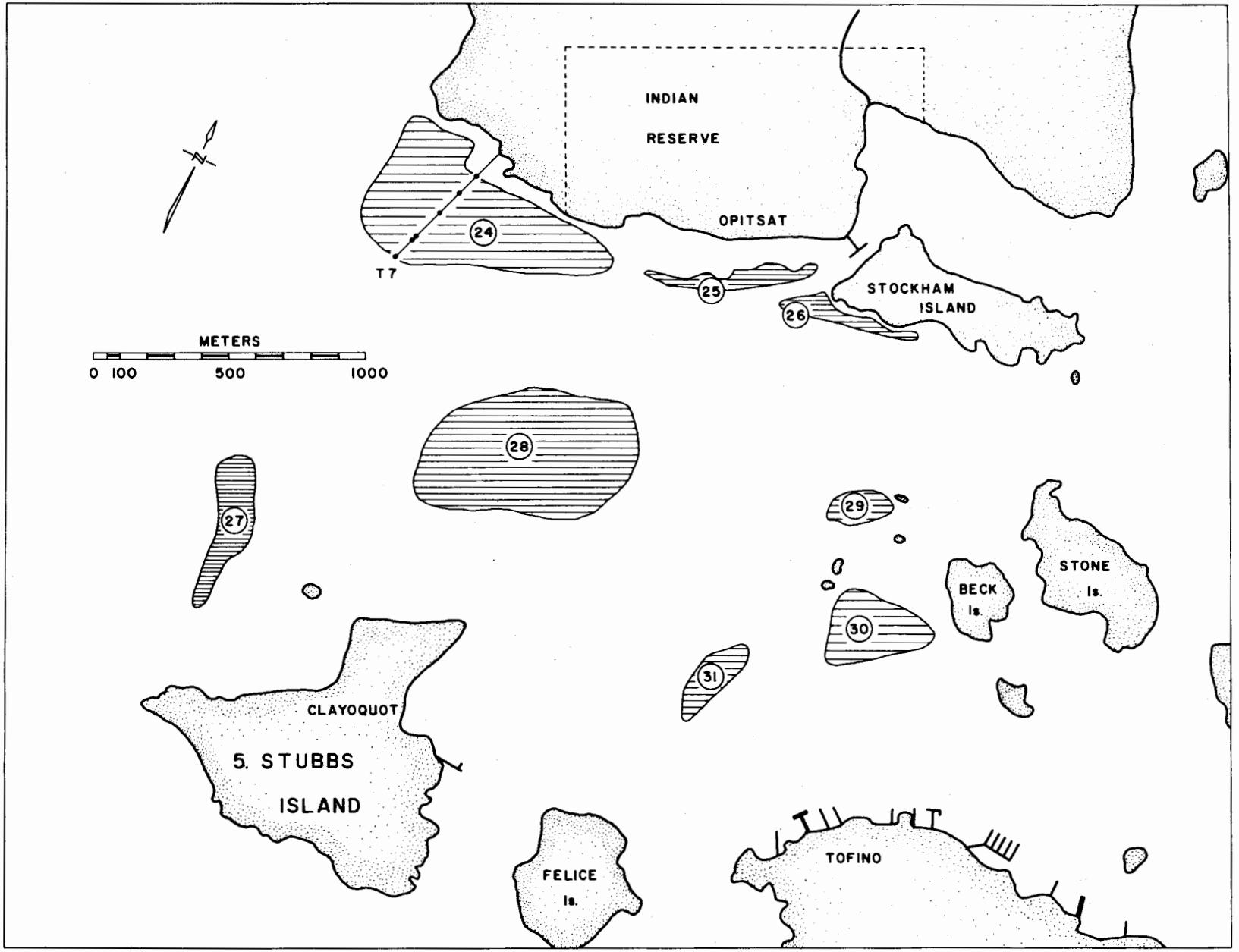

Fig. 7B. Herring spawn zones in 1979 for Stubbs Island (map 5 in Fig. 2). Diver survey transects and sampling stations are indicated.