Kelp Inventory, 1978.

Northwest Coast of Vancouver Island

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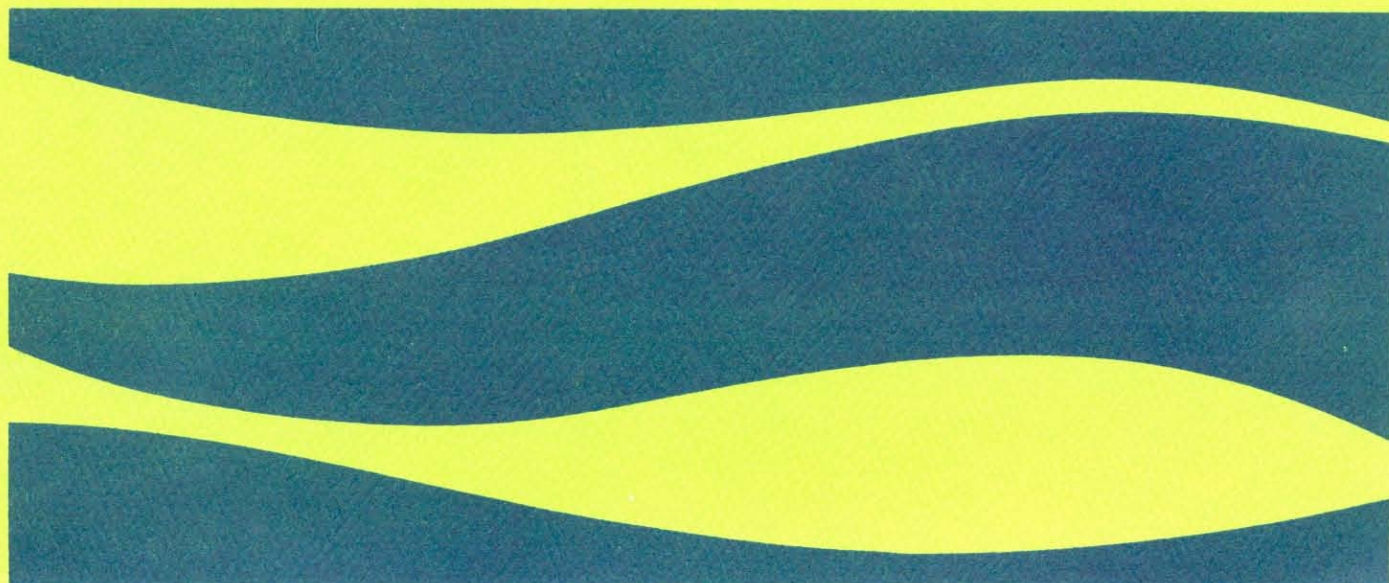
KELP INVENTORY, 1978

NORTHWEST COAST OF VANCOUVER ISLAND

by

L. M. Coon, W. G. Roland, I. R. Sutherland and R. A. Hall

ABSTRACT

The Kelp Inventory Method (KIM-1) developed by Foreman (1975) was used to estimate standing crop biomass of two canopy forming kelps along the northwest coast of Vancouver Island. Results indicated that 35,044 tonnes of pure Nereocystis luetkeana, 523 tonnes of pure Macrocystis integrifolia and 247 tonnes of these kelps in mixed stands were available at mean water level in this region. Total bed surface area was estimated to be 840 hectares. Five charts are presented which show the position, extent, species, and density classification of every discernable kelp bed for each of five geographic subdivision within the survey area. For management purposes, all inventoried coastlines were divided into permanent, numbered, kilometer wide blocks. The results of this survey are compared to those obtained in a private kelp survey performed in 1967.

ACKNOWLEDGEMENTS

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INTRODUCTION

Nereocystis luetkeana (Mertens) Postels and Ruprecht and
Macrocystis integrifolia Bory form beds along extensive portions of
the British Columbia coast. Beginning in 1975 the Marine Plant
Management and Development Section of the Marine Resources Branch
undertook a program to locate and quantify the standing crop of these
economically important kelps using the inventory method (KIM-1)
developed by Foreman (1975). Five areas were surveyed in August and
September, 1976 (Field et al, 1977; Field and Clark, 1978; Coon et al,
1979; Coon et al, 1980; Coon et al, 1981). This report contains the
results of our 1978 survey of the northwest coast of Vancouver Island.
A small portion of our survey area overlapped with an earlier survey
carried out by M. W. Huff and Co; the results of the two surveys are
compared for the area of overlap.

Accurate and comprehensive data on the standing crop of kelp in
British Columbia provide a basis for allocating these resources
through licensing and for establishing area specific harvest quotas.
Because kelp beds are important to other marine species, there are a
growing number of other users of kelp inventory data, including those
preparing environmental impact statements for major coastal
developments. Inventory charts will also be of value to those
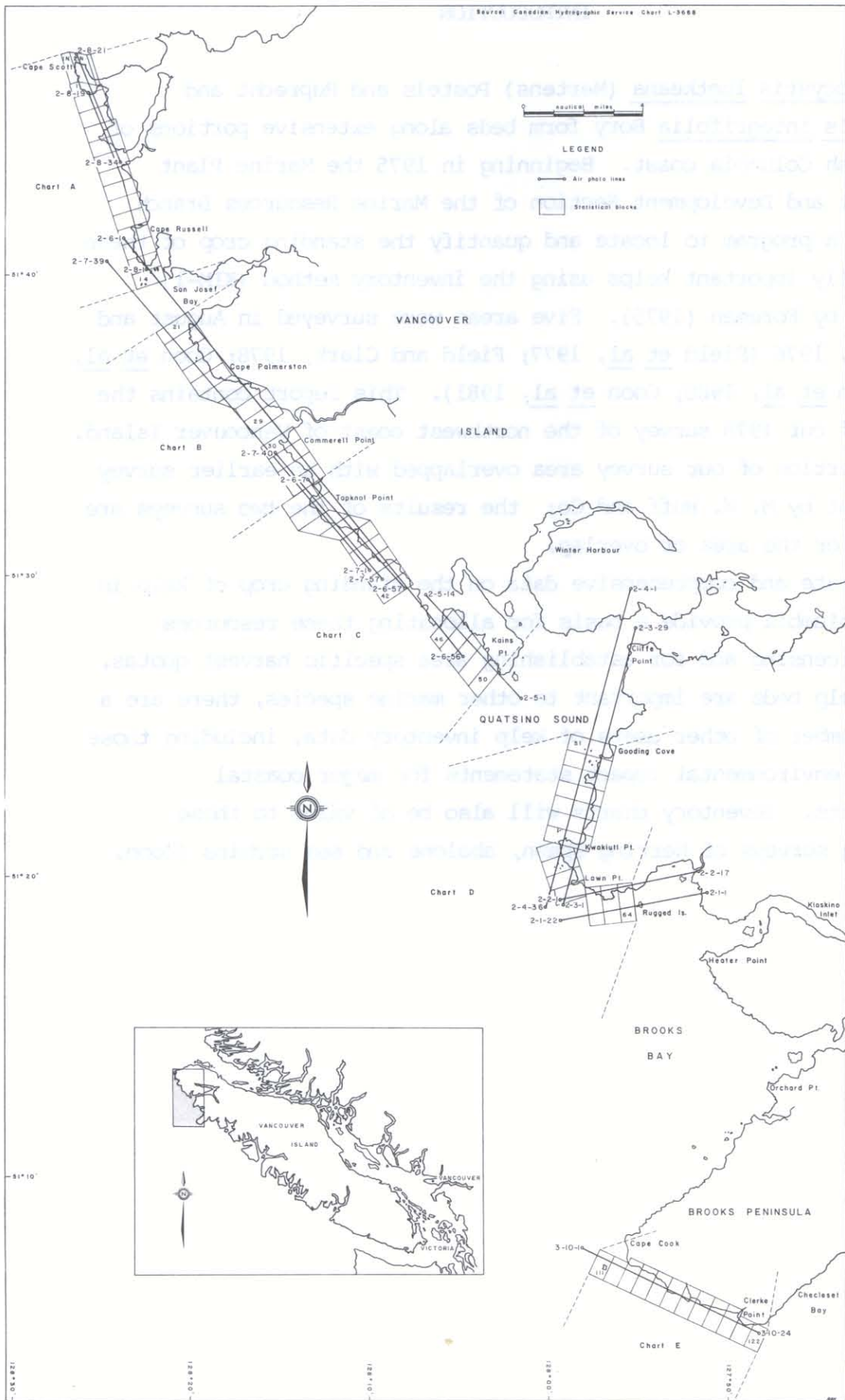conducting surveys of herring spawn, abalone and sea urchins (Coon,
1977).

Figure 1: The northwest coast of Vancouver Island, showing the area inventoried for floating kelp resources and tie mode of division of this area into inventory charts (see Appendix). Also indicated are the layout of statistical blocks, aerial photographic flight lines and locations of biomass sampling stations.

METHODS

The standing crop of Nereocystis and Macrocystis was estimated by the Kelp Inventory Method (KIM-1) developed by Foreman (1975). Modifications of this method as stated by Coon et al (1977) and Field et al (1977) were used in this study. On September 3 and 4, 1978 the Surveys and Mapping Branch, Ministry of Environment obtained black and white infrared aerial photography of the survey area. Photographic coverage was made along the prescribed flight lines illustrated in Figure 1.

Briefly, the KIM-1 technique involves obtaining 24 cm format black and white infrared (IR) aerial photography of the kelp bed and shoreline in the desired region. These black and white IR negatives are used to prepare charts of the coastline and the offshore kelp beds. On these charts the survey area is divided into 1 km wide statistical blocks. Bed areas for each of six bed types listed below are determined for each block. The density of kelp is determined directly from the photographs with the aid of a microscope. Field crews obtain samples of kelp from the area for mean weight per plant (Nereocystis) or frond (Macrocystis) determination, near the time that the beds are photographed. The total available kelp per block is determined by multiplying the mean weight per plant/frond values by the observed plant/frond densities and multiplying this product by the observed bed areas. The KIM-1 technique identifies six bed types on the basis of:

a) species - Macrocystis or Nereocystis

b) stand purity - pure bed or mixed (42% Nereocystis and 58% Macrocystis; Foreman, 1975)

c) plant or frond density - low (less than 10 plants/fronds per/10 m^2) or high (greater than 10 plants/fronds per/10 m^2).

All bed area and density estimates given in this report are derived from the September, 1978 photography but, since we were unable to field a team to collect mean weight per plant/frond and vertical biomass distribution data at that time, the biomass data used herein was derived from our late August, 1975 sampling efforts in Nootka Sound

(Coon et al, 1977). This data substitution may, of course, introduce considerable error in our overall standing crop estimate.

Foreman (in prep.) has noted in his Malcolm Island study area that the individual plant biomass in Nereocystis populations tends to increase as the bed density decreases. From Foreman's data we determined that in high density portions of the bed a 31% decrease in density between 1974 and 1978 was accompanied by a 48% increase in mean plant weight, and that a 12% decrease in density from 1978 to 1980 was accompanied by a 39% increase in mean plant weight. Thus, relatively small changes in bed density may have large impacts on mean plant weight.

The average densities in high density Nereocystis beds for the whole 1975 survey area in Nootka Sound and the whole 1978 survey area were calculated. Average density in the northwest Vancouver Island survey area was 7.4% lower than that found in the earlier Nootka Sound Survey. On the basis of Foreman's results, it is therefore reasonable to speculate that the use of mean weight per plant data from the Nootka Sound survey could result in a slight underestimation of the Nereocystis standing crop in the northwest Vancouver Island survey area.

Certain areas were photographed when the tide was 1 m higher than the optimal level (MWL ± 0.6 m) as outlined by Foreman (1975). This resulted in a lower density of plants or fronds on the photographs than would have been seen at MWL. A correction procedure for this is given in Coon et al (1979). This procedure permits the calculation of the plant/frond density at MWL by multiplying the adjusted mean biomass per plant/frond factors given in Table 1 by the plant/frond density recorded from the photographs. Cloud cover obscured some of the sea surface; surf nearshore and around offshore rocks may lead to an underestimation of bed area by obscuring kelp in the IR imagery.

All water depth and tide level calculations were based on actual values obtained from computer-drawn daily tide curves for Brooks Penninsula - Mission Group - Bunsby Island obtained from the Federal Department of Fisheries and Oceans.

RESULTS

Charts A through E (Appendix) illustrate the disposition of kelp resources by bed type along the northwest coast of Vancouver Island. It will be noted from these charts and Figure 1 that certain portions of the coast line are not represented. This is due either to incomplete photographic coverage or the absence of detectable kelp. However, sufficient space and block numbers have been reserved for these unsurveyed areas should the need arise for their inclusion in a later inventory.

Table 1. Mean biomass per plant or frond (kg) factors used to calculate biomass estimates at MWL for the northwest coast of Vancouver Island (from end of August, 1975 Nootka Sound - see text).

Species	No. of Stations	Photography at MWL Blocks 1N,2N,3N,1-14,21-60	Photography at + 1 m Blocks 61-64, 111-122
Nereocystis	4	4.21	6.37
Macrocystis	2	0.86	1.05
Mixed*	–	2.27	3.50

* based on 42% Nereocystis and 58% Macrocystis (Foreman, 1975).

A summary of the field determined biomass data collected at the end of August, 1975 is given in Table 2. This table gives vertical distribution of kelp biomass in 1 m increments above and below MWL. Again, this data is derived from the 1975 Nootka Sound inventory.

Tables 3 and 4 present estimates of bed areas, kelp density and kelp biomass available at MWL, by bed type, for each block as follows:

a) Table 3 - Blocks 1N-50; Cape Scott to Kains Point.

b) Table 4 - Blocks 51-122; Gooding Cove to Clerke Point.

Tables 5, 6 and 7 summarize the bed area and biomass estimates in these tables by bed type, by percent composition of biomass, and by percent composition of bed area for each bed type in each geographical

Table 2:   The cumulative number of plants or fronds and their weight
           (biomass), and the mean weight per plant or frond at one metre
           increments for samples of Nereocystis and Macrocystis collected
           off Nootka Sound at the end of August, 1975.

Nootka - 1975

| Cutting Depth (m) | End August | | | | | | Mixed |
| | Nereocystis | | | Macrocystis | | | |
	Cum B	Cum N	x̄B/plant	Cum B	Cum N	x̄B/frond	*x̄B/plant or frond
+6	–	–	–	4.04	5	0.81	0.47
+5	16.58	3	5.53	5.90	8	0.74	2.75
+4	42.85	11	3.90	8.34	13	0.64	2.01
+3	98.24	22	4.47	14.62	28	0.52	2.18
+2	159.99	38	4.21	24.72	36	0.69	2.17
+1	231.99	52	4.46	37.42	49	0.76	2.32
MWL	332.67	79	4.21	51.55	60	0.86	2.27
-1	388.02	95	4.08	66.61	67	0.99	2.29
-2	411.20	99	4.15	77.88	73	1.07	2.36
-3	426.91	102	4.19	85.38	74	1.15	2.43
-4	435.54	104	4.19	92.49	81	1.14	2.42
-5	443.14	105	4.22	99.36	83	1.20	2.47
-6	447.13	105	4.26	105.96	89	1.19	2.48

* Values based on 42% Nereocystis and 58% Macrocystis

Cum N = cumulative number of plants or fronds

Cum B = cumulative biomass in kilograms

x̄B/plant (frond) = mean biomass per plant or frond in kilograms

subdivision, respectively. A total of 35,994 tonnes of kelp were estimated to be available at MWL along the surveyed coast line (Table 5). The greatest concentration (14,279 tonnes) occurred in Nereocystis beds along 12 km of coast line between Clerke Point and Cape Cook (Table 5). A further 7,831 tonnes of Nereocystis were estimated to lie in beds along 14 km of coast line between San Josef Bay and Top Knot Point. The majority (35,444 tonnes or 98.47%) of the kelp biomass occurred as pure stands of Nereocystis, with 57.64% in low density beds and 40.83% in high density beds (Table 6). Nereocystis beds formed 92.97% of the total bed areas (Table 7); Macrocystis occurred only in small beds scattered along the coast line.

Factors for estimating biomass at selected cutting levels other than MWL are presented in Table 8. By multiplying these factors times the biomass at MWL, an estimate of the amount of kelp available at other tide heights can be obtained. Estimates of Nereocystis and Macrocystis standing crops at the different depth levels are given in Table 9 for the entire survey area. We estimated the total standing crop for all of the surveyed area in September, 1978 to be 48,614 tonnes. This was thought to be a somewhat conservative estimate primarily because of incomplete photographic coverage, and, very secondarily, to inevitable losses of kelp laminae during field sampling procedures which result in under estimation of mean biomass per plant/frond.

Table 3. Estimates of kelp area and biomass for the northwest coast of Vancouver Island: Cape Scott to Kains Points, September, 1978. See Charts A, I

Block	Nereocystis - low density				Nereocystis - high density				Macrocystis - low density				Ma
	$\bar{x}D/ha$	A	$\bar{x}B/ha$	B	$\bar{x}D/ha$	A	xB/ha	B	xD/ha	A	xB/ha	B	$\bar{x}D/ha$
1N	6,990	5.144	44.55	229.9	11,570	0.157	73.74	11.6	7,030	0.614	7.36	4.5	
2N	6,990	1.527	44.55	68.0					7,030	1.213	7.36	8.9	
3N	6,990	2.205	44.55	98.2									
1	7,640	5.065	48.69	246.6	11,570	0.472	73.74	34.8	7,030	2.058	7.36	15.1	
2	7,640	13.280	48.69	646.6	11,570	2.084	73.74	153.7	7,030	1.202	7.36	8.8	14,800
3	7,220	5.774	46.01	265.7	11,570	1.155	73.74	85.2					
4	7,220	3.632	46.01	167.1	11,570	0.315	73.74	23.2					
5	7,220	8.493	46.01	390.8	11,570	1.548	73.74	114.1					
6	7,400	3.958	47.16	186.7	11,570	0.331	73.74	24.4	7,030	0.058	7.36	0.4	
7	7,400	5.459	47.16	257.4	11,570	0.709	73.74	52.3					
8	7,400	3.727	47.16	175.8									
9													
10	7,450	1.391	47.48	66.0	11,570	1.123	73.74	82.8					
11	7,450	9.810	47.48	465.8	11,570	0.152	73.74	11.2					
12	6,990	4.462	44.55	198.8	11,570	0.577	73.74	42.5					
13	6,990	6.577	44.55	293.0	11,570	0.367	73.74	27.1	7,030	2.304	7.36	17.0	
14	6,990	4.304	44.55	191.7	11,570	0.761	73.74	56.1	7,030	1.365	7.36	10.0	
21	5,900	7.640	37.60	287.3	14,780	0.262	94.19	24.7	7,030	0.785	7.36	5.8	14,800
22	5,900	16.746	37.60	629.7	14,780	2.303	94.19	216.9					
23	5,840	11.722	37.22	436.3	14,780	1.465	94.19	138.0					
24	5,840	4.239	37.22	157.8	14,670	0.105	93.49	9.8					
25	5,780	15.856	36.84	584.1	14,670	7.536	93.49	704.6					
26	5,020	9.786	31.99	313.1	14,330	4.710	91.33	430.1					
27	5,020	4.762	31.99	152.3	14,330	0.680	91.33	62.1					
28	5,170	15.647	32.95	515.5	14,170	4.710	90.31	425.3	7,030	0.471	7.36	3.5	
29	5,470	12.402	34.86	432.3	14,150	2.617	90.18	236.0	7,030	0.314	7.36	2.3	
30	5,560	10.780	35.43	382.0	14,150	2.303	90.18	207.7					14,800
31	5,250	19.571	33.46	654.8	14,150	3.558	90.18	320.9					
32	5,610	9.158	35.75	327.4	14,150	1.308	90.18	118.0					
33	5,740	1.622	36.58	59.3	14,150	0.052	90.18	4.7					
34	7,090	7.31	45.18	330.3	16,410	3.95	104.58	413.1					
35	7,090	6.74	45.18	304.5	16,410	1.02	104.58	106.7					
36	7,090	11.74	45.18	530.5	16,410	2.00	104.58	209.2					
37	5,610	5.30	35.75	189.5	16,410	1.48	104.58	154.8					
38	5,610	4.98	35.75	178.0	16,410	0.68	104.58	71.1					
39	5,610	3.15	35.75	112.6	16,410	0.37	104.58	38.7					
40	5,610	4.11	35.75	146.9	16,410	2.68	104.58	280.3					
41	5,480	2.39	34.92	83.5	16,410	1.39	104.58	145.4					
42	5,780	0.06	36.84	2.2									
46	5,780	1.42	36.84	52.3	16,410	0.29	104.58	30.3					
47	5,780	7.62	36.84	280.7	16,410	1.04	104.58	108.8					
48	5,780	1.85	36.84	68.1	16,410	0.52	104.58	54.4					
49	5,780	6.96	36.84	256.4	16,410	3.65	104.58	381.7					
50	5,780	2.43	36.84	89.5	16,410	0.58	104.58	60.7					14,800
Totals		291		11,504		61		5,673		10		76	

D = Density (no. of plants or fronds)

A = Area (hectares)

B = Biomass (metric tonnes)

$\bar{x}$ = Mean (obtained by averaging only those b

ha = hectare

B	Macrocystis – high density				Mixed – low denisty				Mixed – high denisty				Total A	Total B
	$\bar{x}D/ha$	A	$\bar{x}B/ha$	B	$\bar{x}D/ha$	A	$\bar{x}B/ha$	B	$\bar{x}D/ha$	A	$\bar{x}B/ha$	B		
5													5.915	245.3
9													2.740	76.9
1													2.205	98.2
8													7.595	296.5
	14,800	0.210	15.50	3.3									16.776	812.4
													6.929	350.9
													3.947	190.3
													10.041	504.9
.4													4.347	211.5
													6.168	309.7
													3.727	175.8
													2.514	148.8
													9.962	477.0
.0													5.039	241.3
.0					5,015	0.919	11.37	10.4					10.167	347.5
					5,015	0.157	11.37	1.8					6.587	259.6
.8	14,800	0.942	15.50	14.6									9.629	332.4
													19.049	846.6
													13.187	574.3
													4.344	167.6
													23.392	1,288.7
													14.496	743.2
3.5													5.442	214.4
2.3													20.828	944.3
													15.333	670.6
	14,800	0.471	15.50	7.3									13.554	597.0
													23.129	975.7
													10.466	445.4
													1.674	64.0
													11.26	743.4
													7.76	411.2
													13.74	739.7
													6.78	344.3
													5.66	249.1
													3.52	151.3
													6.79	427.2
													3.78	228.9
													0.06	2.2
													1.71	82.6
													8.66	389.5
													2.37	122.5
													10.61	638.1
	14,800	0.25	15.50	3.9									3.26	154.1
76		2		29		1		12		nil		nil	365	17,295

ts or fronds)

nes)

veragingonly those blocks containing kelp)

Table 4. Estimates of kelp area and biomass for the northwest coast of Vancouver Island: Gooding Cove to Rugged Island and Cape Cook to Clerke Point, September 19

Block	Nereocystis - low density				Nereocystis - high density				Macrocystis - low density				Macr
	$\bar{x}D$/ha	A	$\bar{x}B$/ha	B	$\bar{x}D$/ha	A	$\bar{x}B$/ha	B	$\bar{x}D$/ha	A	$\bar{x}B$/ha	B	$\bar{x}D$/ha
51	7,600	3.595	42.70	153.5									
52	7,600	3.290	42.70	140.5	16,410	0.270	104.58	28.2	7,030	2.695	7.36	19.8	14,800
53	7,600	1.960	42.70	83.7	16,410	0.855	104.58	89.4	7,030	0.580	7.36	4.3	14,800
54	7,600	1.265	42.70	54.0					7,030	0.555	7.36	4.1	14,800
55	7,600	0.145	42.70	6.2	16,410	1.610	104.58	168.4					
56	7,600	0.465	42.70	19.9					7,030	0.330	7.36	2.4	14,800
57	7,600	1.605	42.70	68.5	16,410	0.030	104.58	3.1	7,030	2.350	7.36	17.3	14,800
58	7,600	17.680	42.70	754.9	16,410	1.620	104.58	169.4					14,800
59	7,600	13.635	42.70	660.4	16,410	1.015	104.58	106.1	7,030	10.185	7.36	75.0	14,800
60	7,600	12.985	42.70	628.9	16,410	0.835	104.58	87.3	7,030	2.600	7.36	19.1	14,800
61	6,630	13.205	27.92	368.7	10,750	0.675	45.27	30.6	5,980	6.580	5.14	33.8	19,150
62	5,900	8.765	24.84	217.8	10,750	0.310	45.27	14.0	5,980	2.840	5.14	14.6	19,150
63	5,900	5.230	24.84	129.9	10,750	0.360	45.27	16.3	5,980	2.705	5.14	13.9	
64	5,900	0.135	24.84	3.4					5,980	0.035	5.14	0.2	
111	7,440	3.109	31.33	97.4									
112	7,440	29.283	31.33	917.4	21,380	28.062	90.03	2,526.5					
113	6,710	21.702	28.26	613.2	16,240	28.392	68.39	1,941.6					
114	6,850	23.421	28.85	675.6	13,810	11.530	58.15	670.5					
115	7,100	24.695	29.90	738.3	17,120	6.994	72.09	504.2					
116	6,120	19.505	25.77	502.7	17,120	11.173	72.09	805.5					
117	6,890	20.144	29.01	584.5	15,200	8.111	64.01	519.2	5,980	0.897	5.14	4.6	
118	5,400	18.393	22.74	418.2	17,630	10.256	74.24	761.4	5,980	0.514	5.14	2.6	
119	6,040	17.072	25.43	434.2	14,750	5.269	62.11	327.3	5,980	0.629	5.14	3.2	19,150
120	6,000	13.606	25.27	343.8	14,750	2.491	62.11	154.7					
121	4,920	19.898	20.72	412.2	14,750	1.599	62.11	99.3					
122	4,790	10.722	20.17	216.3									
Totals		306		9,244		121		9,023		33		215	

D = Density (no. of plants or fronds)
A = Area (hectares)
B = Biomass (metric tonnes)
$\bar{x}$ = Mean (obtainable by averaging only those blocks contai
ha = Hectare

B	Macrocystis – high density				Mixed – low density				Mixed – high density				Total A	Total B
	x̄D/ha	A	x̄B/ha	B	x̄D/ha	A	x̄B/ha	B	x̄D/ha	A	x̄B/ha	B	Total A	Total B
													~~3.595~~	153.5
19.8	14,800	0.325	15.50	5.0					17,644	0.110	40.00	4.4	6.690	197.9
4.3	14,800	0.315	15.50	4.9	5,015	0.300	11.37	3.4					4.010	185.7
4.1	14,800	0.160	15.50	2.5									1.980	60.6
													1.755	174.6
2.4	14,800	0.535	15.50	8.3									1.330	30.6
17.3	14,800	0.680	15.50	10.5									4.665	99.4
	14,800	0.188	15.50	2.9									19.488	927.2
75.0	14,800	6.823	15.50	105.7									31.658	947.2
19.1	14,800	0.835	15.50	12.9									17.255	748.2
33.8	19,150	2.150	16.45	35.4									22.610	468.5
14.6	19,150	0.835	16.45	13.7									12.750	260.1
13.9					5,015	0.165	11.37	1.9					8.460	162.0
0.2													0.170	3.6
													3.109	97.4
													57.345	3,443.9
													50.094	2,554.8
													34.951	1,346.1
													31.689	1,242.5
													30.678	1,308.2
4.6													29.152	1,108.3
2.6					5,015	0.419	11.37	4.8					29:582	1,187.0
3.2	19,150	0.021	16.45	0.3									22.991	765.0
													16.097	498.5
													21.497	511.5
													10.722	216.3
215		13		202		1		10		0		4	474	18,699

ronds)

g only those blocks containing kelp)

Table 5. Summary of biomass and kelp bed area estimates, by geographical subdivision and bed type for the northwest coast of Vancouver Island. Estimates are harvestable biomass at MWL $\pm$ 0.6 m.

Geographical Area	Blocks	Biomass (tonnes)	Area (hectares)
Low Density Nereocystis			
Cape Scott to San Joseph Bay	1-14,1N,2N,3N	3947	85
San Joseph Bay to Topknot Point	21-33	4932	140
Topknot Point to Kains Point	34-50	2625	66
Gooding Cove to Rugged Island	51-64	3290	84
Cape Cook to Clerke Point	111-122	5954	222
High Density Nereocystis			
Cape Scott to San Joseph Bay	1-14,1N,2N,3N	719	10
San Joseph Bay to Topknot Point	21-33	2899	32
Topknot Point to Kains Point	34-50	2055	20
Gooding Cove to Rugged Island	51-64	713	8
Cape Cook to Clerke Point	111-122	8310	114
Low Density Macrocystis			
Cape Scott to San Joseph Bay	1-14,1N,2N,3N	65	9
San Joseph Bay to Topknot Point	21-33	12	2
Topknot Point to Kains Point	34-50	0	0
Gooding Cove to Rugged Island	51-64	205	31
Cape Cook to Clerke Point	111-122	10	2
High Density Macrocystis			
Cape Scott to San Joseph Bay	1-14,1N,2N,3N	3	0 (.2)
San Joseph Bay to Topknot Point	21-33	22	1
Topknot Point to Kains Point	34-50	4	0 (.03)
Gooding Cove to Rugged Island	51-64	202	13
Cape Cook to Clerke Point	111-122	0 (.3)	0 (.02)
Low Density Mixed			
Cape Scott to San Joseph Bay	1-14,1N,2N,3N	12	1
San Joseph Bay to Topknot Point	21-33	0	0
Topknot Point to Kains Point	34-50	0	0
Gooding Cove to Rugged Island	51-64	5	0 (.47)
Cape Cook to Clerke Point	111-122	5	0 (.4)
High Density Mixed			
Cape Scott to San Joseph Bay	1-14,1N,2N,3N	0	0
San Joseph Bay to Topknot Point	21-33	0	0
Topknot Point to Kains Point	34-50	0	0
Gooding Cove to Rugged Island	51-64	5	0 (.1)
Cape Cook to Clerke Point	111-122	0	0
Totals			
Cape Scott to San Joseph Bay	1-14,1N,2N,3N	4746	105
San Joseph Bay to Topknot Point	21-33	7865	175
Topknot Point to Kains Point	34-50	4684	86
Gooding Cove to Rugged Island	51-64	4420	136
Cape Cook to Clerke Point	111-122	14279	338
GRAND TOTALS	1-122,1N,2N,3N	35994	840
Totals by Species			
Nereocystis	1-122,1N,2N,3N	35444	781
Macrocystis	1-122,1N,2N,3N	523	58

Table 6: Percent composition of low and high density Nereocystis, Macrocystis and mixed bed estimates of biomass in each of five geographic subdivisions. The last column gives percent composition of total biomass for the northwest coast of Vancouver Island.

Bed Type	Cape Scott/San Joseph	San Joseph/Topknot Pt.	Topknot/Kains Pt.	Gooding Cove/Rugged Is.	Cape Cook/Clerke Pt.	Combined
Nereocystis - low density	83.16	62.71	56.04	74.43	41.70	57.64
- high density	15.15	36.86	43.87	16.13	58.20	40.83
Macrocystis - low density	1.37	0.15	nil	4.64	0.07	0.81
- high density	0.06	0.28	0.09	4.57	nil	0.64
Mixed - low density	0.25	nil	nil	0.11	0.04	0.06
- high density	nil	nil	nil	0.11	nil	0.01

Table 7: Percent composition of low and high density Nereocystis, Macrocystis and mixed bed estimates of surface area in each of five geographic subdivisions. The last column gives percent composition of total bed area for the northwest coast of Vancouver Island.

Bed Type	Cape Scott/San Joseph	San Joseph/Topknot Pt.	Topknot/Kains Pt.	Gooding Cove/Rugged Is.	Cape Cook/Clerke Pt.	Combined
Nereocystis - low density	80.95	80.00	76.74	61.76	65.68	71.07
- high density	9.52	18.29	23.26	5.88	33.73	21.90
Macrocystis - low density	8.57	1.14	nil	22.79	0.59	5.24
- high density	nil	0.57	nil	9.56	nil	1.67
Mixed - low density	0.95	nil	nil	nil	nil	0.12
- high density	nil	nil	nil	nil	nil	nil

Table 8: Combined biomass and density correction factors for cutting
levels six metres above and below MWL, used for the
northwest coast of Vancouver Island. (Taken from 1976
Nootka Sound Kelp Inventory report. Biomass data was
gathered at the end of August, 1975.)

Cutting Level (m)	Nereocystis n = 105	Macrocystis n = 89	Mixed *
+6	–	0.08	0.01
+5	0.05	0.11	0.11
+4	0.13	0.16	0.16
+3	0.30	0.28	0.36
+2	0.48	0.48	0.52
+1	0.70	0.73	0.76
MWL	1.00	1.00	1.00
-1	1.17	1.29	1.17
-2	1.24	1.51	1.29
-3	1.28	1.66	1.35
-4	1.31	1.79	1.42
-5	1.33	1.92	1.48
-6	1.34	2.06	1.54

* Based on 42% Nereocystis and 58% Macrocystis

Table 9: Total harvestable kelp biomass at selected depth levels for the
northwest coast of Vancouver Island in September, 1978. (Based
on mean plant biomass and vertical biomass distribution data from
Nootka Sound, late August, 1975.)

Depth Level (m)	Cumulative Biomass (tonnes)			
	Nereocystis	Marcrocystis	Mixed	Total
+6	–	42	–	42
+5	1,722	58	3	1,833
+4	4,608	84	4	4,696
+3	10,633	146	10	10,789
+2	17,013	251	14	17,278
+1	24,811	382	21	25,214
MWL	35,444	523	27	35,994
-1	41,469	675	32	42,176
-2	43,951	790	35	44,776
-3	45,368	868	36	46,272
-4	46,432	936	38	47,406
-5	47,141	1,004	40	48,185
-6	47,495	1,077	42	48,614

DISCUSSION

The largest kelp beds were located between Clerke Point and Cape Cook off the southwest coast of Brooks Peninsula. This area was surveyed by M.W. Huff and Co. (Huff, 1967), in 1967. Huff's estimate of Nereocystis bed area, density and standing crop are fairly close to our 1978 estimates. He estimated the biomass to be 4.9 kg/m^2 compared to our estimate of 5.9 kg/m^2, and the bed area to be 469 ha compared to the 338 ha found in 1978. At -4 m below MWL (the depth at which their plant samples were collected for biomass), Huff estimated that 25,500 tonnes were available for harvest. Using the combined biomass and density correction factors in Table 8 for -4 m below MWL, the 1978 estimate of available standing crop was 20,254 tonnes. The techniques used by M.W. Huff were not as precise as those of the KIM-1 method; these methods are more fully discussed in Coon et al 1977.

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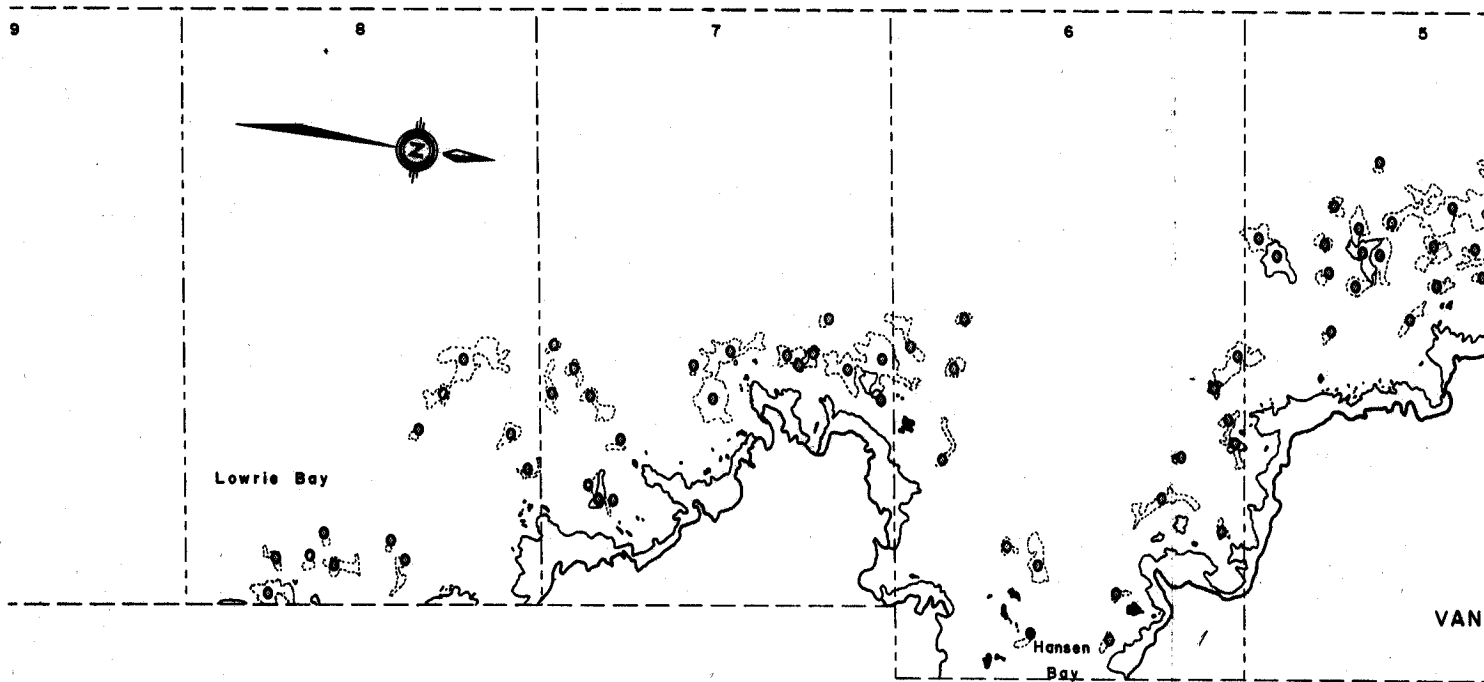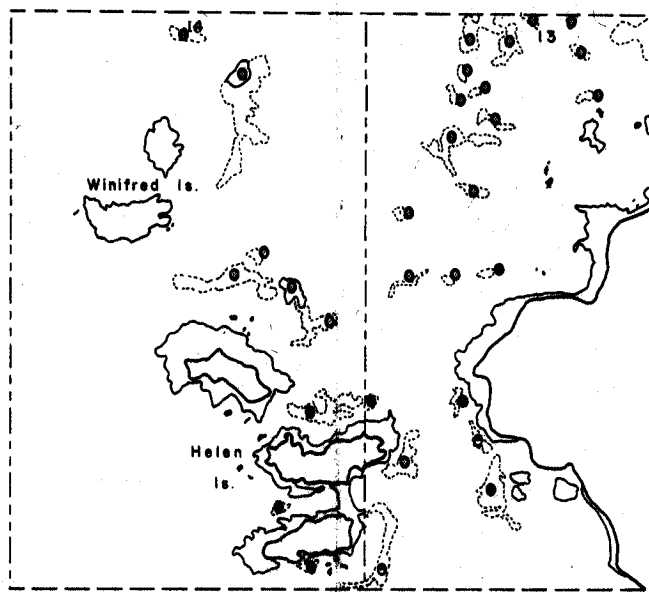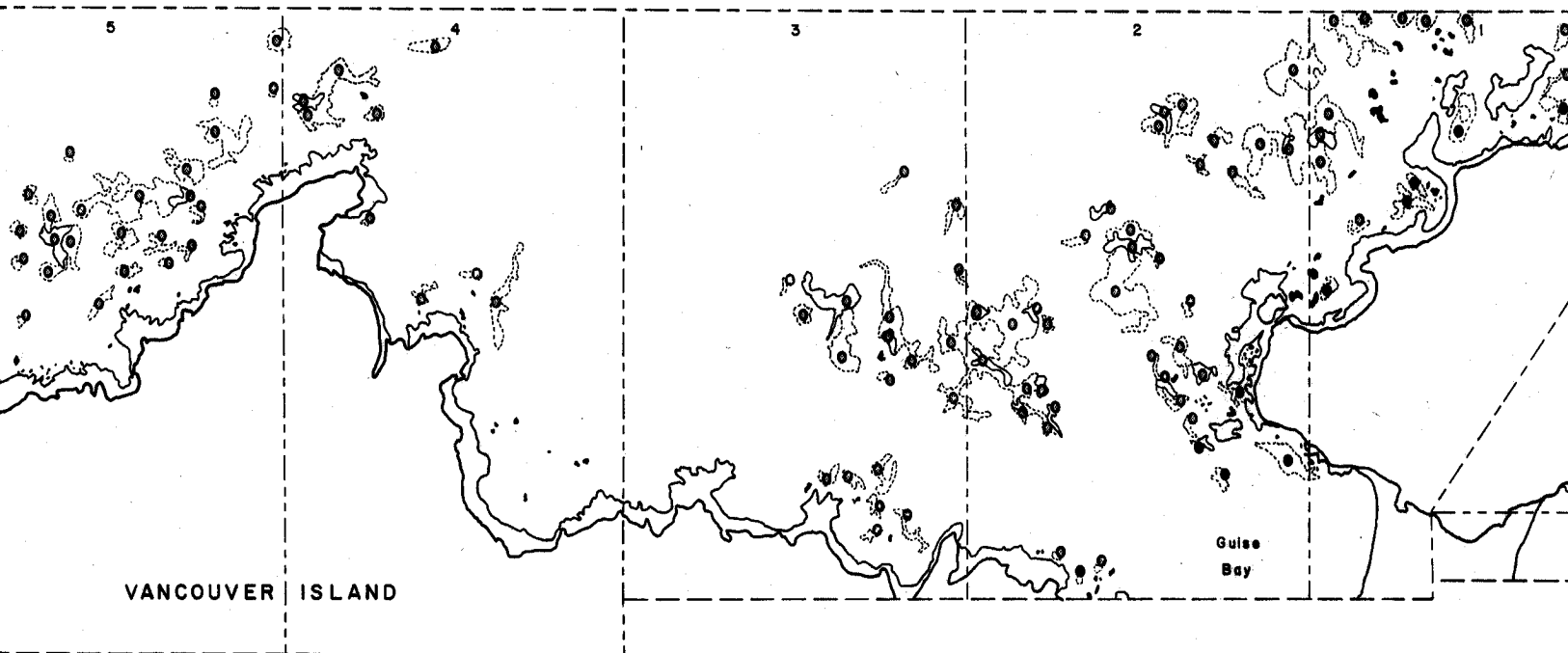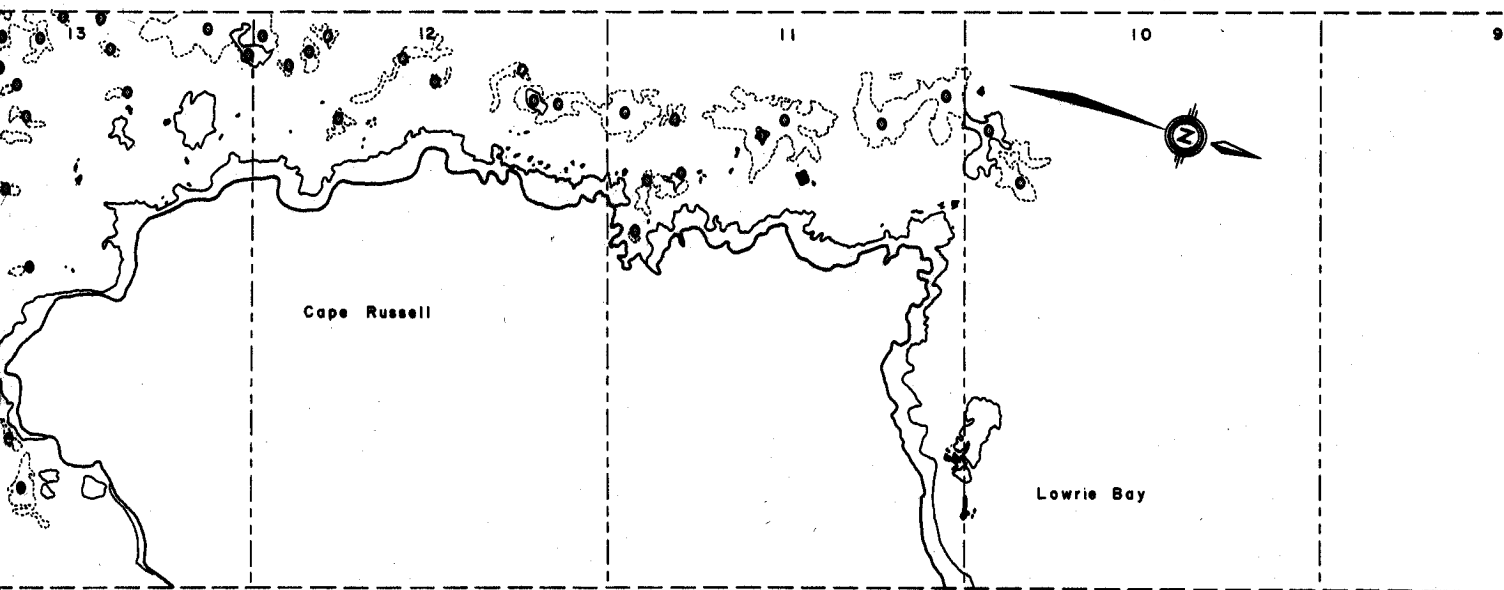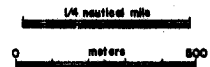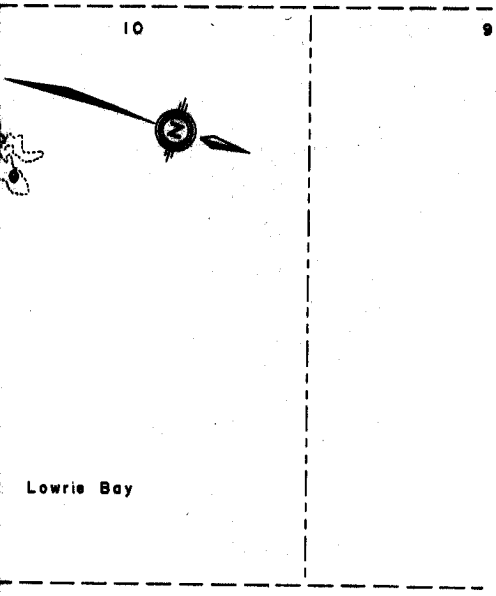
Winifred Is.

Helen Is.

13

9
8
7
6
5

Lowrie Bay

Hansen Bay

VAN

13   12   11   10   9

Cape Russell

Lowrie Bay

5   4   3   2   1

VANCOUVER ISLAND

Guise Bay

10

9

Lowrie Bay

1/4 nautical mile

0   meters   500

LEGEND

———————— edge of terrestrial vegetation
———————— water level at time of photography
— — — — boundary of statistical block
—·—·—·— boundary of photographic line
—··—··— border between adjacent blocks
● Nereocystis beds
● Macrocystis beds
● mixed beds of Nereocystis and Macrocystis
19 block number
high density bed
low density bed
rocks
houses and buildings

2

1

1 N

Cape Scott

2 N

Guise
Bay

3 N

CHART B

26

27

29

28

Raft
Cove

26

25

24

23

Cape Palmerston

VANCOUVER

ISLAND

N

24 23 22 21

VANCOUVER
ISLAND

San Joseph
Bay
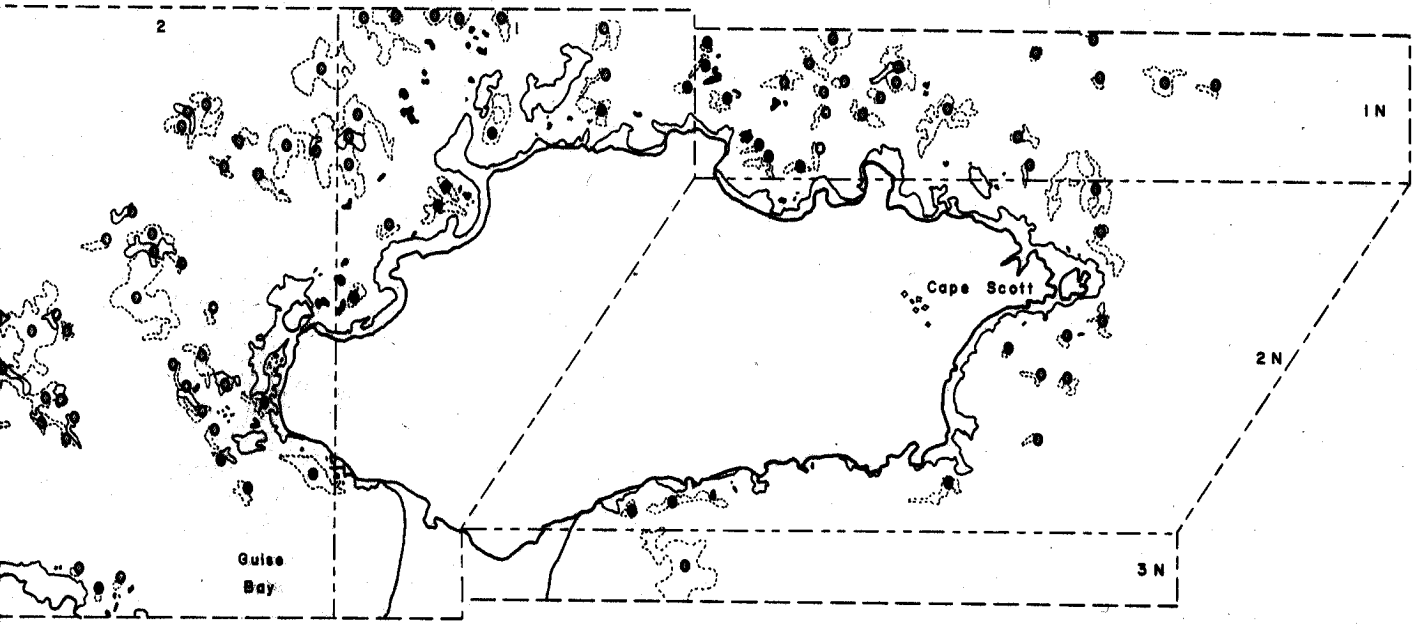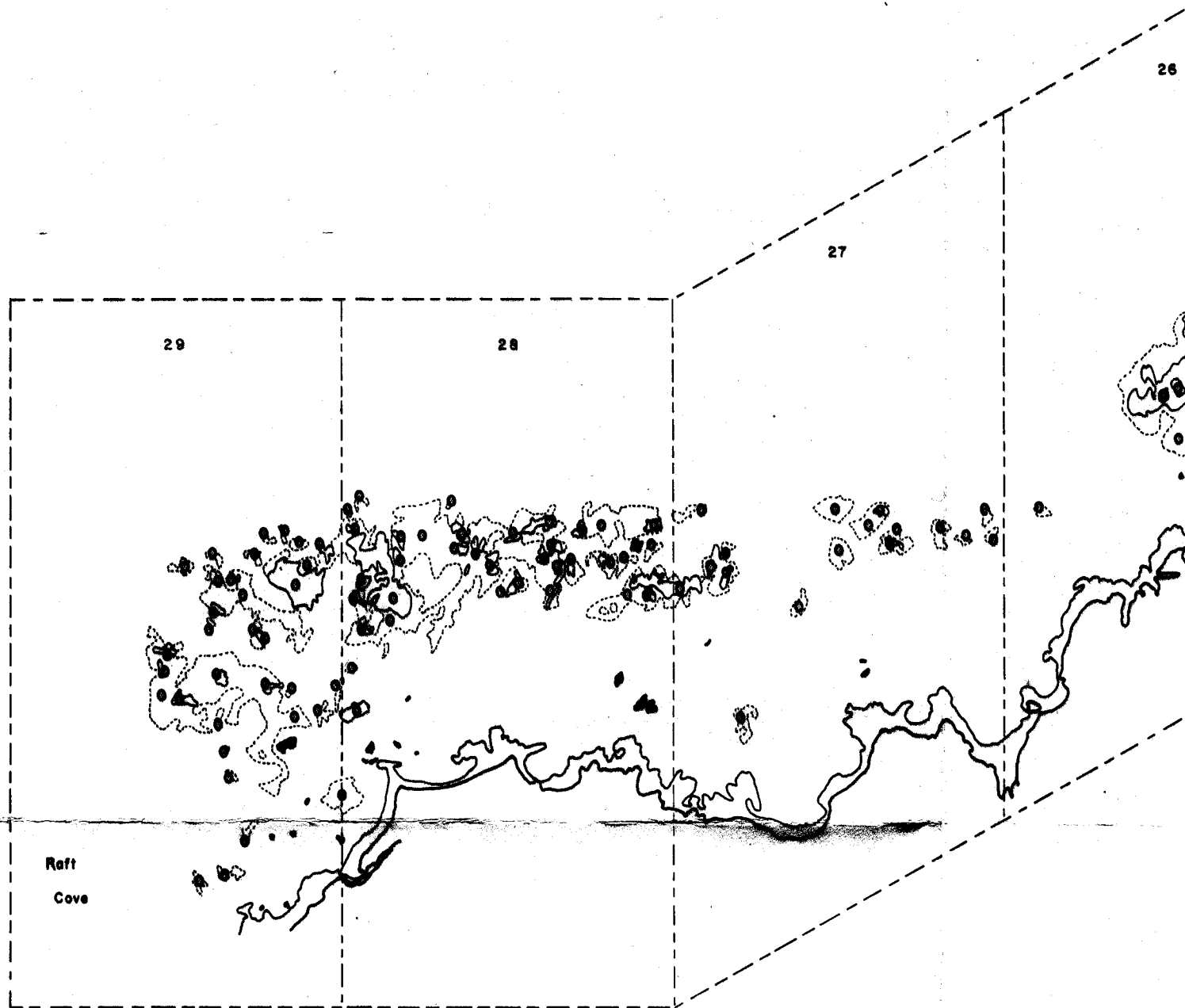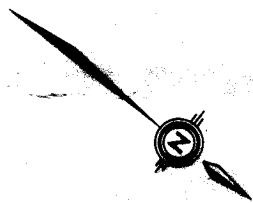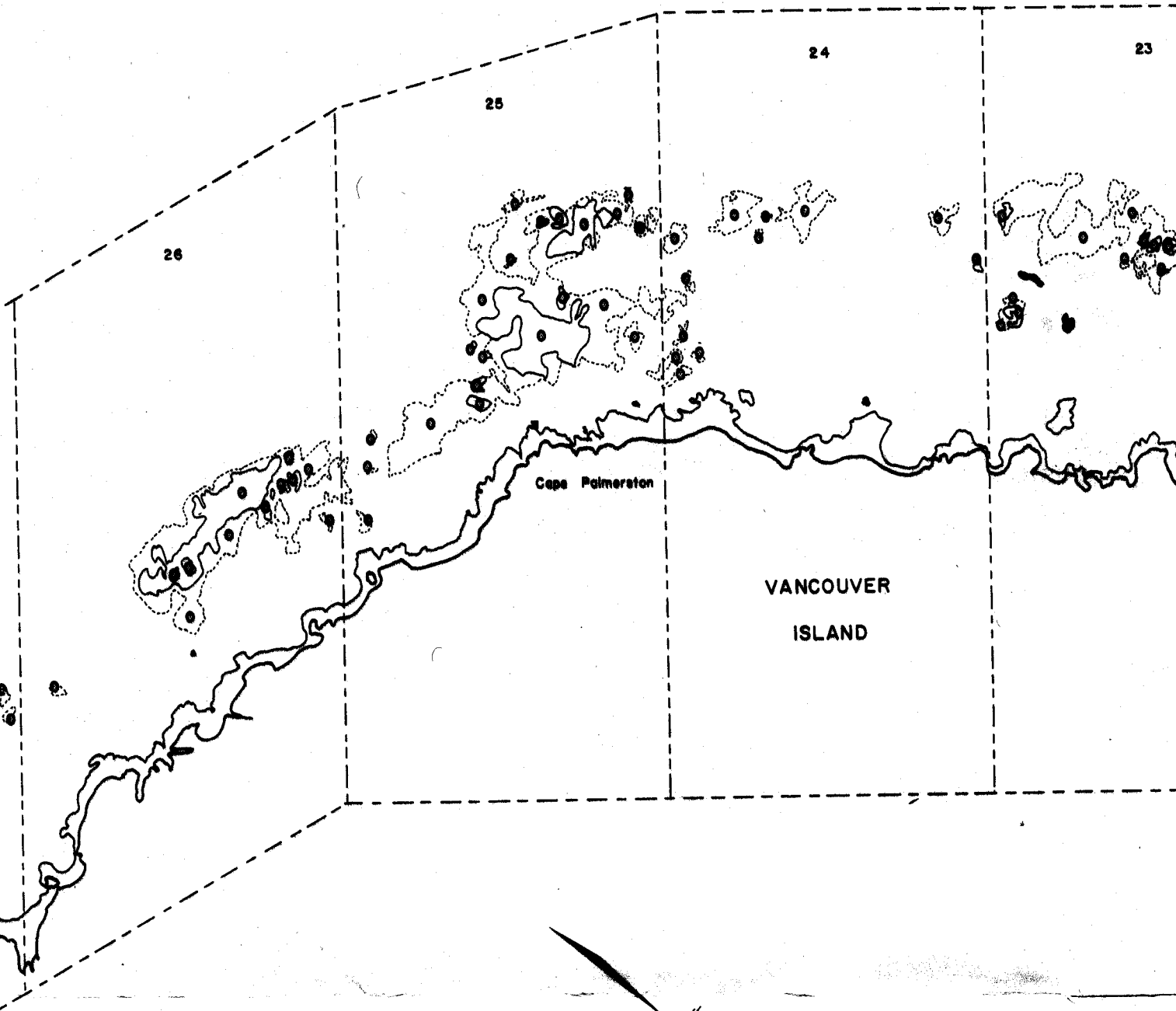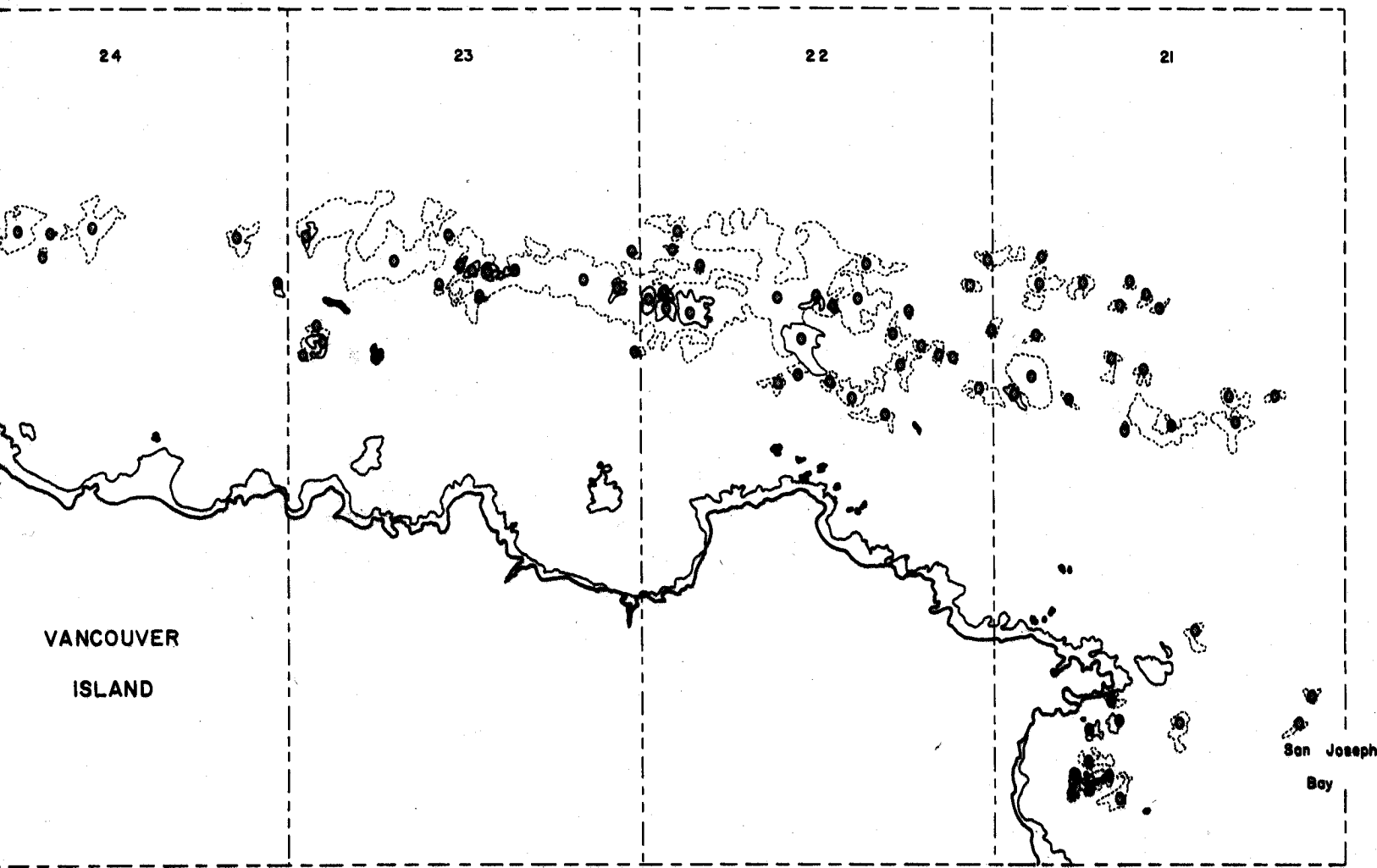
Raft
Cove

1/4 nautical mile

0   meters   500

LEGEND

——————— edge of terrestrial vegetation
——————— water level at time of photography
— — — — boundary of statistical block
—— —— boundary of photographic line
— — — — border between adjacent blocks

● *Nereocystis* beds
● *Macrocystis* beds
◒ mixed beds of *Nereocystis* and *Macrocystis*

19 block number

high density bed

low density bed

rocks

□ houses and buildings

33

32

VANCOUVER

ISLAND

31   30

Commerell
Point

Raft
Cove

CHART C

50

49

Cape
Parkins
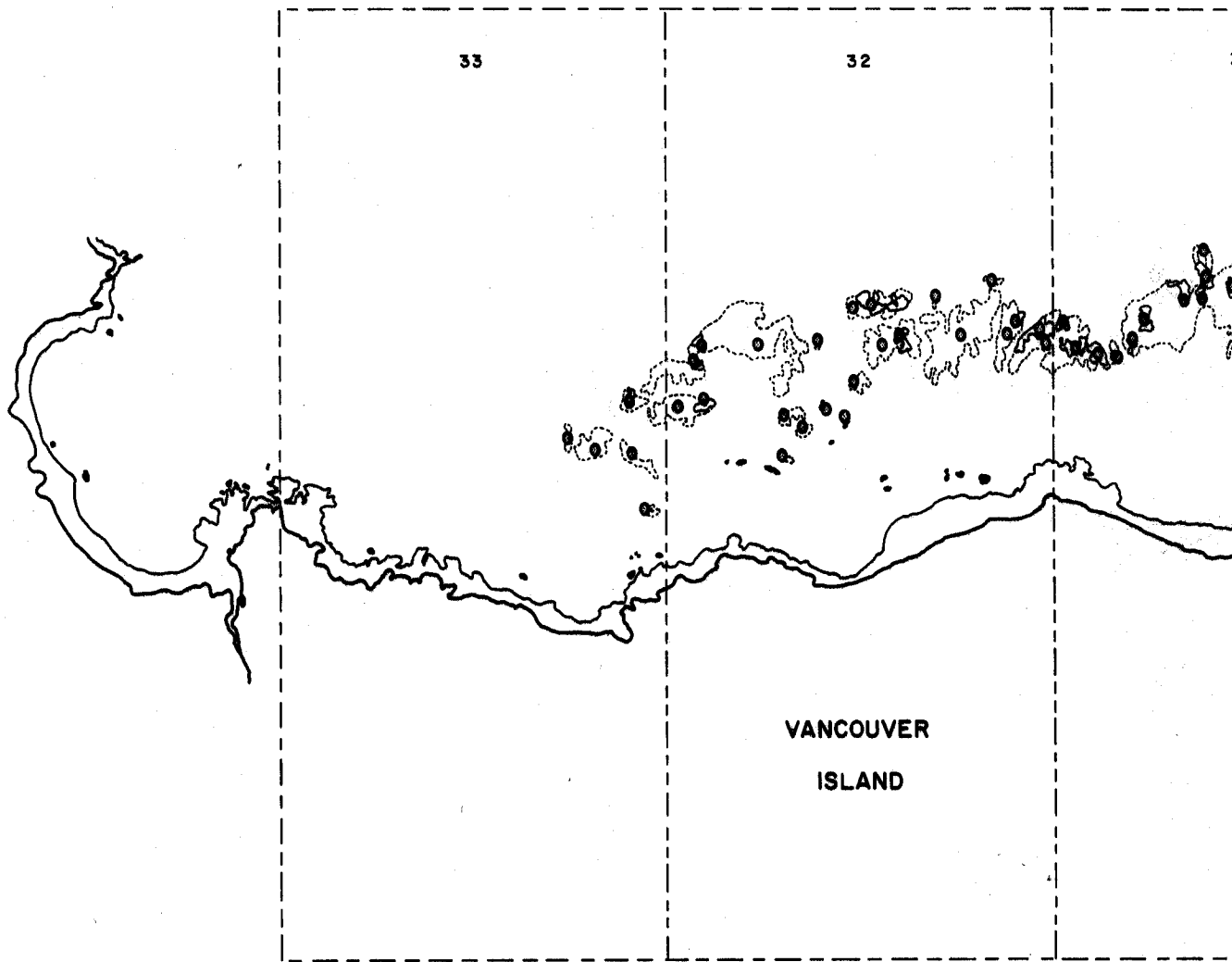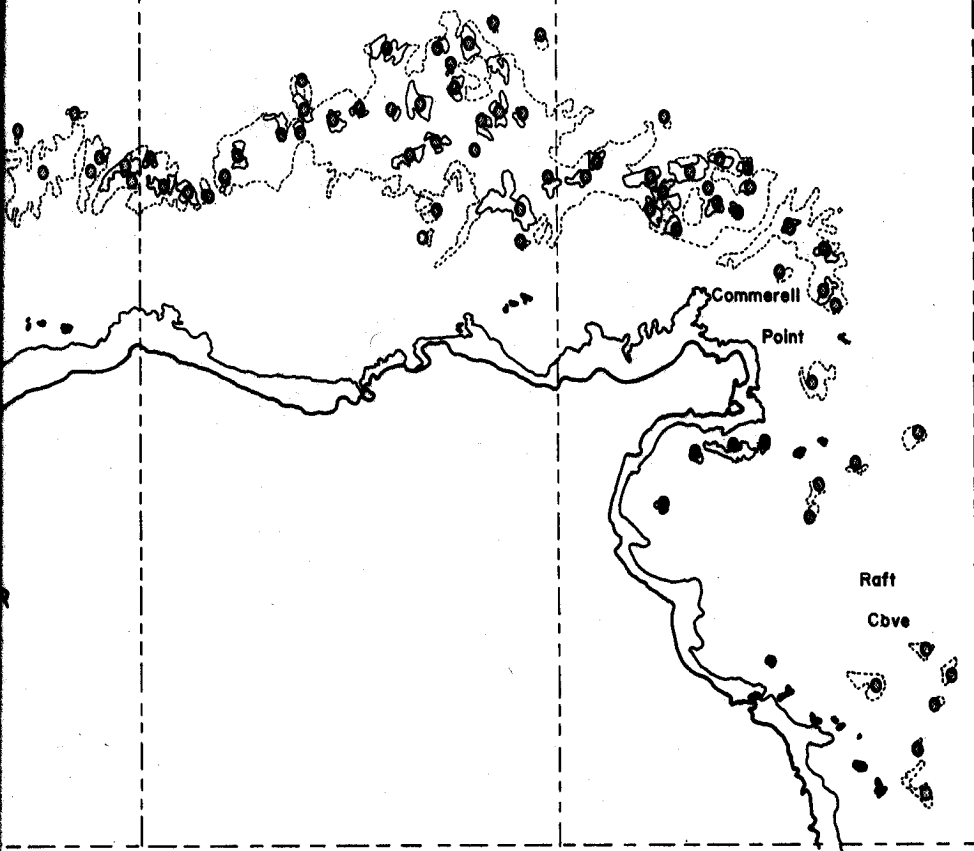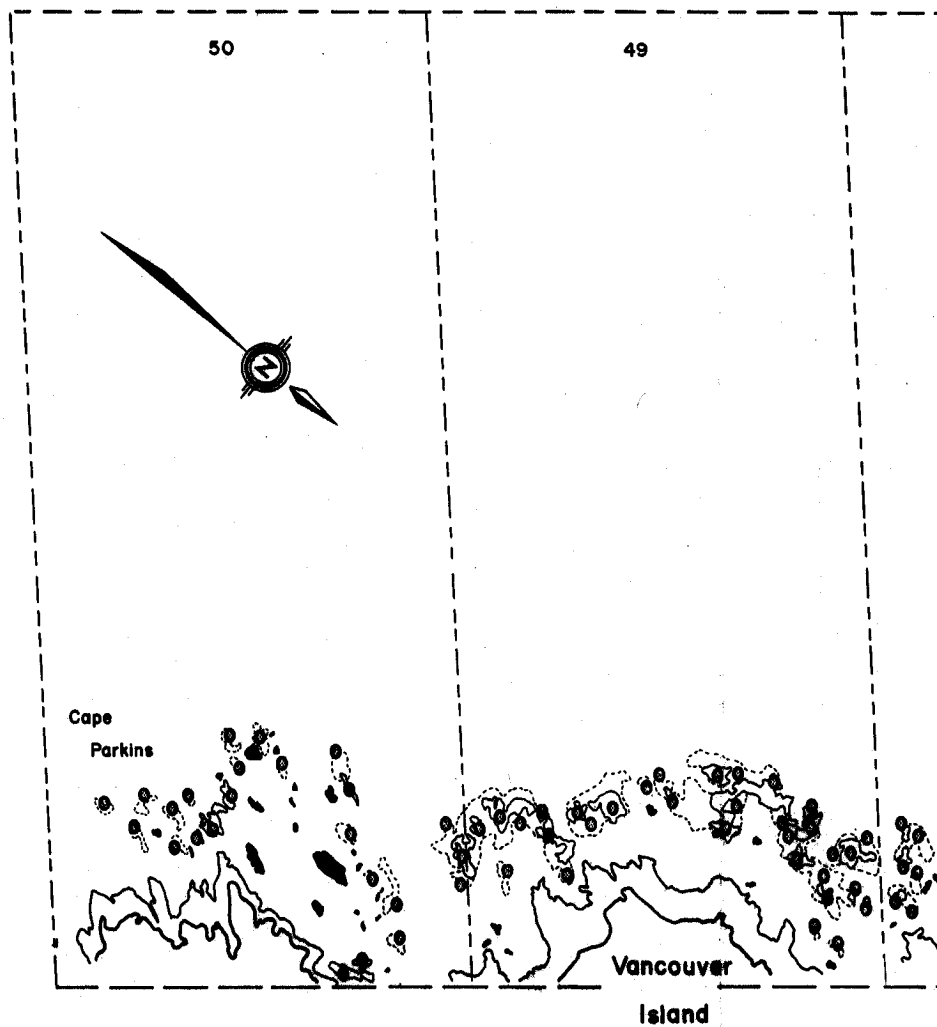
Vancouver

Island

49   48   47   46

Lippy
Point

Vancouver
Island
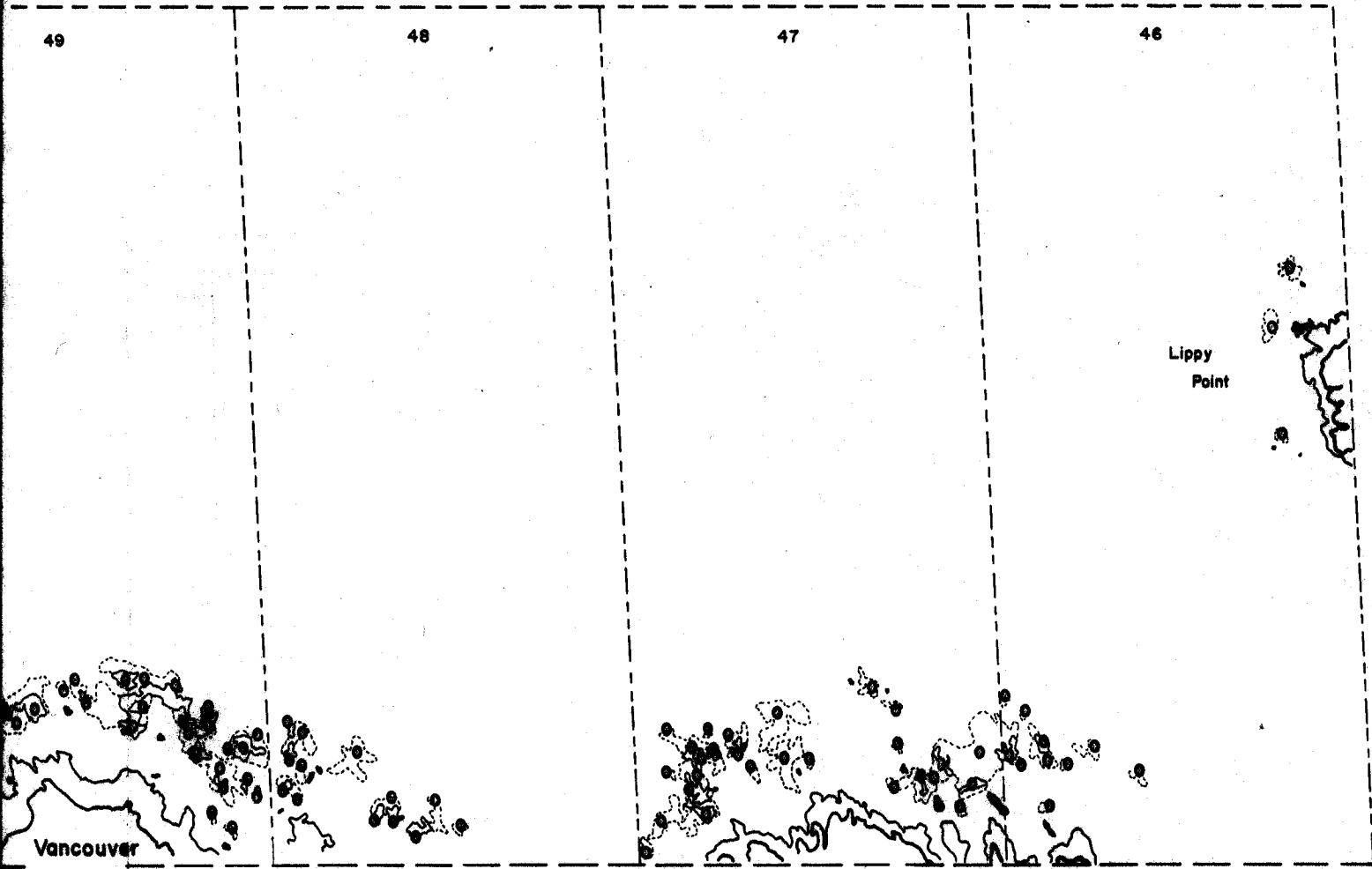
46

Lippy
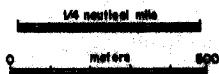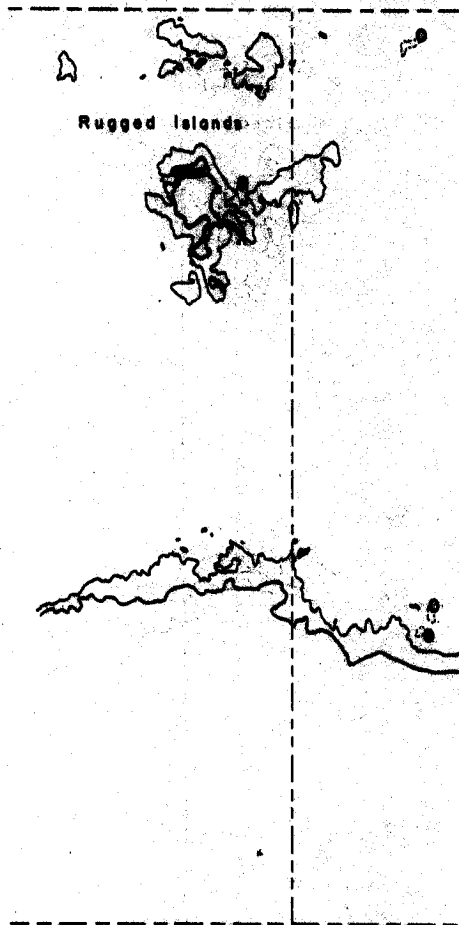Point

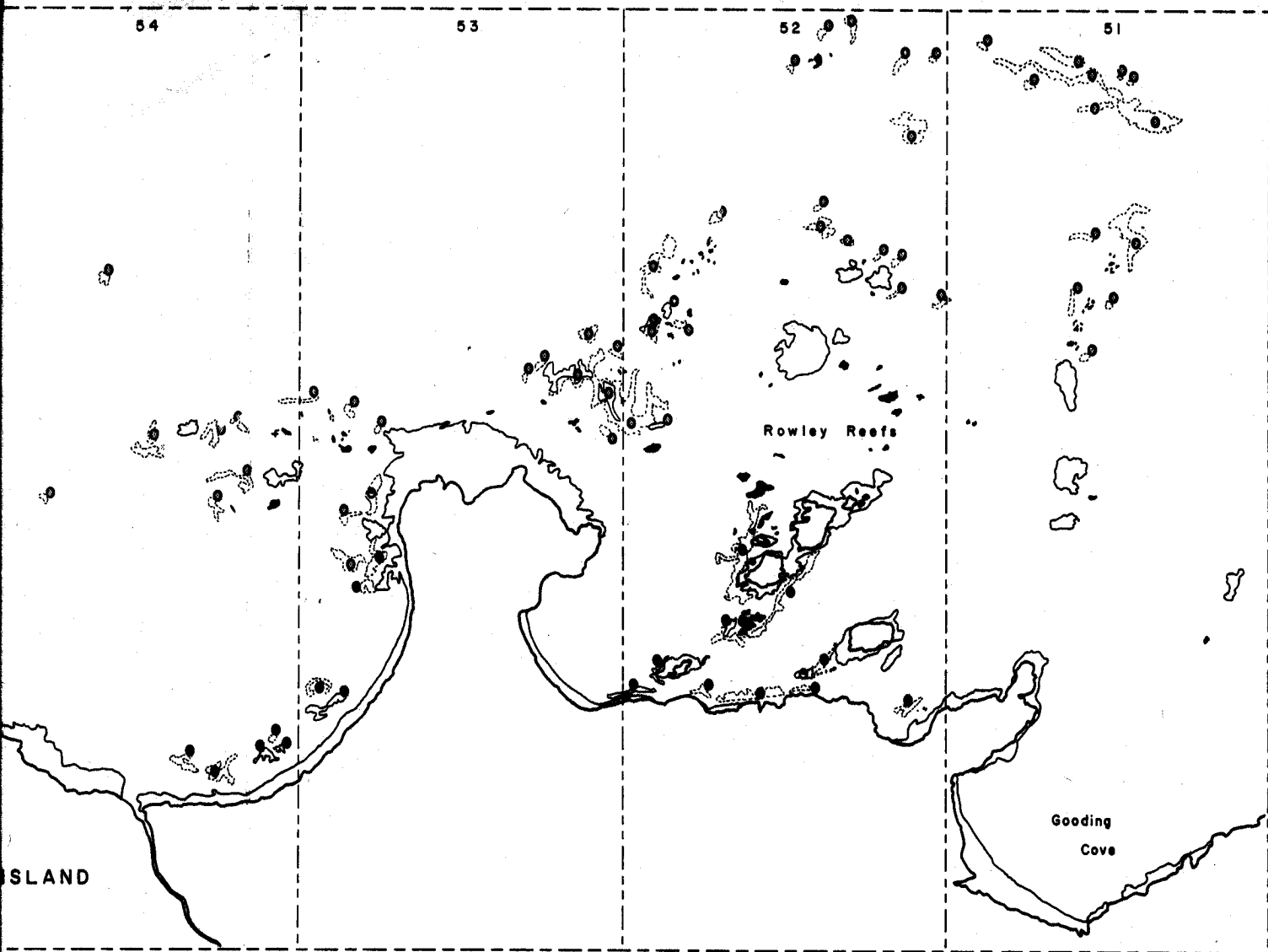1/4 nautical mile

0   meters   500

LEGEND

———————— edge of terrestrial vegetation
———————— water level at time of photography
— — — — boundary of statistical block
— — — — boundary of photographic line
—·—·—·— border between adjacent blocks
● *Nereocystis* beds
● *Macrocystis* beds
◉ mixed beds of *Nereocystis* and *Macrocystis*
19 block number
high density bed
low density bed
rocks
□ houses and buildings

35   34

42   41   40
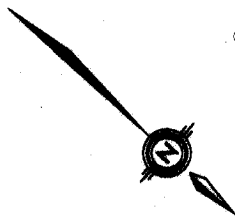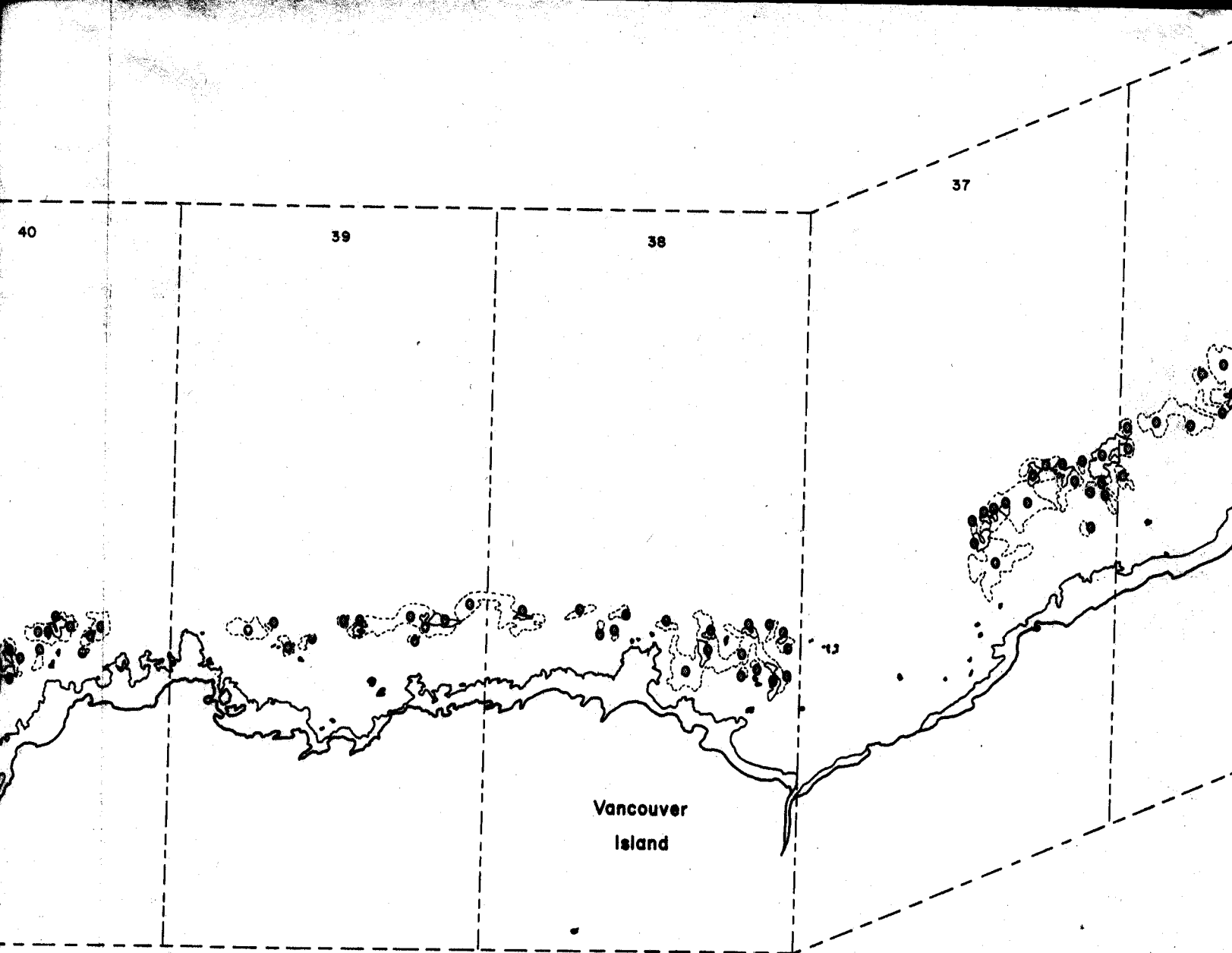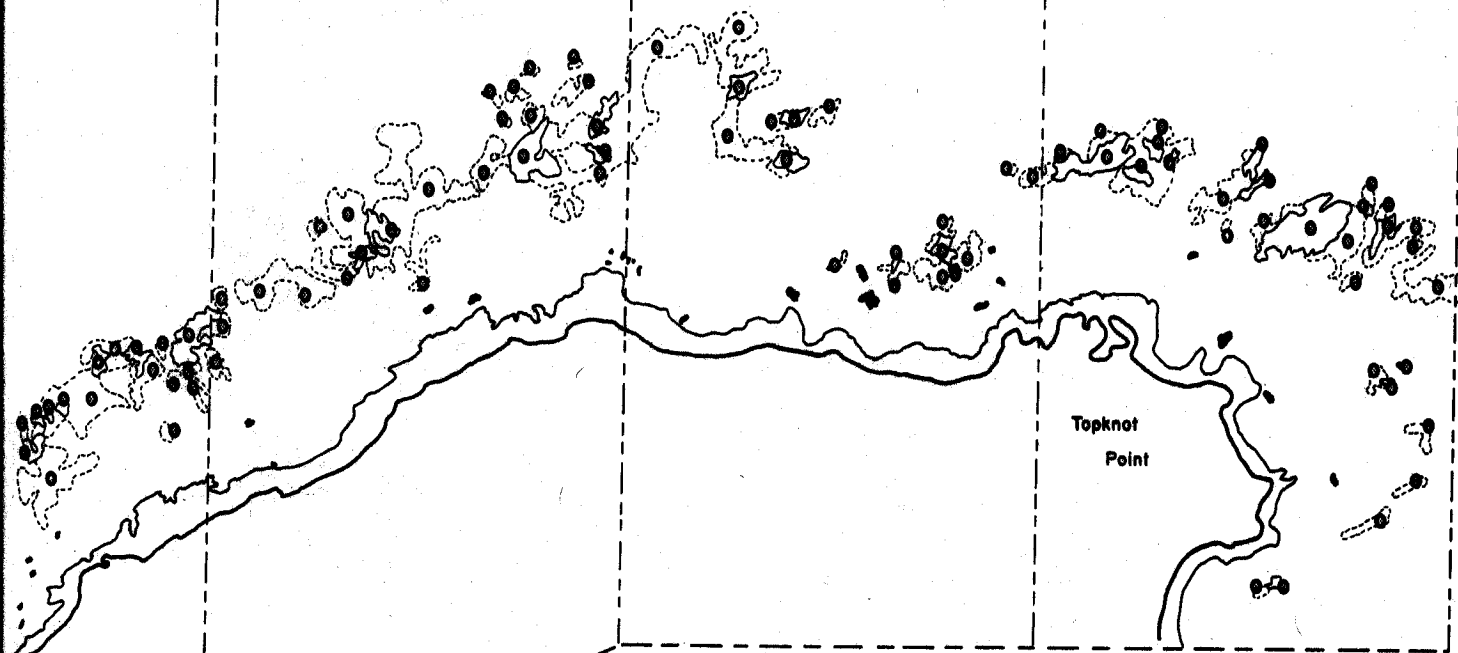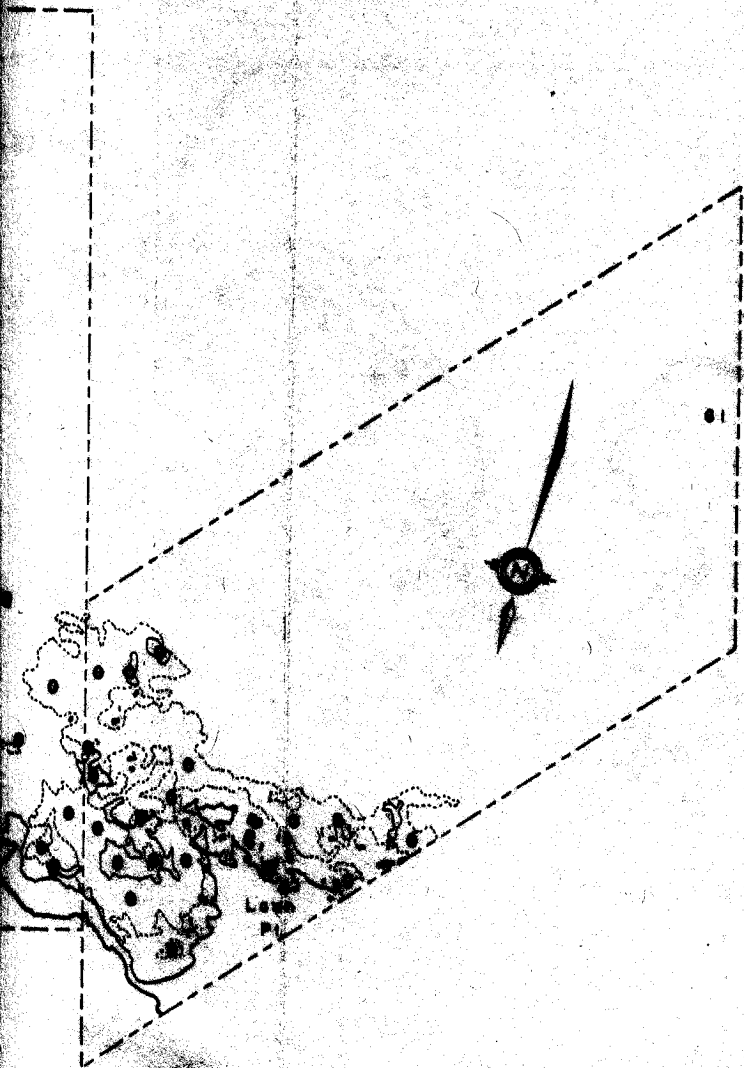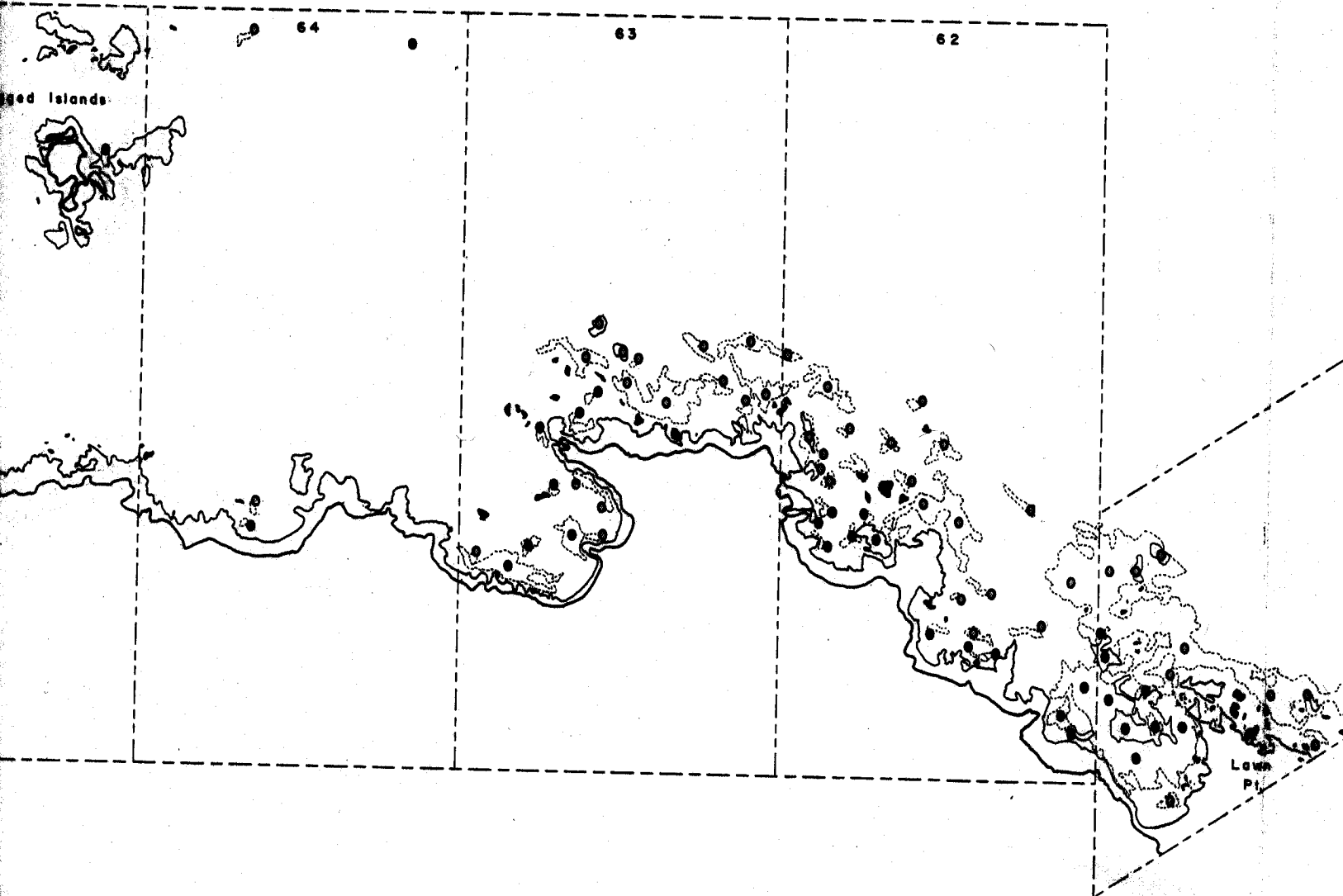
40   39   38   37

Vancouver
Island

Topknot
Point

CHART D

ged Islands

64

63

62

Lawn
Pt

Rugged Islands

LEGEND

――――――― edge of terrestrial vegetation
――――――― water level at time of photography
―― ― ―― boundary of statistical block
――――――― boundary of photographic line
―― ― ― border between adjacent blocks
● *Nereocystis* beds
● *Macrocystis* beds
◉ mixed beds of *Nereocystis* and *Macrocystis*
19 block number
high density bed
low density bed
rocks
□ houses and buildings

1/4 nautical mile

0 meters 500

Rowley Reefs

Gooding Cove

ISLAND

54   53   52   51

57　　　　　　　　56　　　　　　　　55　　　　　　　　54

Kwakiutl
Point

Restless Bight

VANCOUVER ISLAND

58

59

60

57

Kwakiutl
Point

Lawn
Pt.

L E G E N D

——————— edge of terrestrial vegetation
——————— high water line
················· water level at time of photography
— — — — boundary of statistical block
— — — — boundary of photographic line
— ·— ·— border between adjacent blocks
○ *Nereocystis* beds
● *Macrocystis* beds
◐ mixed beds of *Nereocystis* and *Macrocystis*
5 block number
▭ high density bed
▭ low density bed
◥ rocks

121

120

119

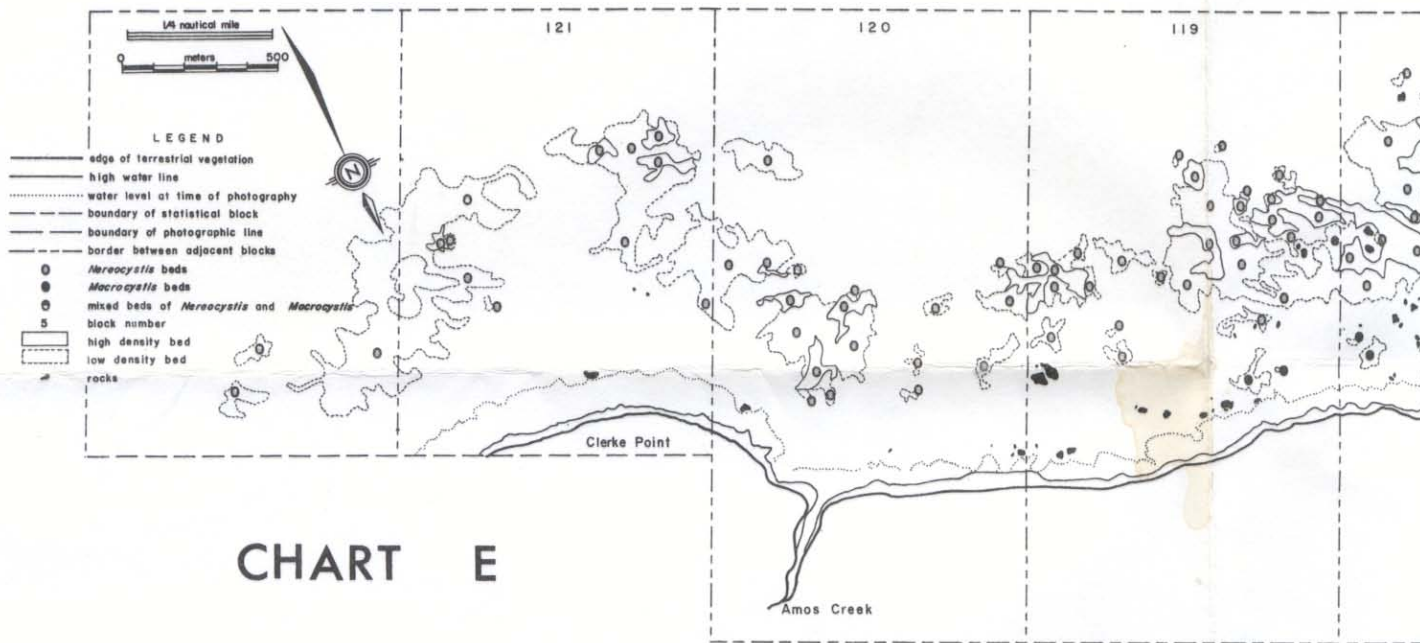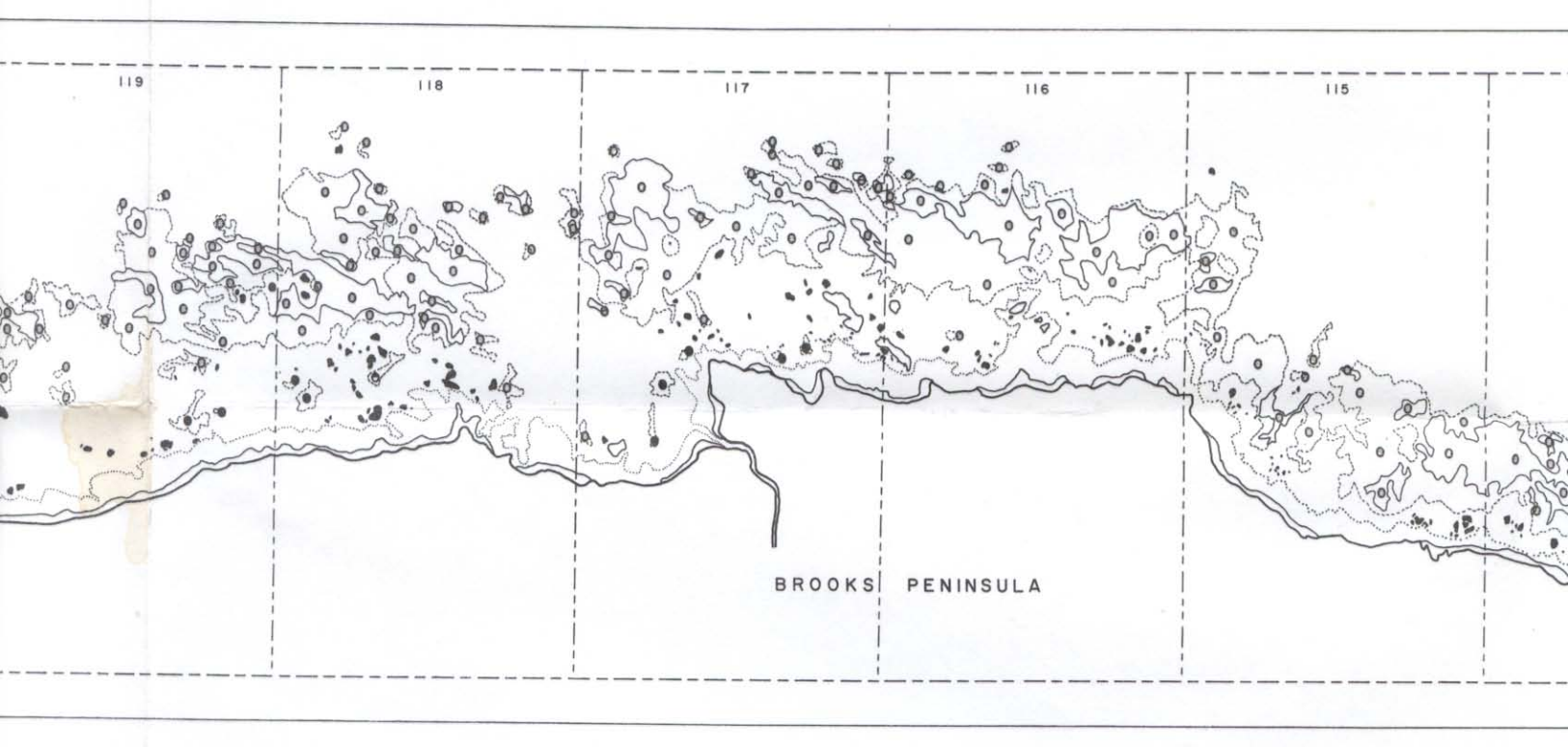Clerke Point

Amos Creek
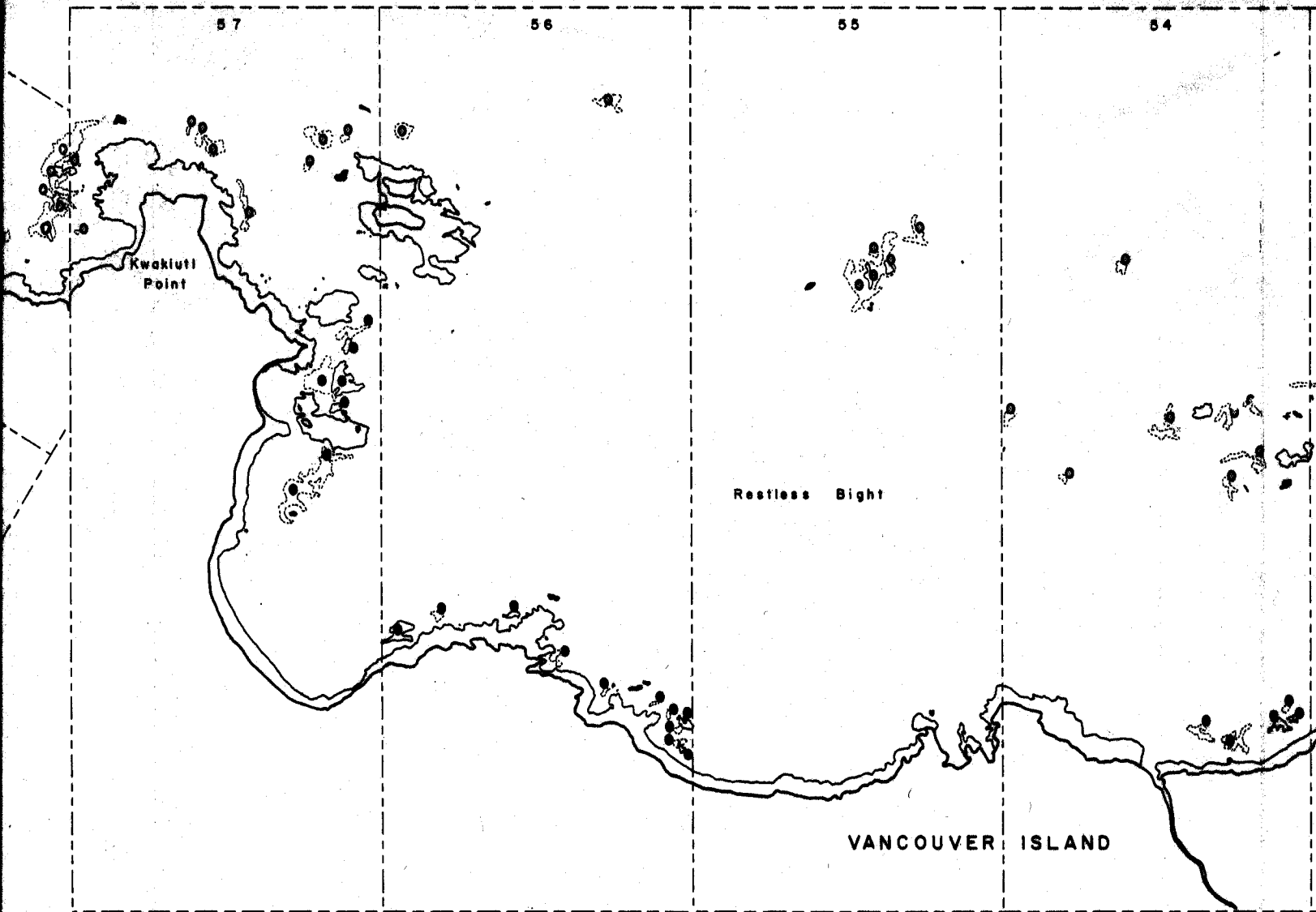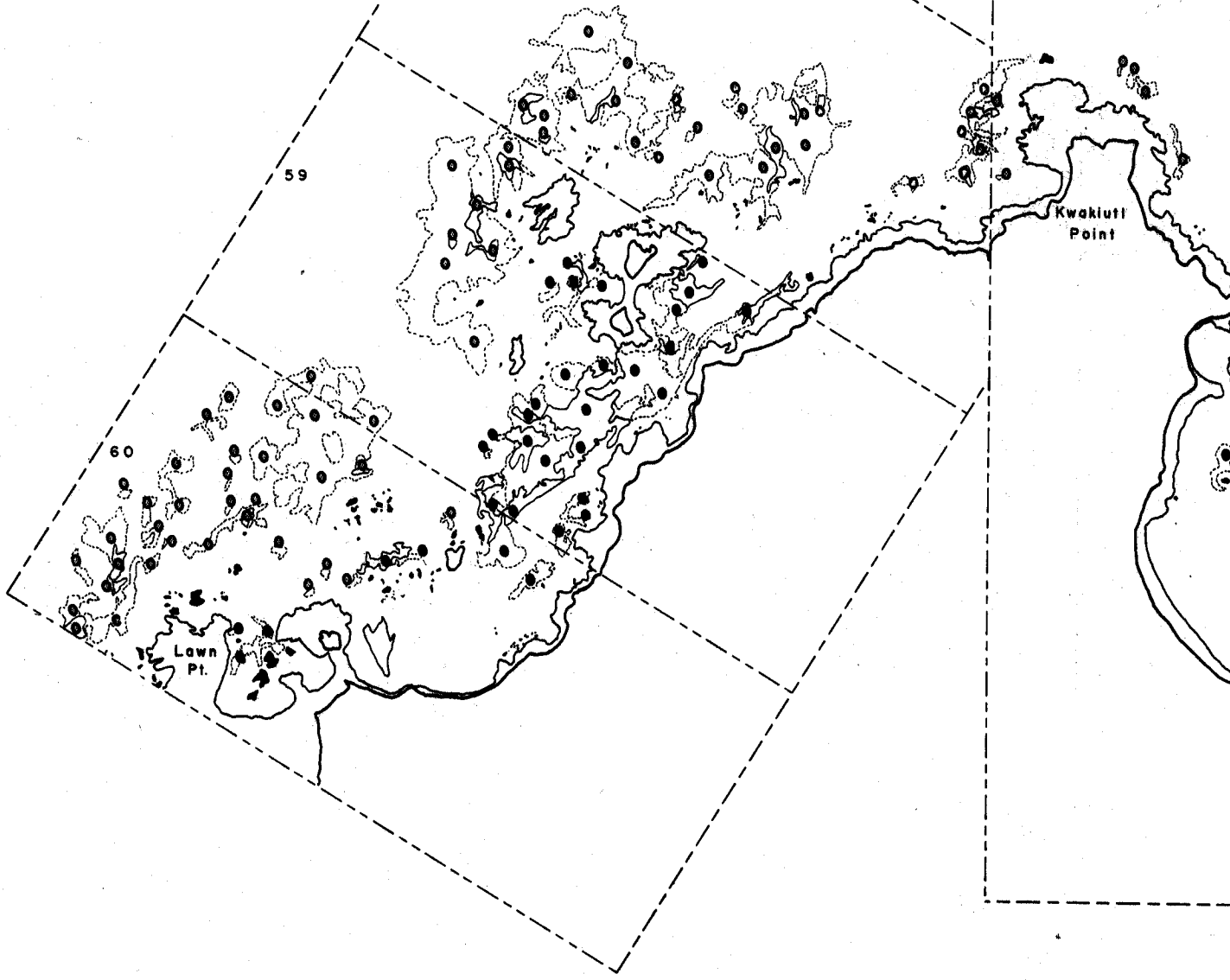
CHART   E

119   118   117   116   115

BROOKS PENINSULA

| 115 | 114 | 113 | 112 | 111 |