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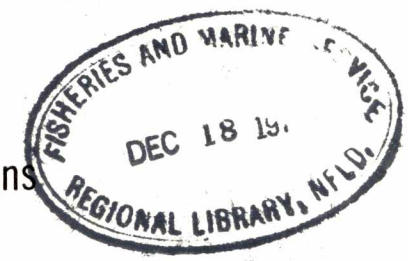

Department of Fisheries and Oceans
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Pacific Biological Station
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SHORELINE VEGETATION ON HERRING SPAWNING GROUNDS IN CLAYOQUOT SOUND

by

C. W. Haegele, and M. J. Hamey[1]

Department of Fisheries and Oceans

Fisheries and Marine Service

Resource Services Branch

Pacific Biological Station

Nanaimo, British Columbia V9R 5K6

[1]Present Address: P.O. Box 34

Zeballos, British Columbia V0P 2A0

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ABSTRACT

Haegele, C. W., and M. J. Hamey. 1979. Shoreline vegetation on herring spawning grounds in Clayoquot Sound. Fish. Mar. Serv. MS Rep. 1536: 39 p.

The ability to accurately record and assess herring spawnings depends to a considerable degree on a knowledge of the vegetative substrate upon which the adhesive eggs are deposited. Large format colour and colour-infrared photographs were obtained for 87 km of shoreline in Clayoquot Sound on June 26, 1978. Vegetation maps were prepared from these using colour and texture keys previously developed. There were 1561 ha of vegetation mapped with sea grasses accounting for 55%, the remainder being associations of red and brown algae. A diver survey of herring spawnings in March 1979 was used to field check the vegetation mapping. The presence of vegetation was identified on aerial photographs for 99% of samples collected by divers along transects and correctly typed for 95% of samples. Sand was the predominant bottom type. The middle two-thirds of the samples were collected between -0.6 and -2.5 m. The percent cover of vegetation was also highest at this depth range at 56($\pm$4), while it was 53($\pm$9) above -0.6m and 34($\pm$5) below -2.5m.

Key words: Marine vegetation, aerial photography, mapping.

RÉSUMÉ

Haegele, C. W., and M. J. Hamey. 1979. Shoreline vegetation on herring spawning grounds in Clayoquot Sound. Fish. Mar. Serv. MS Rep. 1536 : 39 p.

Les possibilités de relever et d'évaluer correctement la fraye du hareng dépendent dans une grande mesure de la connaissance que l'on possède du substrat végétal auquel adhèrent les oeufs déposés. On a réalisé des photographies de grand format en couleur et en couleur-infrarouge, le 26 juin 1978, pour 87 kilomètres de ligne de côte se trouvant dans la baie Clayoquot. À partir de ces photographies ont été préparées des cartes de la végétation à l'aide de clés de couleur et de texture mises au point auparavant. Au total, on a cartographié 1561 ha de végétation, dont les plantes marines constituaient 55%, le reste se composant d'associations d'algues rouges et brunes. Un levé des frayères de hareng, réalisé par des plongeurs en mars 1979, a permis de vérifier sur le terrain la cartographie de la végétation. La présence de végétation apparaissait sur les photographies aériennes pour 99% des échantillons recueillis par les plongeurs le long de transects, et le type végétal était correctement identifié pour 95% des échantillons. Le type prédominant de fond était le fond sablonneux. Les deux-tiers médians des échantillons ont été prélevés par des profondeurs allant de -0.6 à -2.5 m. C'est aussi dans ce secteur que le pourcentage de couvert végétal était le plus élevé avec 56 ($\pm$ 4), alors qu'il était de 53 ($\pm$ 9) au-dessus de -0.6 m et de 34 ($\pm$ 5) au-dessous de -2.5 m.

Mots clés: végétation marine, photographie aérienne, cartographie.

INTRODUCTION

Aerial photographs are used to map vegetation on herring spawning grounds in British Columbia (eg. Haegele 1978). These maps are used to record and assess herring spawnings which take place mainly on rooted algae and sea grasses in the littoral and upper sub-littoral zone. These maps are not routinely field checked because of constraints of time and cost. However, diver surveys of herring spawnings have been conducted in most mapped areas, including Clayoquot Sound, and information obtained from these can be used to provide field checking of vegetation maps and additional data on species composition, percent cover and bottom type.

METHODS

Vertical aerial photographs of 23 cm format at a photo scale of 1:6000 were obtained for Clayoquot Sound (Fig. 1) on June 26, 1978 with a Wild RC110 camera with a 152 mm focal length lens at an altitude of 914 m. There were 14 flight lines, three of which were parallel over Elbow Bank (map 7 in Fig. 1) and two in Ritchie Bay (map 11 in Fig. 1) at 20% sidelap. Forward overlap was 60%. Eighty-seven km of coastline were photographed before predicted low tide (+0.7m at 1055 PST) with Kodak Ektachrome MS aerographic No. 2448 film between 0945 and 1100 PST and with Kodak Aerochrome Infrared No. 2443 film after low tide between 1127 and 1212 PST. A medium yellow (Wild 525 nm AV2x) filter was used with the infrared film and a clear (Wild 420 nm AV2x) filter with the colour film.

Vegetation maps were prepared at the scale of photography, using enlarged Canadian Hydrographic Service Navigation Charts Nos. 3648 and 3649 as a base map, with standard photogrammetric techniques. Exposed vegetation was identified from the 138 infrared diapositives employing a colour key previously developed (Haegele 1975). For vegetation submerged at the time of photography, identification was by colour and texture from the 136 colour diapositives. The vegetation was mapped by five major types identifiable on the photographs: sea grasses, rockweed, red algae, brown algae and green algae.

A diver survey of herring spawnings in March 1979 (Haegele and Miller 1979) was used to field check the vegetation mapping for part of the area (maps 6, 7, 8, 9, and 11 in Fig. 1). Transects roughly perpendicular to the shore were established at positions providing the degree of desired coverage for herring spawnings being surveyed (Fig. 2). A team of divers sampled along each transect at intervals dictated by changes in vegetation type, percent cover or herring spawn density. A sample consisted of all the rooted vegetation and attached herring eggs within a 0.25 m^2 (0.5 x 0.5m) quadrat. All samples were separated into fractions by vegetation species according to Widdowson (1973 and 1975) and Scagel (1967). Each fraction was weighed wet to the nearest gram.

In addition to the sample and its position, the following information was obtained by the divers:

1. Bottom type - one or more of the following; classified according to these criteria;

Bottom-type class	Particle size
Shells	Usually bivalve
Mud	< 0.02 cm
Sand	0.02-0.15 cm
Pebbles	0.16-6.0 cm
Cobbles	6.1-25.0 cm
Boulders	>25.0 cm
Rock	Rockshelf

2. Percent cover: the percentage of the bottom, within the sample quadrat, that was occupied by vegetation.

3. Depth: the depth of water at which the sample was taken. This was corrected to chart datum from Ocean and Aquatic Sciences tidal height printouts.

RESULTS AND DISCUSSION

The shoreline vegetation for major herring spawning grounds in Clayoquot Sound, as mapped from aerial photographs, is presented on 14 maps (Fig. 3 to 16). The total area of vegetation mapped was 1561 ha[a], of which grasses accounted for 55.3% (Table 1). Mixtures of brown and red algae accounted for 22.6% and green algae for 14.9%. Ninety-eight percent of the green algae (14.1% of total vegetation) was mapped for the shallow shoreline of Meares Island (Fig. 12). This vegetation appeared very sparse on aerial photographs and may have included a large proportion of uprooted vegetation that is difficult to distinguish from green algae. Brown algae and red algae were typed for 3.2 and 2.1% of the vegetated area respectively and rockweed for 1.6%.

Eighty-eight percent of the vegetation was mapped in the Meares Island portion of Clayoquot Sound (maps 5 to 14 in Fig. 1), the area to which diving transects were restricted. There were 118 samples collected along the 17 diving transects. The presence of vegetation was identified on aerial photographs for 99.2% of the samples and correctly typed for 94.9% of the samples.

[a]1 hectare (ha)=10,000 m^2

Zostera marina was the dominant species in 104 samples (Table 2). Ten other species were dominant in the other 14 samples and 15 additional species occurred but were never dominant. Of the 26 species, 11 were identified only to the genus level.

Of the 91 samples for which depths were determined, 66% were collected between -0.6 to -2.5m while the total range was from +1.4 to -8.0m (Table 3). The av percent cover of vegetation was also highest between -0.6 and -2.5 at 56(±4). Above -0.6m, av percent cover was 53(±9) and below -2.5m it was 34(±5).

Sand was the most common bottom type class, occurring in 97% of the sample bottoms and was the sole constituent in 87% of the samples (Table 4). This geology at least partially explains the high proportion of sea grasses, which are the only marine vegetation not requiring a solid surface for attachment.

The two large banks, Elbow Bank (Fig. 9) and Yellow Bank (Fig. 13), on which herring frequently spawn, are not uniformly vegetated. The shallow portion of Elbow Bank (above -2m) has sea grasses at an av percent cover of 73(±4) over 61 ha while the deeper portions have an av percent cover of 45(±4) over 90 ha. The rim of Yellow Bank, about half the 80 ha area, consists of 10% cover vegetation while the centre of the bank has patches of high percent cover (80 to 100) sea grasses for 20% of the area occurring with 10 to 30% cover sea grasses.

ACKNOWLEDGEMENTS

We would like to thank the divers who collected and processed the samples. They were Douglas Miller, chief herring technician at PBS, who also took care of many of the logistics of the field work and Thomas Schields, Gary Kingston, Micheal Fabijan and Joan Rosenberg of Archipelago Coastal Marine Research. We are also grateful to Debbie Bams, summer student at PBS, who measured the area of the vegetation and to Parker Williams and Dr. T. A. Rutherford of Integrated Resources Photography who took the excellent photographs. To the captain of the SEA WAVE, Bob Jordan, and his wife Kathy we extend our appreciation for providing accommodation and transportation for the people in the field. To Dr. A. S. Hourston, Herring Program Head at PBS, we remain appreciative of his continued support and encouragement of the vegetation mapping project.

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1974. The marine algae of British Columbia and northern Washington: revised list and keys. Part II. Rhodophyceae (red algae). Syesis 7: 143-186 + Fig. 1-8.

Table 1. Area of photo-identified vegetation in hectares (1 ha=10,000 m^2).

Map	Grasses	Rockweed	Rockweed and reds	Brown Algae	Browns and Reds	Red Algae	Reds and Greens	Green Algae	All
1. Hot Springs Cove	12.33	0.37	0.28	13.87	24.23	-	-	0.28	51.36
2. Riley Cove	14.67	0.10	-	7.04	27.50	0.63	-	0.10	50.04
3. Hootla Kootla	3.78	-	-	6.32	20.34	-	-	-	30.44
4. Matilda Inlet	32.75	1.09	-	2.27	20.16	0.10	-	0.11	56.48
5. Chetarpe	10.99	1.18	-	8.47	52.25	-	-	-	72.89
6. Robert Point	11.88	-	-	0.29	18.19	0.83	-	0.55	31.74
7. Elbow Bank	231.75	5.23	-	4.86	35.75	1.09	-	2.08	280.76
8. Yarksis	89.25	3.88	-	0.36	39.25	-	-	0.28	133.02
9. Stubbs Island	235.75	10.10	-	3.88	35.75	5.06	-	4.77	295.31
10. Beck I. and Stone I.	98.25	2.62	-	-	15.49	16.57	-	218.00	350.93
11. Ritchie Bay	91.75	0.54	-	2.53	24.32	0.19	-	1.53	120.86
12. Hecate Bay	12.26	-	-	-	8.56	-	2.80	0.37	23.99
13. Cypre River	15.57	0.10	0	0.46	18.47	8.29	-	4.69	47.58
14. Cypress Bay	2.17	-	-	-	13.43	-	-	-	15.60
All	863.15	25.21	0.28	50.35	353.69	32.76	2.80	232.76	1,561.00

Table 2. Number of occurrences of species by vegetation type of sample with the number of times a species was dominant in parenthesis.

	Grasses	Rockweed	Kelp	Foliose red algae	Filamentous red algae	All
SEA GRASSES						
Zostera marina	104(104)	1	-	2	-	107(104)
ROCKWEEDS						
Fucus distichus	-	1(1)	-	-	-	1(1)
KELP						
Agarum sp.	-	-	1(1)	-	-	1(1)
Laminaria sp.	3	-	2(2)	-	-	5(2)
OTHER BROWN ALGAE						
Desmarestia ligulata	1	-	-	-	-	1
FOLIOSE RED ALGAE						
Callophyllis flabellulata	-	-	-	4(1)	-	4(1)
Callophyllis sp.	7	-	1	5(4)	1	14(4)
Cryptopleura sp.	-	-	-	2	-	2
Gigartina sp.	2	-	1	1	2	6
Hymenema sp.	-	-	-	1	-	1
Iridea cordata	-	-	-	1	-	1
Iridea sp.	-	-	-	-	1	1
Prionitis lyalli	1	-	-	1(1)	-	2(1)
Prionitis sp.	-	-	-	-	1	1
Rhodymenia pertusa	-	-	-	1(1)	-	1(1)
FILAMENTOUS RED ALGAE						
Cryptosiphonia woodii	-	-	-	-	1	1
Gracilaria sp.	1	-	1	1	1(1)	4(1)
Microcladia coulteri	-	-	-	2	-	2
Neoaghardhilla baileyi	1	-	-	1	1(1)	3(1)
Odonthalia flocossa	-	-	-	1	-	1
Plocamium cartilagineum	2	-	-	-	-	2
Plocamium sp.	4	-	-	-	-	4
Ptilota sp.	2	-	-	1	1	4
Rhodemela larix	-	1	-	-	1(1)	2(1)
Rhodoptilum plumosum	-	-	-	1	-	1
GREEN ALGAE						
Ulva lactuca	1	-	-	-	1	2

Table 3. Av percent cover and no. of samples (in parenthesis) at depth for vegetation type of sample.

Depth (m)	Grasses	Rockweed	Kelp	Foliose red algae	Filamentous 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)

Table 4. Number of occurrences of bottom type for vegetation type of sample.

Bottom type	Grasses	Rockweed	Kelp	Foliose red algae	Filamentous red algae	All
shells	1	-	-	-	-	1
shells, sand	3	-	-	1	1	5
shells, cobbles	1	-	-	-	-	1
mud, sand	1	-	-	-	1	2
sand	95	1	2	5	-	103
sand, pebbles	1	-	-	-	-	1
sand, cobbles	1	-	-	1	-	2
sand, rock	1	-	-	-	-	1
pebbles, cobbles	-	-	-	-	1	1
rock	-	-	1	-	-	1
All	104	1	3	7	3	118

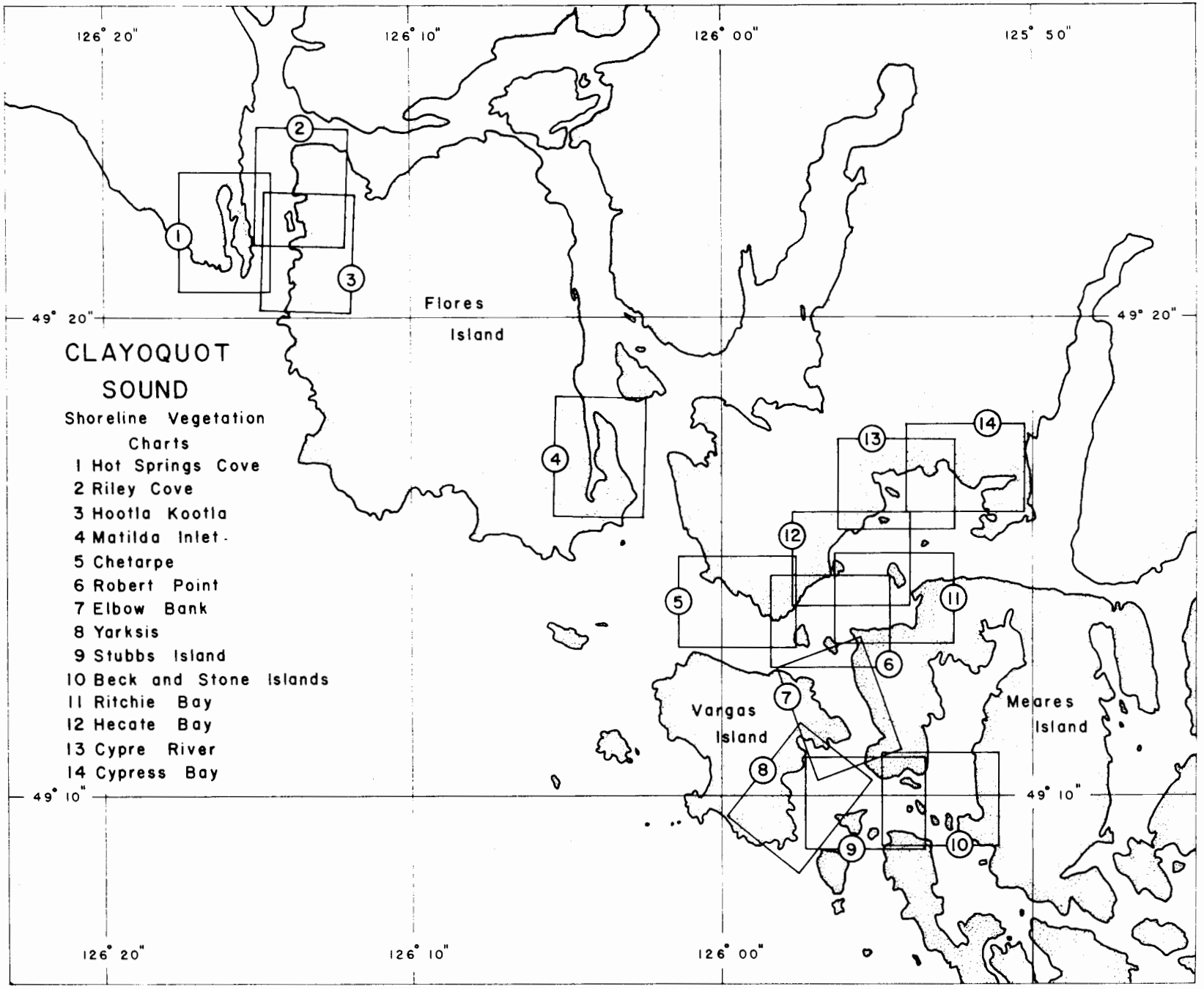

Fig. 1. Shoreline vegetation maps for Clayoquot Sound.

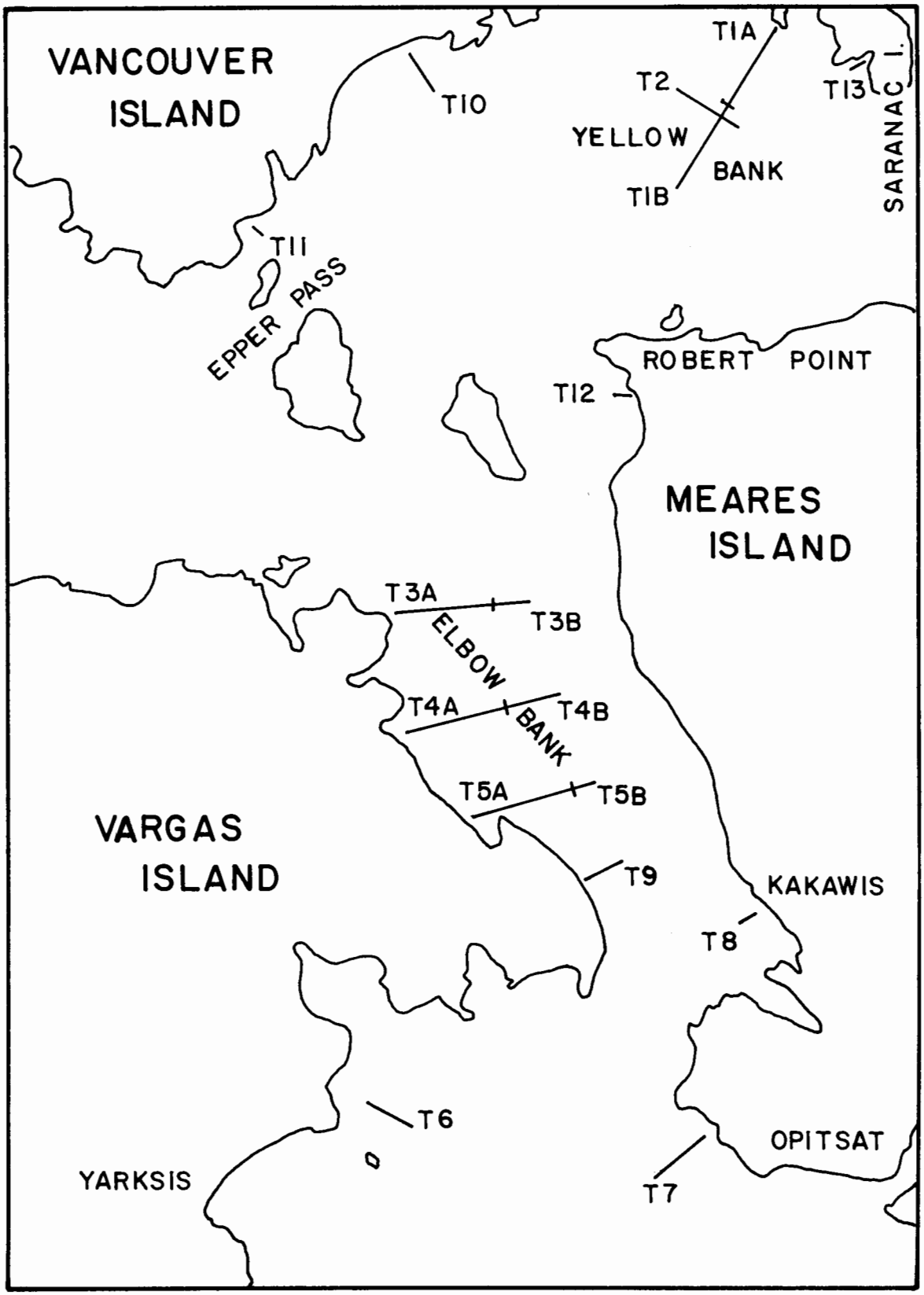

Fig. 2. Herring spawn survey diving transects.

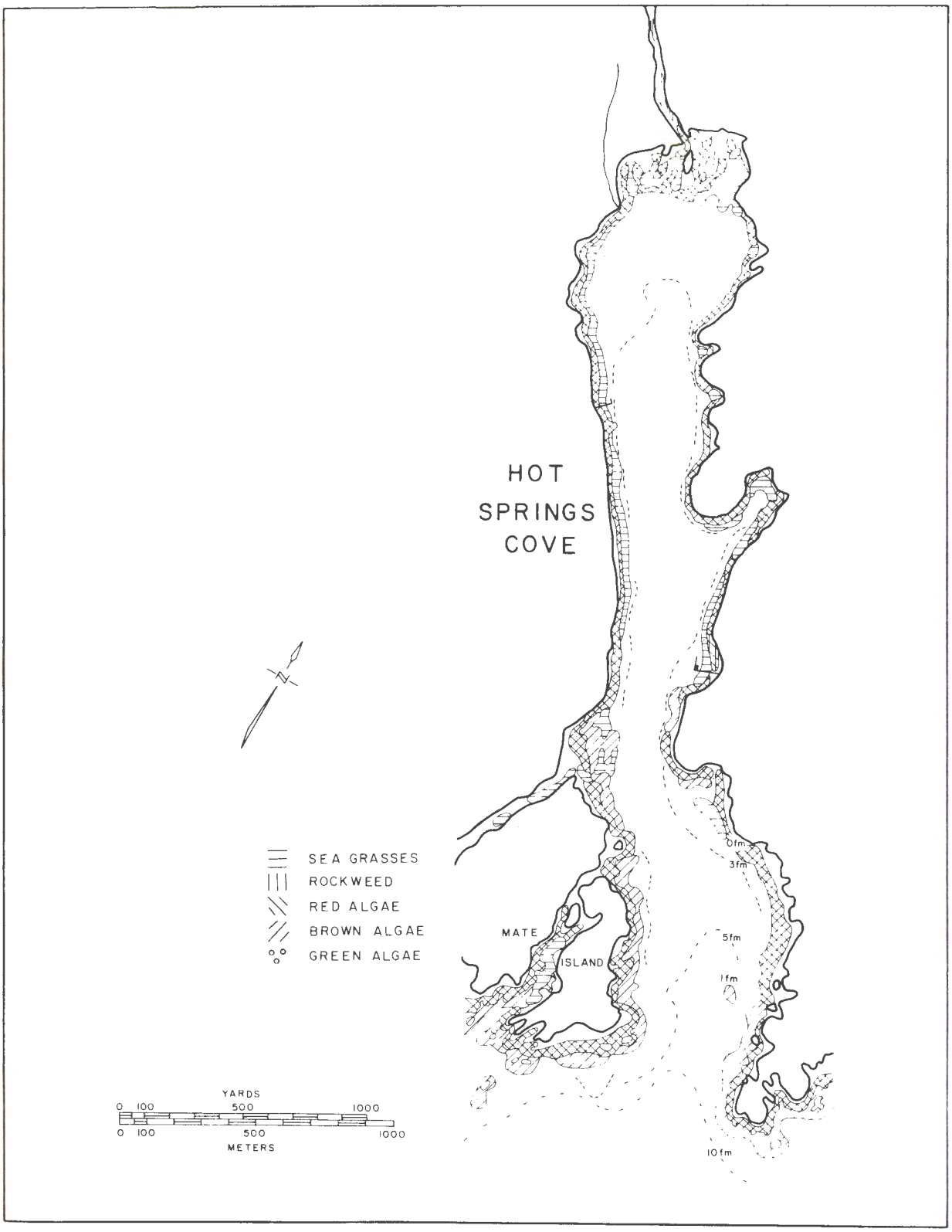

Fig. 3. Shoreline vegetation map from aerial photographs for Hot Springs Cove (map 1 in Fig. 1).

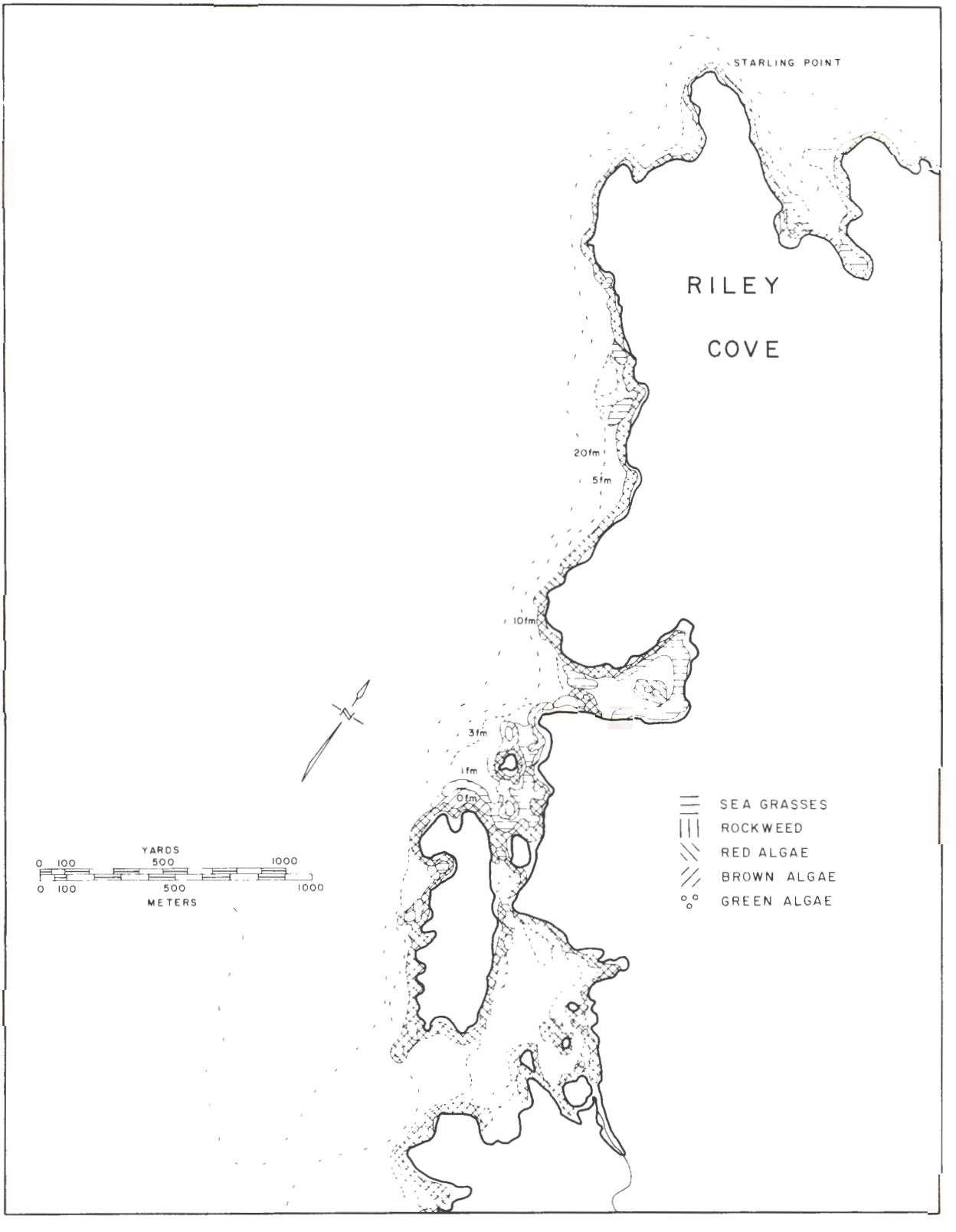

Fig. 4. Shoreline vegetation map from aerial photographs for Riley Cove (map 2 in Fig. 1).

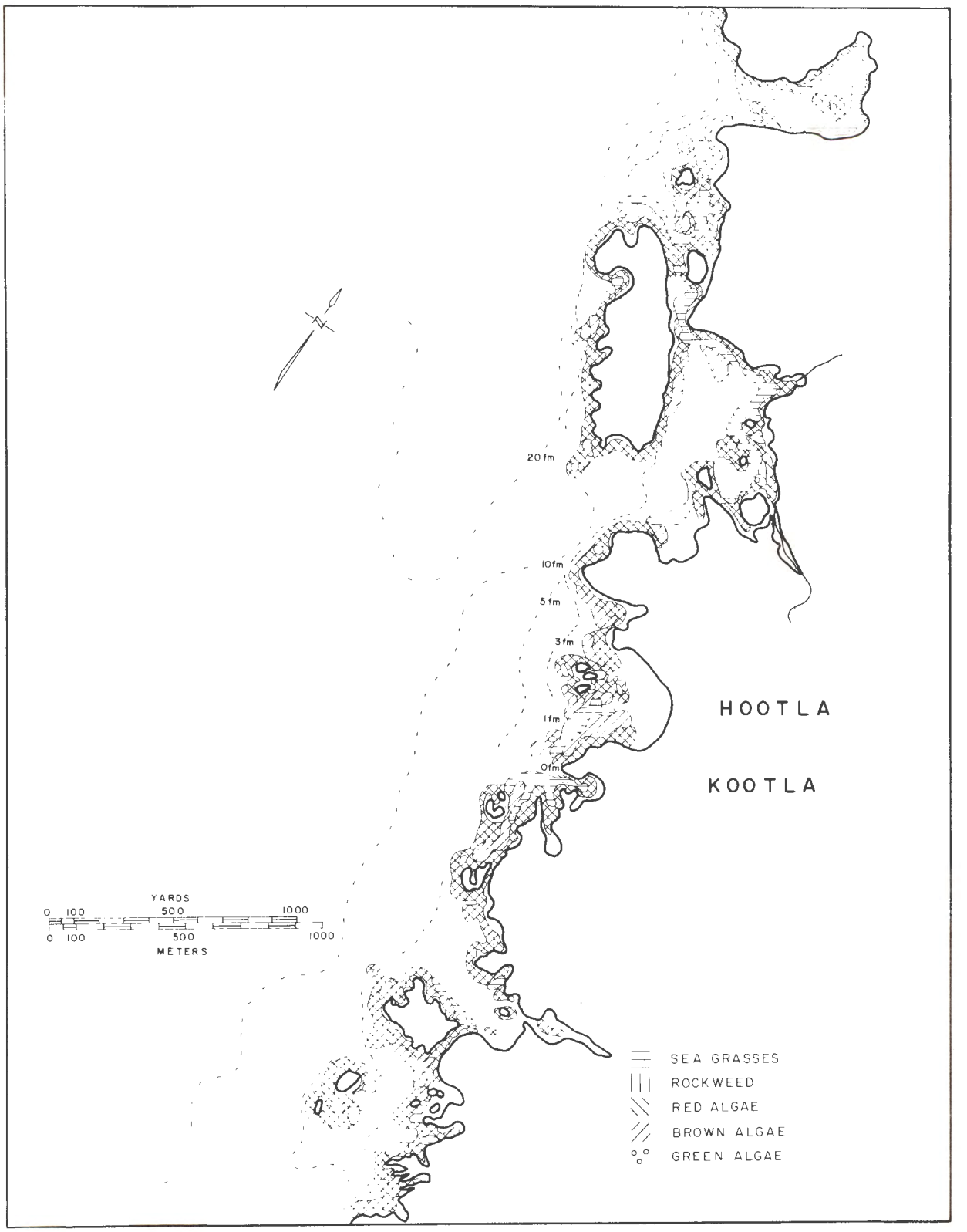

Fig. 5. Shoreline vegetation map from aerial photographs for Hootla Kootla (map 3 in Fig. 1).

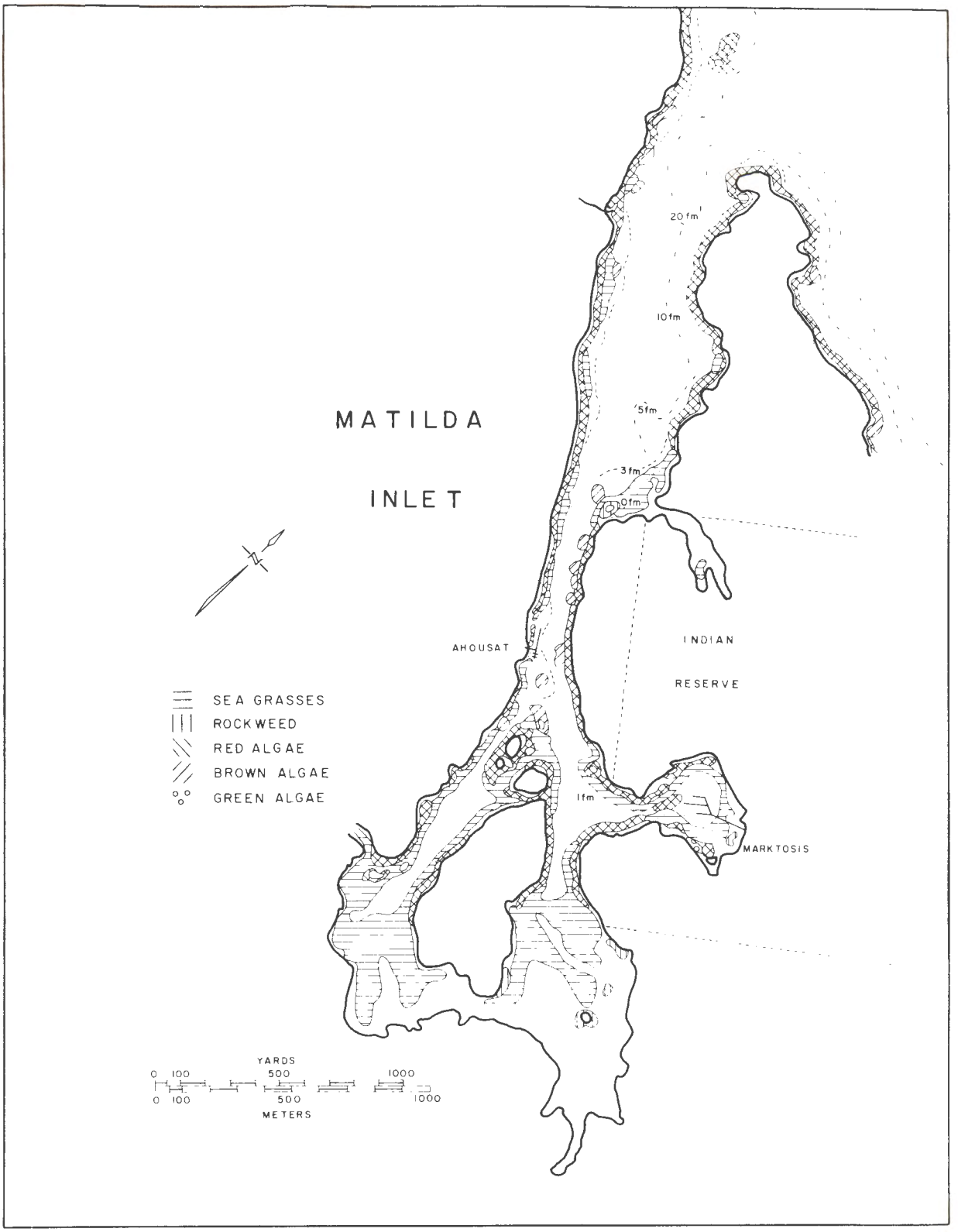

Fig. 6. Shoreline vegetation map from aerial photographs in Matilda Inlet (map 4 in Fig. 1).

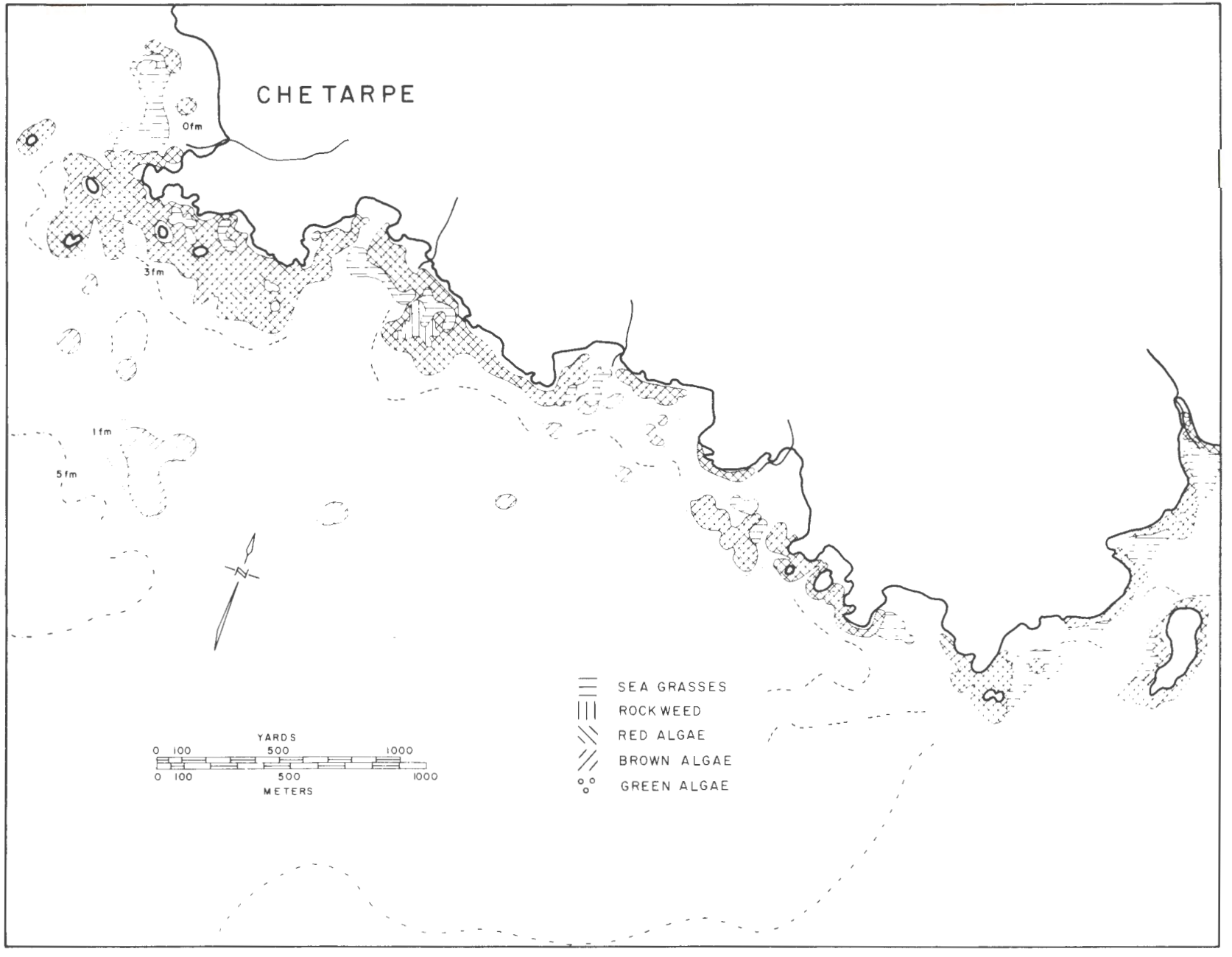

Fig. 7. Shoreline vegetation map from aerial photographs for Chetarpe (map 5 in Fig. 1).

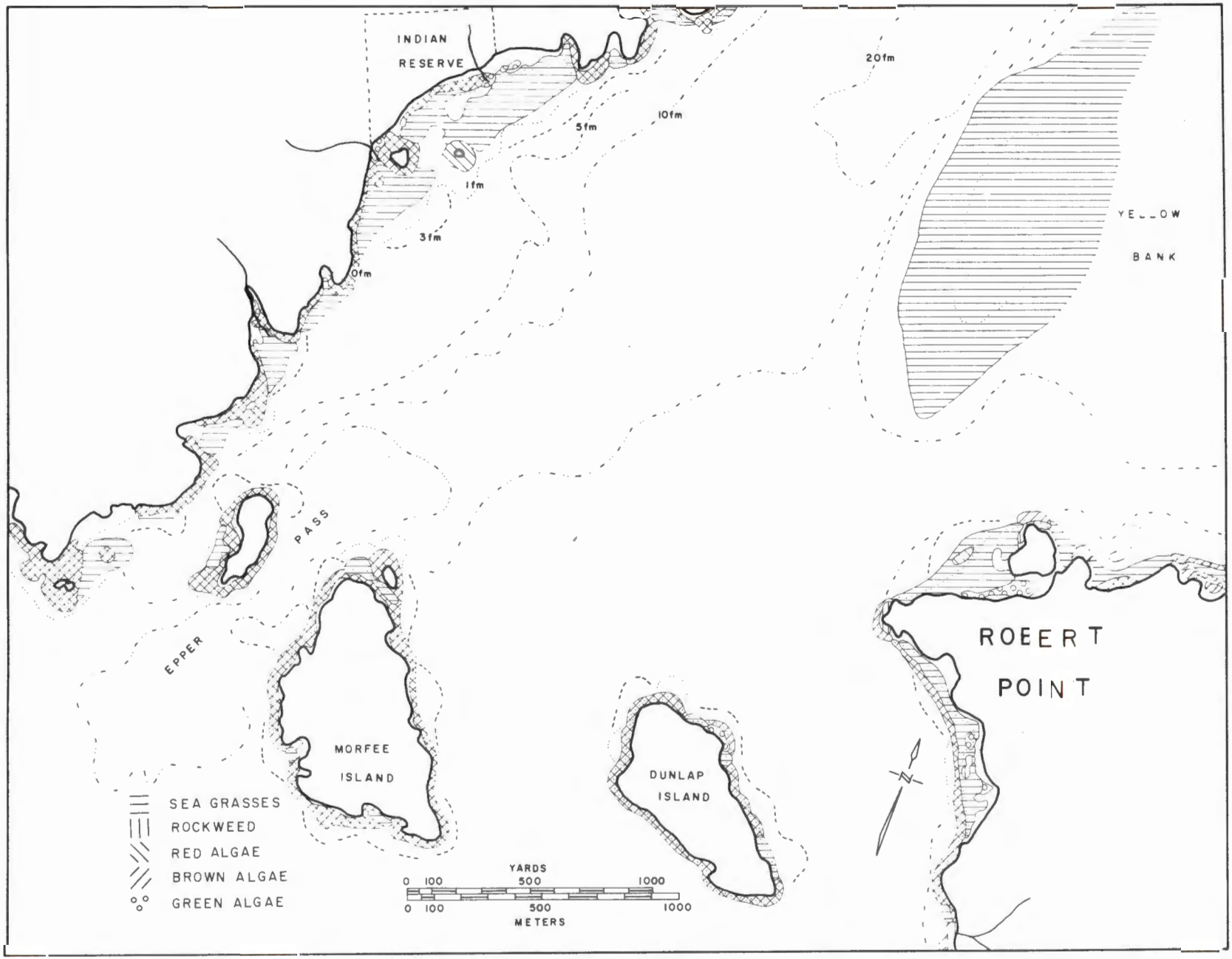

Fig. 8. Shoreline vegetation map from aerial photographs for Robert Point (map 6 in Fig. 1).

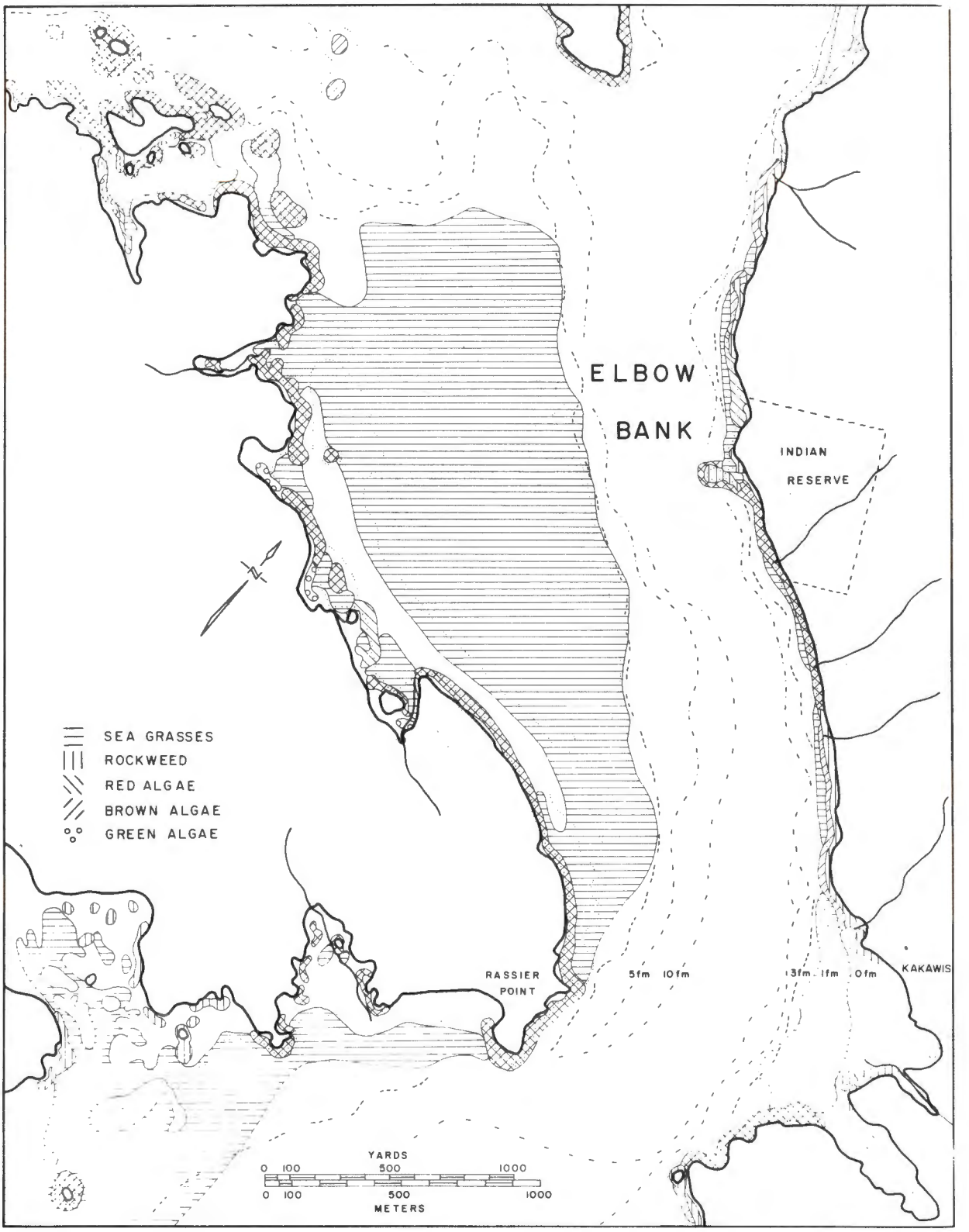

Fig. 9. Shoreline vegetation map from aerial photographs for Elbow Bank (map 7 in Fig. 1).

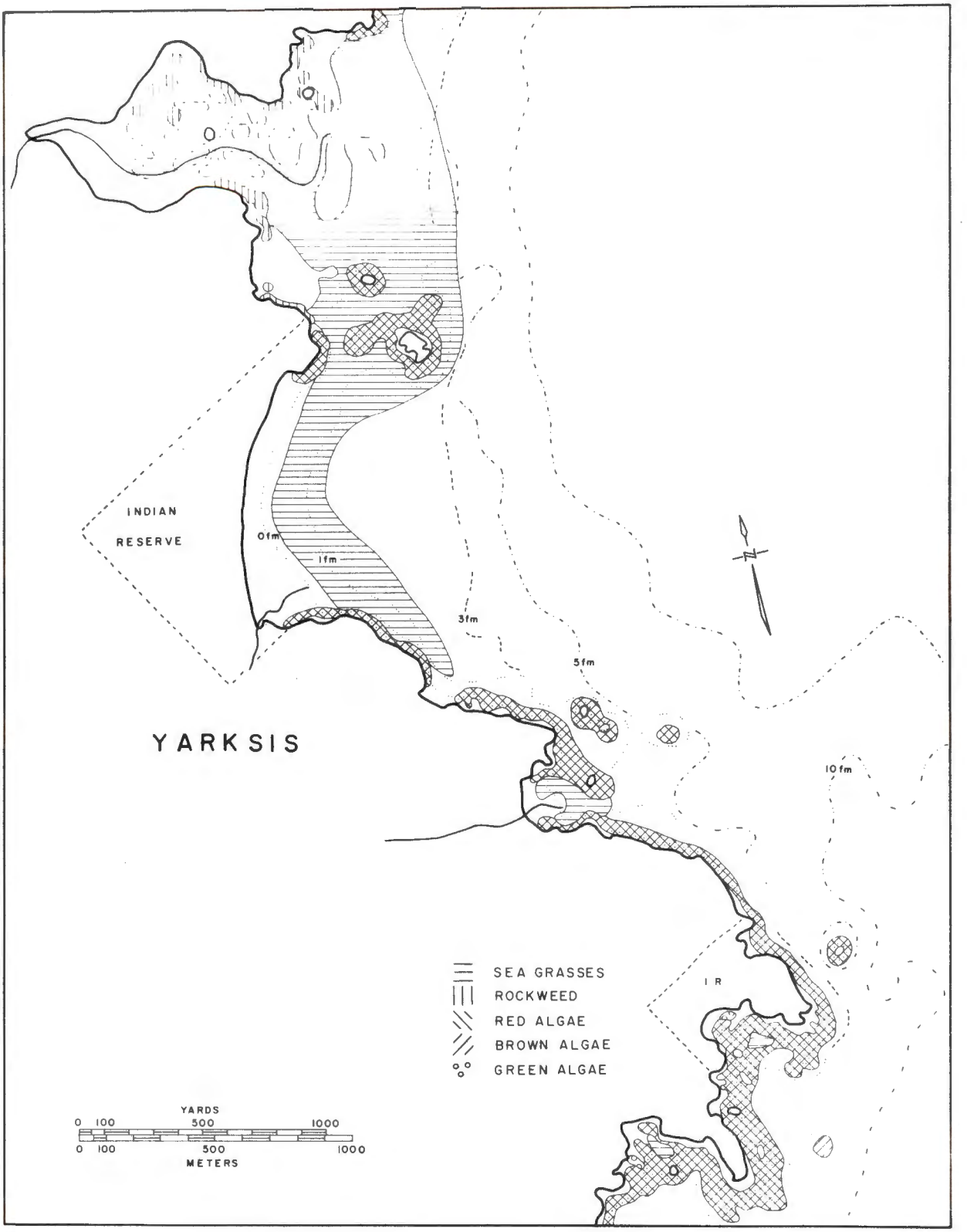

Fig. 10. Shoreline vegetation map from aerial photographs for Yarksis (map 8 in Fig. 1).

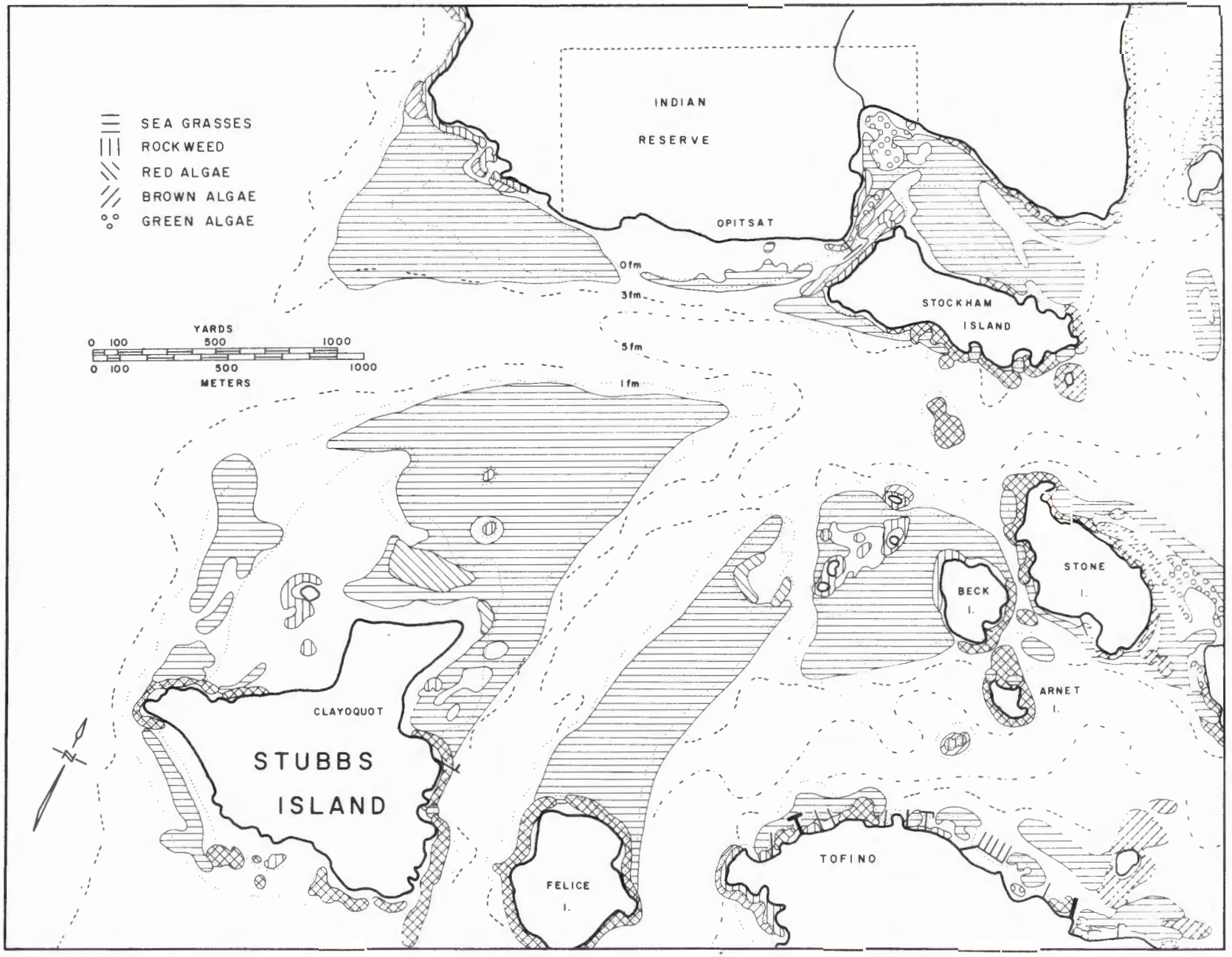

Fig. 11. Shoreline vegetation map from aerial photographs for Stubbs Island (map 9 in Fig. 1).

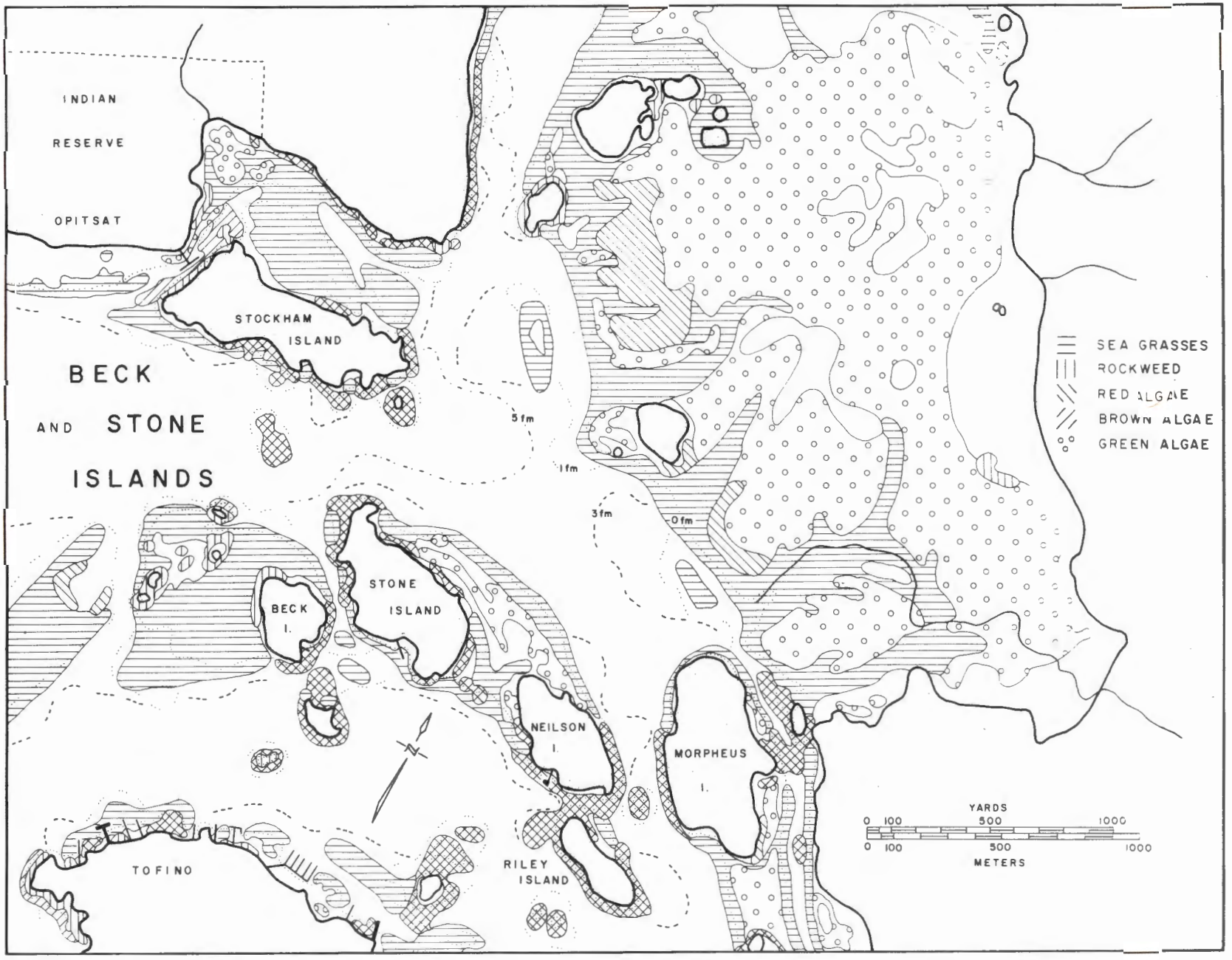

Fig. 12. Shoreline vegetation map from aerial photographs for Beck and Stone Islands (map 10 in Fig. 1).

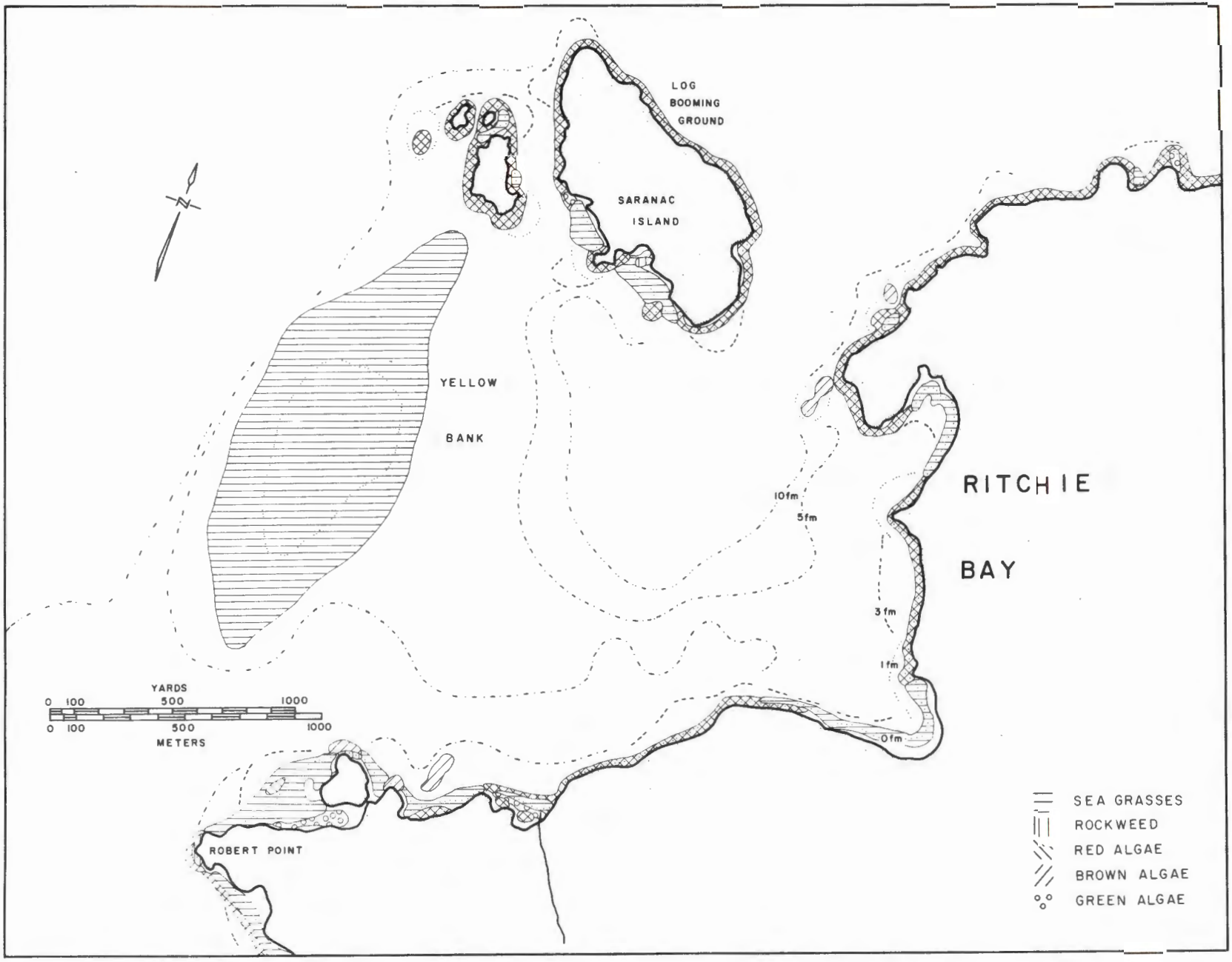

Fig. 13. Shoreline vegetation map from aerial photographs for Ritchie Bay (map 11 in Fig. 1).

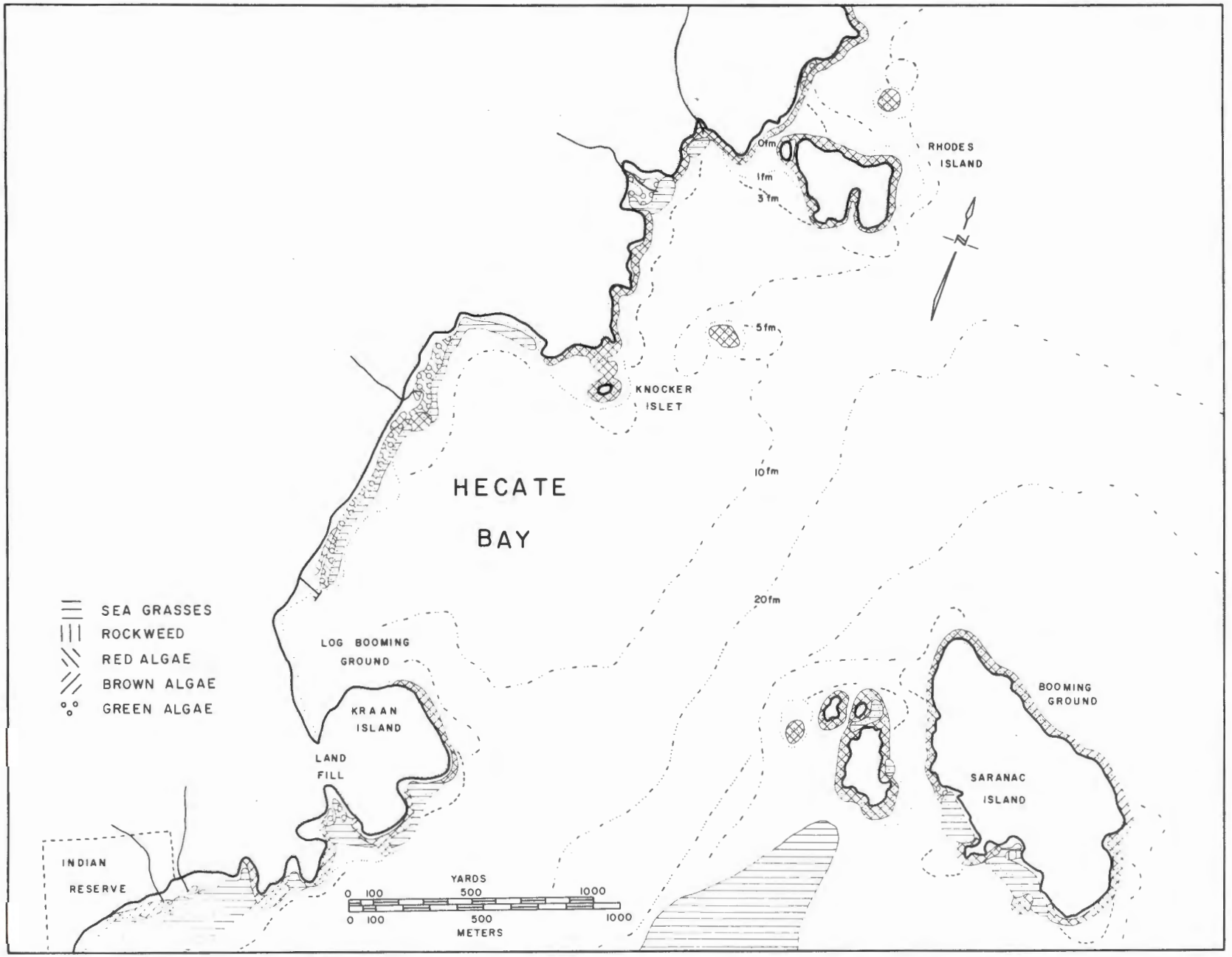

Fig. 14. Shoreline vegetation map from aerial photographs for Hecate Bay (map 12 in Fig. 1).

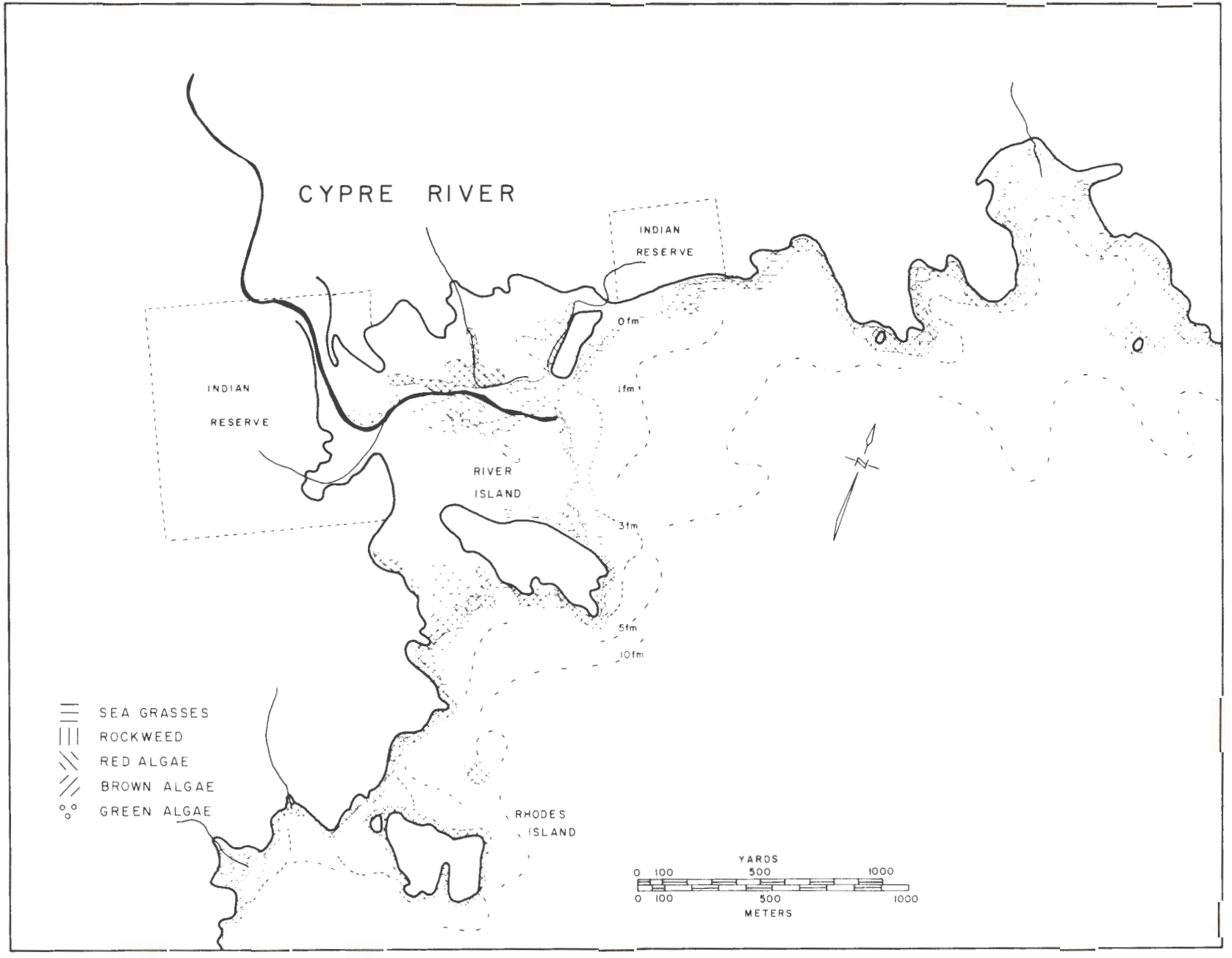

Fig. 15. Shoreline vegetation map from aerial photographs for Cypre River (map 13 on Fig. 1).

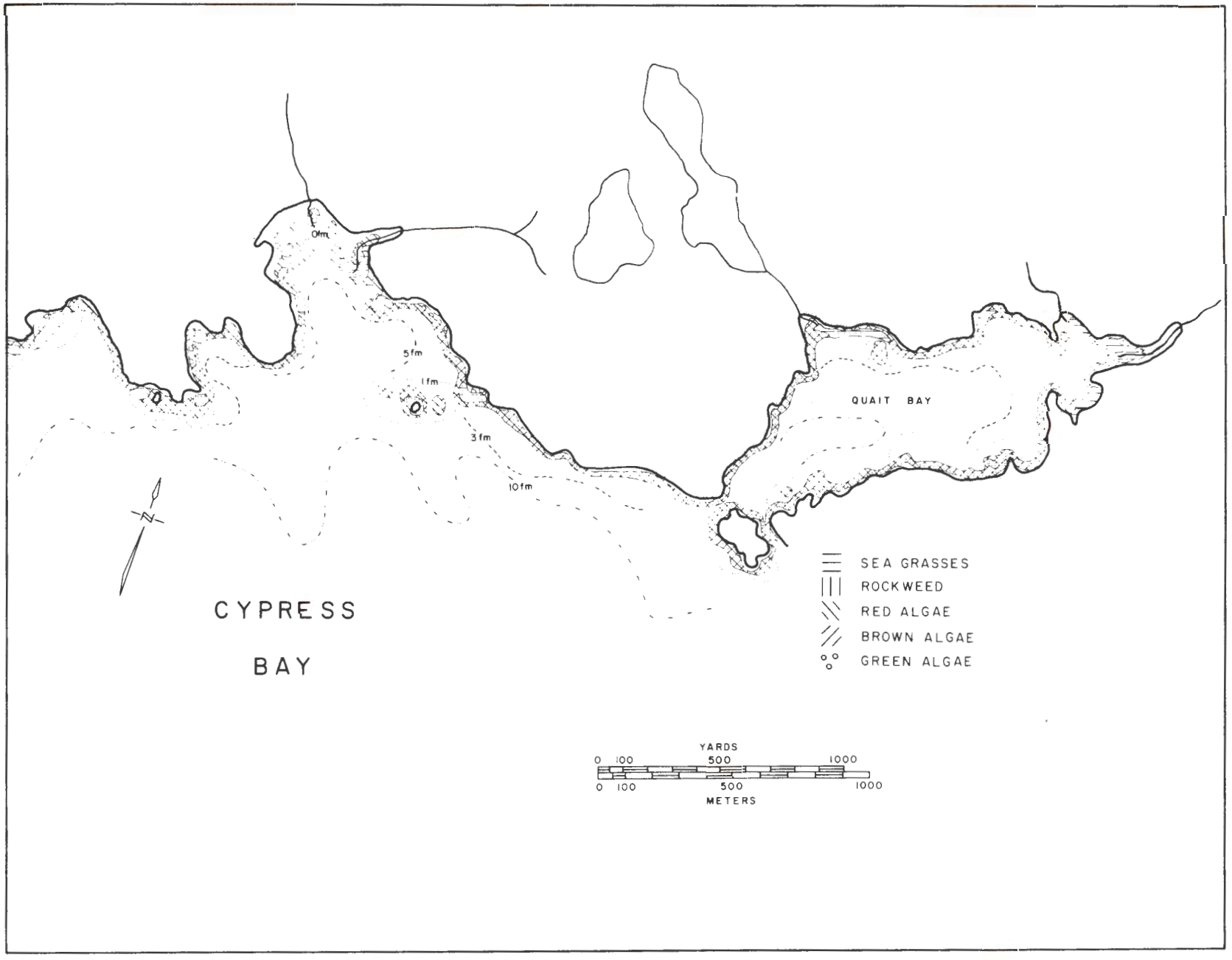

Fig. 16. Shoreline vegetation map from aerial photographs for Cypress Bay (map 14 in Fig. 1).