

# Kelp Inventory, 1976

## Part 1. The Estevan Group and Campania Island.

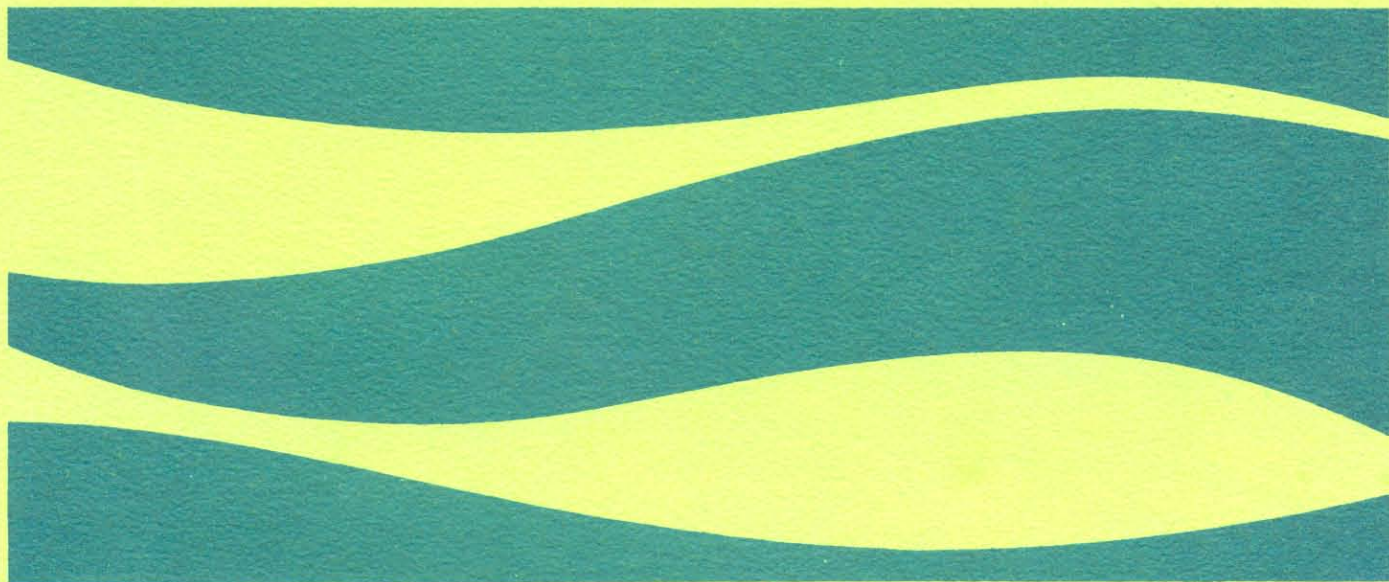
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MINISTRY OF ENVIRONMENT  
PROVINCE OF BRITISH COLUMBIA

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KELP INVENTORY, 1976. PART I. THE ESTEVAN GROUP AND CAMPANIA ISLAND

by

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Introduction:

This is the third in a continuing series (see Foreman, 1974, and Coon et al, 1976) and the first of five Kelp Inventory, 1976 reports aimed at locating and quantifying the major kelp resources of British Columbia. Species inventoried include the alginophytes *Nereocystis luetkeana* (Mertens) Postels and Ruprecht and *Macrocystis integrifolia* Bory.

Historically, little was known of the kelp stocks off Campania Island and in the Estevan Group. In the summer of 1946, during a boat-based survey of the coast, British Columbia Research Council (1948) investigators located about 1,056 tons (958 metric tonnes) off the west side of Campania Island in narrow, sparse, beds. They also reported some 10,500 tons (9,520 tonnes) in a large bed on an "uncharted reef" in Estevan Sound.

Rationale for the present inventory was based, firstly, on indications of large beds on Canadian Hydrographic Service charts of the area and subsequently, on the sighting of these beds during a brief aerial tour of the outer coast in January, 1976. Of particular interest during this flight was the apparent presence of a huge kelp bed in a bay at the south end of the Estevan Group, bounded by Dewdney Island to the west, Lotbinière Island to the north, and Hickey Island to the east (Figure 4). Large beds found in protected or semi-protected waters are especially valuable to prospective commercial harvesters because of their ease of exploitation when other areas are made inaccessible by inclement weather conditions.

The Estevan Sound area is fairly remote, having no permanent population or land-based facilities, nor is it on any major shipping routes, though coastal freighters pass by occasionally. It lies between two route proposals for passage of oil supertankers to and from Kitimat. The nearest population centers are Prince Rupert, (140 kilometers northwest) and Kitimat (110 kilometers northeast), where road access and wharfage facilities are available.

Sources: Canadian Hydrographic Service Charts 3724 and 3742

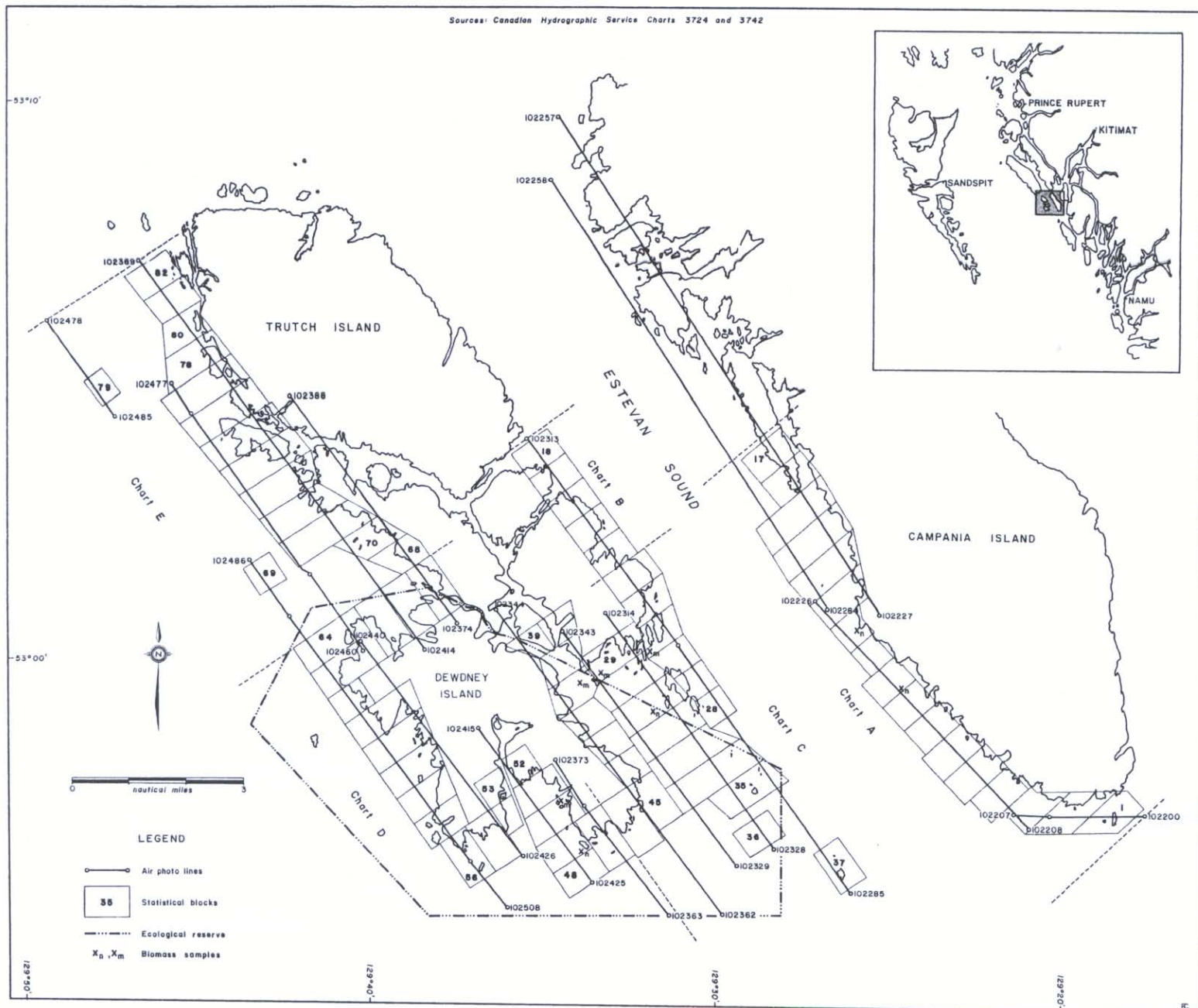


Figure 1: Composite map of the Estevan Group and Campania Island coastlines, showing photographic lines and layout of statistical blocks for inventory charts A to E. The inset at upper right locates the study area on the northern British Columbia coast.



Figure 2: Marine Resources Branch vessels used in obtaining field samples: "Noctiluca": our home and base (left), and "Cymathere": our all-weather sampling runabout.



Figure 3: Crew member measuring weight of *Nereocystis* stipe tip.

Methods:

The technique used was the Kelp Inventory Method (KIM-1) established by Foreman (1974), and incorporating the modifications suggested by Coon et al, (1976), with one variant. It was felt that three separate bed density designations (low, medium and high) for each of three species classifications (*Macrocystis*, *Nereocystis*, and mixed) would greatly complicate visual interpretation of inventory charts for this area, and as a result, the medium density designation was not employed. It is suggested this category may only be practical for very extensive beds exhibiting large areas of uniform density.

Infrared black and white aerial photographs of the coastline and kelp beds were taken on September 19, 1976 by Pacific Survey Co., when KIM-1 flight parameters (Foreman, 1974) were virtually ideal. However, tide height at time of photography was one meter below mean water level (MWL), making conversion of biomass per plant at -1m. to MWL necessary. These photographs were subsequently used for determination of bed densities and for charting and measuring bed areas.

The kelp beds were sampled from Branch vessels (Figure 2) on September 19 and 20 at eight randomly-selected stations (four each for *Nereocystis* and *Macrocystis*). Approximately 25 plants or fronds were collected at each, for a total of more than 100 of each species, and were cut and weighed (Figure 3) as described in KIM-1. The resulting data were later used to calculate mean biomass per plant at MWL and to determine the vertical distribution of kelp biomass.

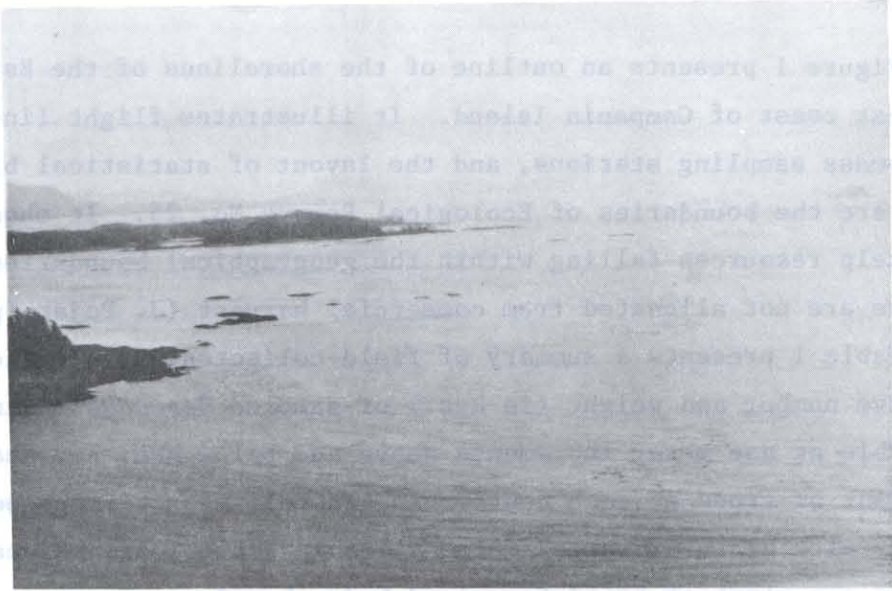


Figure 4: Aerial view of a portion of a large *Nereocystis* bed in a large island-bounded bay at the south end of the Estevan Group, January, 1976

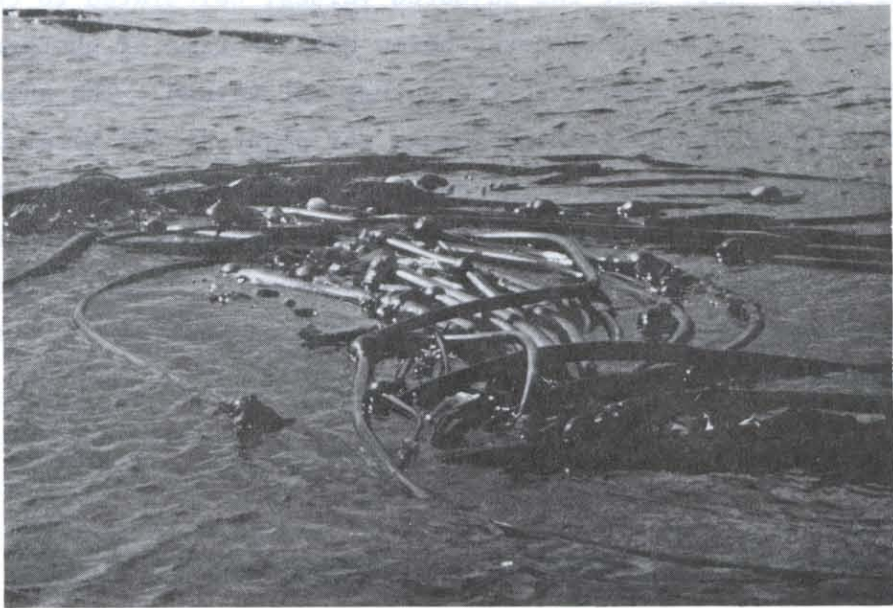


Figure 5: Close-up of a tangled clump of *Nereocystis* plants.

Results:

Figure 1 presents an outline of the shorelines of the Estevan Group and west coast of Campania Island. It illustrates flight lines, positions of biomass sampling stations, and the layout of statistical blocks. Also shown are the boundaries of Ecological Reserve No. 25. It should be noted that kelp resources falling within the geographical boundaries of this reserve are not alienated from commercial harvest (J. Pojar, pers. comm.).

Table 1 presents a summary of field-collected data, indicating cumulative number and weight (in kgs.) of sampled *Nereocystis* and *Macrocystis* available at one meter increments above and below MWL, and mean biomass per plant or frond at each depth. In general, mean biomass per plant increases with depth of water. Also given in Table 1 are values of mean biomass per plant or frond for mixed beds, based on an assumed surface density of 42% *Nereocystis* and 58% *Macrocystis*, (Foreman, 1974). The actual surface density ratio for this area was not determined due to limited time availability in the field and in consideration of the low incidence of mixed beds in the area.

Table 2 summarizes mean biomass per plant or frond values for each species type. Note that the adjusted values, calculated to compensate for the low water level (1 meter below MWL) at time of photography (see Methods) do not correspond to the actual MWL values. The adjusted values were derived by dividing mean biomass per plant at the water level at time of photography (Table 1) by the combined biomass and density factor at that level (Table 8). These adjusted means were used in conjunction with density estimates and bed area determinations to calculate the biomass of each species available in each block, and were applied to beds at both Campania Island and the Estevan Group.



Table 1: Summary of field-determined biomass data

Cutting Depth (m)	<i>Nereocystis</i>			<i>Macrocystis</i>			Mixed
	Cum B	Cum N	$\bar{x}B/\text{plant}$	Cum B	Cum N	$\bar{x}B/\text{frond}$	* $\bar{x}B/\text{plant or frond}$
+6	—	—	—	1.66	3	0.552	0.320
+5	6.80	1	6.795	2.38	5	0.475	3.129
+4	11.01	2	5.503	3.21	10	0.321	2.497
+3	31.56	8	3.945	4.59	12	0.382	1.878
+2	88.96	20	4.448	7.93	28	0.283	2.032
+1	188.32	50	3.766	16.51	47	0.351	1.785
MWL	295.45	81	3.647	27.79	61	0.456	1.796
-1	387.17	97	3.991	41.47	79	0.525	1.981
-2	431.33	100	4.313	56.63	99	0.572	2.143
-3	451.73	101	4.473	69.51	109	0.638	2.249
-4	463.58	101	4.590	75.67	113	0.670	2.316
-5	471.08	101	4.664	78.16	113	0.692	2.360
-6	475.96	102	4.666	—	—	—	—

\* Based on 42% *Nereocystis* and 58% *Macrocystis*

Cum N = cumulative number of plants or fronds

Cum B = cumulative biomass, in kilograms

$\bar{x}B/\text{plant (frond)}$  = mean biomass per plant or frond

Table 2: Mean biomass per plant or frond (kg.) at MWL

Species	# Stns.	$\bar{x}$	adjusted $\bar{x}$
<i>Nereocystis</i>	4	3.647	3.047
<i>Macrocystis</i>	4	0.456	0.352
Mixed*	—	1.796	1.436

\* Based on 42% *Nereocystis* and 58% *Macrocystis*

Bed area (in hectares) and kelp biomass (in metric tonnes) estimates for Campania Island and for the Estevan Group are presented in Tables 3 and 4, respectively. Within each statistical block, estimates are given for both low and high density beds for each of three bed types: pure *Nereocystis*, pure *Macrocystis*, and mixed. Block totals, grand totals, and totals of each species and density type for the two geographically-distinct regions are also given. Each statistical block is one kilometer wide.

Chart A (Appendix) illustrates the precise location of kelp resources off Campania Island. Beds are delimited by species and by density; dense areas are further high-lighted with Letratone<sup>TM</sup>. Charts B, C, D, and E (Appendix) present the southeast, south and west coasts of the Estevan Group in the same manner. (Refer to Figure 1 for orientation). These charts provide a visual representation of the beds at a tide level approximately one meter below mean water level. Because of the vertical habit of kelp plants and to the fact that few young plants were observed during sampling, one can probably assume little apparent increase in bed size occurs at the lower level. On all charts, effort has been made to indicate all rocks and reefs which might prove to be obstacles to potential harvester, but it should be emphasized the majority of the standing stock biomass here is easily accessible, and much of it lies in relatively sheltered waters. It should also be noted the major commercially available kelp resources in the region were located off the west coast of Campania Island south of Cartwright Rocks, (12,112 tonnes) and in the eastern portion of the large embayment south of Lotbinière Island (Figure 4) (8,423 tonnes). These two locales alone account for 43% of the kelp biomass (at MWL) and 43% of the bed area in this study area.

Table 5 summarizes the more detailed information of Tables 3 and 4, giving bed area and biomass totals for each bed type in each geographic region. Regional, grand, and species totals appear at the bottom of the table. Tables 6 and 7 indicate percentage make-up, by bed type, of the biomass (Table 6) and area (Table 7) totals in each of the regions and of the combined totals.

Table 3: Area and biomass estimates for Campania Island: September, 1976

Block	Heterocystis-Low Density				Heterocystis-High Density				Macrocyctis-Low Density				Macrocyctis-High Density				Mixed-Low Density				Mixed-High Density					
	$\bar{x}$ /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	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	Total A	Total B
1	5,910	9,487	17.99	170.6	12,540	1,063	38.12	40.5	5,800	1,192	2.04	2.4	5,800	0.881	2.04	1.8	13,510	0.052	4.74	0.2	5,940	0.311	8.31	2.6	10.55	211.1
2	5,910	16,485	18.00	296.8	16,410	19,699	50.01	985.1	5,800	1,192	2.04	2.4	5,800	0.881	2.04	1.8	13,510	0.052	4.74	0.2	5,940	0.311	8.31	2.6	37.69	1286.9
3	5,080	5,599	15.46	86.5	14,650	12,286	44.64	548.5	5,800	1,192	2.04	2.4	5,800	0.881	2.04	1.8	13,510	0.052	4.74	0.2	5,940	0.311	8.31	2.6	17.89	635.0
4	5,080	15,552	15.48	240.7	14,650	14,412	44.63	643.2	5,800	0.881	2.04	1.8	5,800	0.881	2.04	1.8	13,510	0.052	4.74	0.2	5,940	0.311	8.31	2.6	30.30	885.9
5	5,490	26,698	16.73	446.7	13,430	32,867	40.92	1344.9	5,800	1,400	2.04	2.9	5,800	1.400	2.04	2.9	13,510	0.311	4.75	1.5	5,940	0.104	8.28	0.9	59.67	1792.5
6	4,600	27,164	14.02	380.9	15,740	24,831	47.95	1190.8	5,800	1,400	2.04	2.9	5,800	1.400	2.04	2.9	13,510	0.311	4.75	1.5	5,940	0.104	8.28	0.9	54.02	1578.7
7	4,400	20,632	13.41	276.7	13,600	31,985	41.44	1325.4	5,800	1,659	2.04	3.4	5,800	1.659	2.04	3.4	13,510	0.311	4.75	1.5	5,940	0.311	8.31	2.6	56.97	1628.5
8	5,160	16,070	15.72	252.6	11,920	38,310	36.32	1391.6	5,800	0.570	2.04	1.2	5,800	0.570	2.04	1.2	13,510	0.881	4.75	4.2	5,940	6.013	8.53	51.3	60.96	1696.7
9	5,160	10,524	15.72	165.5	14,710	16,070	44.82	720.3	5,800	5.443	2.04	11.1	5,800	5.443	2.04	11.1	13,510	0.881	4.75	4.2	5,940	0.311	8.31	2.6	32.92	901.1
10	5,700	8,087	17.37	140.5	14,250	16,070	43.42	697.8	5,800	1.348	2.04	2.7	5,800	1.348	2.04	2.7	13,510	0.207	4.76	1.0	5,940	0.311	8.31	2.6	26.02	844.6
11	5,460	6,117	16.64	101.3	12,520	7,724	38.15	294.6	5,800	0.052	2.03	0.1	5,800	0.052	2.03	0.1	13,510	0.207	4.76	1.0	5,940	0.207	8.32	1.7	14.10	398.2
12	5,460	3,577	16.61	59.4	12,520	5,080	38.15	193.8	5,800	0.052	2.03	0.1	5,800	0.052	2.03	0.1	13,510	0.207	4.76	1.0	5,940	0.207	8.32	1.7	8.66	253.2
13	5,140	3,370	15.64	52.7	18,480	7,828	56.32	440.9	5,800	0.052	2.03	0.1	5,800	0.052	2.03	0.1	13,510	0.207	4.76	1.0	5,940	0.207	8.32	1.7	11.20	493.6
14	5,140	6,843	15.67	107.3	18,530	9,539	56.47	538.7	5,800	0.052	2.03	0.1	5,800	0.052	2.03	0.1	13,510	0.207	4.76	1.0	5,940	0.207	8.32	1.7	16.38	646.0
15	5,850	5,132	17.81	91.4	18,530	7,154	56.48	404.0	5,800	0.052	2.03	0.1	5,800	0.052	2.03	0.1	13,510	0.207	4.76	1.0	5,940	0.207	8.32	1.7	12.44	495.4
16	5,850	4,044	17.86	72.2	14,210	3,162	43.27	136.8	5,800	0.467	2.04	1.0	5,800	0.467	2.04	1.0	13,510	0.207	4.76	1.0	5,940	0.156	8.28	1.3	7.67	211.3
17	5,850	4,458	17.84	79.5	14,210	6,532	43.29	282.8	5,800	0.467	2.04	1.0	5,800	0.467	2.04	1.0	13,510	0.207	4.76	1.0	5,940	0.156	8.28	1.3	10.99	362.3
Totals	190			3,022	255		11,180		11,180	13		27	27	1		86	7	1		7	10		0	0	469	14,321
Means	11.2			177.8	15.0		657.6		657.6	0.8		1.6	1.6	0.1		5.1	0.4	0.1		0.4	0.6		0	0	27.6	842.4

D = Density (no. of plants or fronds)

A = Area (hectares)

B = Biomass (metric tonnes)

$\bar{x}$  = Mean

ha = Hectare

Table 4: Area and biomass estimates for the Steeven Group: September, 1976

Block	Herpetofauna-Low Density			Herpetofauna-High Density			Macrofauna-Low Density			Macrofauna-High Density			Mixed-Low Density			Mixed-High Density			Total A	Total B
	$\bar{X}$ /ha	A	B	$\bar{X}$ /ha	A	B	$\bar{X}$ /ha	A	B	$\bar{X}$ /ha	A	B	$\bar{X}$ /ha	A	B	$\bar{X}$ /ha	A	B		
15	6,420	3,421	19,359	67.0	15,390	3,421	46.85	160.3	5,800	0.829	2.04	1.7	5,940	0.311	8.31	2.6	7.98	231.6		
19	6,420	6,791	19,56	132.8	15,390	3,270	46.93	138.1	5,800	3.318	2.04	6.8	5,940	0.311	8.31	2.6	10.16	390.9		
20	6,820	4,717	20,80	98.1	15,380	3,162	46.83	148.1	5,800	0.622	2.04	1.3	5,800	0.622	2.04	1.3	9.23	251.0		
21	6,820	3,314	20,78	66.7	13,750	3,391	41.88	235.8	5,800	4.004	2.05	8.3	5,800	4.004	2.05	8.3	9.95	232.6		
22	7,240	2,229	22.01	49.1	15,610	3,681	47.60	175.2	5,800	0.052	2.03	0.1	5,800	0.052	2.03	0.1	1.97	64.6		
23	7,240	1,140	22.18	25.3	15,610	0.829	47.41	39.3	7,200	0.104	2.37	0.2	7,200	0.104	2.37	0.2	9.43	369.3		
24	7,240	3,110	22.04	68.6	15,610	6.324	47.56	300.7	7,200	0.196	2.37	0.2	7,200	0.196	2.37	0.2	4.36	169.4		
25	7,090	0,467	21.53	10.1	13,970	3,732	42.54	138.7	7,200	1.296	2.53	3.3	7,200	1.296	2.53	3.3	8.76	294.6		
26	7,090	3,732	21.64	80.7	13,970	5,028	42.54	213.9	7,200	0.052	2.71	0.1	7,200	0.052	2.71	0.1	8.66	347.6		
27	7,090	1,763	21.60	38.1	14,940	6,791	45.34	309.3	7,200	0.104	2.37	0.2	7,200	0.104	2.37	0.2	6.84	228.9		
28	7,090	3,577	21.64	77.4	16,610	2,955	50.63	149.6	7,200	0.196	2.37	0.2	7,200	0.196	2.37	0.2	13.84	567.6		
29	7,090	2,436	21.64	52.7	16,610	10,109	50.61	511.6	7,200	1.866	2.53	4.7	7,200	1.866	2.53	4.7	89.68	3409.9		
30	4,930	31,519	15.02	473.5	18,180	52,255	55.39	2894.7	7,200	0.052	2.71	0.1	7,200	0.052	2.71	0.1	92.12	3195.2		
31	5,550	35,355	16.91	397.8	15,380	54,989	46.86	2572.6	7,200	0.104	2.37	0.2	7,200	0.104	2.37	0.2	26.85	1250.0		
32	5,550	11,301	17.23	194.7	22,470	13,390	68.46	1094.0	7,200	1.503	2.53	3.8	7,200	1.503	2.53	3.8	2.28	51.0		
33	6,550	1,918	20.02	38.4	13,350	0.363	40.29	14.6	7,200	1.089	2.52	2.7	7,200	1.089	2.52	2.7	4.82	149.9		
34	6,550	2,229	19.96	44.5	13,350	2,592	40.67	105.4	7,200	0.599	2.53	14.2	7,200	0.599	2.53	14.2	11.41	711.2		
35	6,550	2,229	19.96	44.5	23,840	9,176	72.66	666.7	7,200	0.052	2.71	0.1	7,200	0.052	2.71	0.1	2.07	64.3		
36	6,240	1,400	18.93	26.5	18,390	0.674	56.06	37.8	7,200	1.296	1.79	2.3	7,200	1.296	1.79	2.3	30.74	1022.5		
37	6,240	19,181	19.01	364.7	18,390	11,560	647.8	647.8	7,200	0.202	1.79	3.6	7,200	0.202	1.79	3.6	5.39	22.3		
38					17,020	0.778	51.70	40.2	7,200	0.829	2.04	1.7	7,200	0.829	2.04	1.7	1.09	2.7		
39					17,020	4,095	51.86	212.4	7,200	0.599	2.53	14.2	7,200	0.599	2.53	14.2	4.46	55.2		
40					17,020	6,117	49.96	305.6	7,200	0.104	2.37	0.2	7,200	0.104	2.37	0.2	15.55	316.3		
41	6,280	4,303	19.12	82.3	16,390	6,117	49.96	305.6	7,200	0.196	2.37	0.2	7,200	0.196	2.37	0.2	3.68	187.0		
42	6,280	0,622	19.10	11.9	16,390	3,577	51.71	185.0	7,200	0.599	2.53	14.2	7,200	0.599	2.53	14.2	6.79	317.6		
43	6,280	0,104	19.04	2.0	16,970	3,577	51.71	185.0	7,200	0.196	2.37	0.2	7,200	0.196	2.37	0.2	6.79	317.6		
44	6,280	0,363	19.31	7.0	17,020	1,918	51.79	99.3	7,200	0.052	2.71	0.1	7,200	0.052	2.71	0.1	3.68	187.0		
45	6,280	3,421	19.15	65.5	16,580	5,651	50.52	285.5	7,200	0.104	2.37	0.2	7,200	0.104	2.37	0.2	9.07	351.0		
46	5,300	17,025	16.15	275.4	16,580	9,124	50.53	461.0	7,200	0.196	2.37	0.2	7,200	0.196	2.37	0.2	26.18	736.4		
47	6,480	7,224	19.76	132.7	15,550	11,094	47.38	525.6	7,200	1.296	1.79	2.3	7,200	1.296	1.79	2.3	26.44	756.3		
48	6,480	1,711	19.77	31.8	15,550	4,717	47.35	223.3	7,200	0.202	1.79	3.6	7,200	0.202	1.79	3.6	6.43	231.1		
49	6,480	1,607	19.72	31.7	14,250	13,375	43.42	580.8	7,200	0.196	2.37	0.2	7,200	0.196	2.37	0.2	17.26	631.9		
50	6,230	5,080	18.95	96.3	15,260	18,662	46.50	867.8	7,200	1.296	1.79	2.3	7,200	1.296	1.79	2.3	26.75	978.8		
51	6,230	6,536	18.96	125.8	14,240	11,042	43.38	479.0	7,200	0.202	1.79	3.6	7,200	0.202	1.79	3.6	20.43	614.6		
52	6,680	1,296	20.45	26.5	14,240	2,022	43.40	87.8	7,200	0.156	1.81	0.3	7,200	0.156	1.81	0.3	3.73	117.9		
53	6,680	1,140	20.31	23.2	14,240	0,933	43.44	40.5	7,200	0.156	1.81	0.3	7,200	0.156	1.81	0.3	2.07	63.7		
54	6,680	2,229	20.37	45.4	14,240	2,903	43.35	125.8	7,200	0.052	2.71	0.1	7,200	0.052	2.71	0.1	5.13	171.2		
55	6,680	5,028	20.36	102.4	15,120	18,970	46.07	869.3	7,200	0.202	1.79	3.6	7,200	0.202	1.79	3.6	23.90	971.7		
56	6,150	5,443	18.75	104.8	12,980	14,100	39.55	557.6	7,200	0.156	1.81	0.3	7,200	0.156	1.81	0.3	19.80	666.0		
57	6,150	1,866	18.78	35.0	14,560	3,162	44.33	140.2	7,200	0.156	1.81	0.3	7,200	0.156	1.81	0.3	5.39	176.3		
58	6,150	4,355	18.75	81.7	14,560	8,398	44.37	372.6	7,200	0.202	1.79	3.6	7,200	0.202	1.79	3.6	14.26	480.1		
59	6,150	9,798	18.75	183.7	14,560	6,460	44.34	287.3	7,200	0.156	1.81	0.3	7,200	0.156	1.81	0.3	16.43	471.3		
60	6,530	4,095	17.19	70.4	13,980	9,124	42.61	388.8	7,200	0.202	1.79	3.6	7,200	0.202	1.79	3.6	13.22	459.2		
61	6,530	6,117	17.14	104.8	13,980	7,206	42.58	306.8	7,200	0.156	1.81	0.3	7,200	0.156	1.81	0.3	5.55	184.7		
62	6,530	1,400	17.19	24.1	12,710	4,147	38.72	160.6	7,200	0.156	1.81	0.3	7,200	0.156	1.81	0.3	7.41	262.1		
63	6,530	1,400	17.19	24.1	12,980	6,013	39.58	238.0	7,200	0.415	1.78	0.7	7,200	0.415	1.78	0.7	8.29	281.3		
64	6,530	1,140	17.11	19.5	12,710	6,739	38.75	261.1	7,200	0.104	2.37	0.2	7,200	0.104	2.37	0.2	9.33	222.3		
65	6,530	6,376	17.16	109.4	12,980	2,851	39.54	112.7	7,200	0.415	1.78	0.7	7,200	0.415	1.78	0.7	31.18	483.2		
66	6,380	13,064	16.40	214.2	12,980	4,925	39.60	195.0	7,200	0.037	1.80	1.8	7,200	0.037	1.80	1.8	6.01	43.5		
67	6,380	1,348	16.50	22.2	14,830	2,074	45.25	93.8	7,200	0.037	1.80	1.8	7,200	0.037	1.80	1.8	3.94	133.1		
68	6,910	1,866	21.06	39.3	14,830	0.274	45.25	93.8	7,200	0.259	7.21	1.9	7,200	0.259	7.21	1.9	4.98	207.2		
69	6,910	0,726	20.98	15.2	14,830	4,251	45.16	192.0	7,200	0.104	2.37	0.2	7,200	0.104	2.37	0.2	15.71	493.7		
70	6,910	8,554	21.05	180.1	14,830	6,895	45.21	311.7	7,200	0.104	2.37	0.2	7,200	0.104	2.37	0.2	34.73	1356.7		
71	6,720	16,671	20.48	300.4	17,360	19,958	52.93	1055.8	7,200	0.674	4.26	1.7	7,200	0.674	4.26	1.7	21.90	1022.1		
72	6,340	6,584	19.30	127.1	16,300	15,293	55.77	852.9	7,200	0.674	4.26	1.7	7,200	0.674	4.26	1.7	15.35	542.8		
73	6,340	6,376	19.31	123.1	16,600	8,191	50.78	415.9	7,200	0.104	2.37	0.2	7,200	0.104	2.37	0.2	38.98	1304.4		
74	5,920	17,729	18.05	319.9	15,330	21,047	46.72	983.3	7,200	0.104	2.37	0.2	7,200	0.104	2.37	0.2	10.21	328.7		
75	6,540	3,473	19.30	67.0	15,330	5,443	46.69	254.1	7,200	0.674	4.26	1.7	7,200	0.674	4.26	1.7	24.47	767.1		
76	5,710	10,627	17.04	185.0	14,900	7,206	45.41	327.2	7,200	0.089	7.12	7.8	7,200	0.089	7.12	7.8	21.36	541.6		
77	7,380	15,396	22.48	346.1	16,630	8,191	50.67	415.0	7,200	0.829	7.10	5.9	7,200	0.829	7.10	5.9	24.47	767.1		
78	7,320	11,020	22.30	263.6	15,460	13,582	47.11	639.9	7,200	0.259	7.21	1.9	7,200	0.259	7.21	1.9	25.40	903.5		
79	5,710	5,236	17.47	91.1	14,900	2,955	45.37	134.1	7,200	0.156	1.81	0.3	7,200	0.156	1.81	0.3	8.19	225.2		
80	6,770	8,450	20.63	174.3	15,720	11,405	47.90	546.3	7,200	2.125	1.79	3.8	7,200	2.125	1.79	3.8	20.01	721.3		
81	5,910	8,813	18.01	138.7	14,430	12,338	44.58	550.0	7,200	0.089	7.12	7.8	7,200	0.089	7.12	7.8	23.79	714.9		
82	5,710	2,592	17.40	55.1	16,350	6,273	49.84	312.6	7,200	0.037										

Table 5: Summary of biomass estimates, at MWL, for the south west coast of Campania Island and the south and western coasts of the Estevan Group, in September, 1976.

<u>Geographical area</u>	<u>Blocks</u>	<u>Biomass (tonnes)</u>	<u>Area (hectares)</u>
<i>Low Density Nereocystis</i>			
Campania Island	1-17	3,022	190
Estevan Group	18-82	7,060	379
<i>High Density Nereocystis</i>			
Campania Island	1-17	11,180	255
Estevan Group	18-82	26,038	535
<i>Low Density Macrocyctis</i>			
Campania Island	1-17	27	13
Estevan Group	18-82	75	35
<i>High Density Macrocyctis</i>			
Campania Island	1-17	7	1
Estevan Group	18-82	111	24
<i>Low Density Mixed Beds</i>			
Campania Island	1-17	86	10
Estevan Group	18-82	184	23
<i>High Density Mixed Beds</i>			
Campania Island	1-17	nil	nil
Estevan Group	18-82	145	6
Totals			
Campania Island	1-17	14,321	469
Estevan Group	<u>18-82</u>	<u>33,613</u>	<u>1,002</u>
Grand Totals	1-82	47,934	1,471
Totals by Species			
<i>Nereocystis</i>	1-82	47,300	1,359
<i>Macrocyctis</i>	1-82	219	73
Mixed	1-82	415	39

Of 47,934 tonnes of kelp found in 1,471 hectares of bed surface area at MWL, 47,300 tonnes, or 98.67% was pure *Nereocystis*; 219 tonnes (0.46%) of pure *Macrocystis* and 415 tonnes (0.86%) of mixed beds made up the the balance. Note, however, in terms of surface area *Macrocystis* beds made up a considerably larger proportion (4.99%), and mixed beds showed a larger area-based make-up as well (2.67%). These discrepancies result from a much smaller mean biomass per frond value determined for *Macrocystis* (0.352 kg/frond vs. 3.047 kg/plant for *Nereocystis* - Tables 1 and 2). The Estevan Group contained a somewhat larger proportion of *Macrocystis* than Campania Island. Most of this was found in the most protected waters: in channels between islands and at the heads of bays (Chart C).

Perhaps the most significant result of the present inventory was the discovery of extensive standing stocks of pure *Nereocystis*. Over 50% of all bed area and better than 75% (Tables 6 and 7) of biomass at both the Estevan Group and Campania Island was found as dense beds, where biomass averaged 47.1 tonnes per hectare (range 36.3 to 72.7 tonnes/ha).

Table 8 presents the combined biomass and density factors which are calculated from cumulative biomass values obtained from field samples (Table 1). These may be used, in conjunction with any given biomass at MWL, to determine the amount of kelp which would, on the average, be available at depth increments of one meter above and below MWL. They may be applied to individual blocks, species and densities, or to the area as a whole, as has been done in Table 9. From this table it can be seen, for example, that a harvester cutting at 3 meters below MWL could potentially gather an estimated 72,369 tonnes of *Nereocystis*, 548 tonnes of *Macrocystis* and 793 tonnes of mixed *Nereocystis* and *Macrocystis*. The total standing crop of kelp is estimated to be 77,615 tonnes (Table 9).

All estimates using the Kelp Inventory Method are considered conservative, rather than optimistic. In addition to the reasons for this given by Foreman (1974), there are two other factors which may contribute to these low estimates. Many of the *Nereocystis* plants were observed at the time of photography to have become entangled, forming clumps of up to a hundred or more individuals (Figure 5). This would effectively reduce the number of "hits" per grid count during the random density-determination procedure. In addition,

Table 6: Composition (in %) of Biomass totals.

Bed type	Campania Island	Estevan Group	Combined
<i>Nereocystis</i> - low density	21.10	21.00	21.03
- high density	78.07	77.46	77.64
<i>Macrocystis</i> - low density	0.19	0.22	0.21
- high density	0.05	0.33	0.25
Mixed beds - low density	0.60	0.55	0.56
high density	0	0.43	0.30

Table 7: Composition (in %) of Area totals.

Bed type	Campania Island	Estevan Group	Combined
<i>Nereocystis</i> - low density	40.51	37.82	38.69
- high density	54.37	53.39	53.67
<i>Macrocystis</i> - low density	2.77	3.49	3.28
- high density	0.21	2.40	1.71
Mixed beds - low density	2.13	2.30	2.26
high density	0	0.60	0.41

Table 8: Combined biomass and density factors for various cutting levels.

Cutting level (m)	<i>Nereocystis</i>	<i>Macrocystis</i>	Mixed
	n=103	n=113	*
+6	-	0.06	0.00
+5	0.02	0.09	0.08
+4	0.04	0.12	0.13
+3	0.11	0.16	0.16
+2	0.30	0.29	0.40
+1	0.64	0.59	0.69
MWL	1.00	1.00	1.00
-1	1.31	1.49	1.38
-2	1.46	2.04	1.71
-3	1.53	2.50	1.91
-4	1.57	2.72	2.01
-5	1.59	2.81	2.04
-6	1.61	-	-

\*Based on 42% *Nereocystis* and 58% *Macrocystis*



Table 9: Total harvestable kelp biomass at selected depth levels for Campania Island and Estevan Group, in September, 1976

Depth Level (m)	Cumulative Biomass (tonnes)			
	<i>Nereocystis</i>	<i>Macrocystis</i>	Mixed	Total
+6	-	13	2	15
+5	946	20	33	999
+4	1,892	26	54	1,972
+3	5,203	35	66	5,304
+2	14,190	64	166	14,420
+1	30,272	129	286	30,687
MWL	47,300	219	415	47,934
-1	61,963	326	573	62,862
-2	69,058	447	710	70,215
-3	72,369	548	793	73,710
-4	74,261	596	834	75,691
-5	75,207	615	847	76,669
-6	76,153	-	-	77,615

and especially because of this clumping, an undetermined amount of lamina loss occurred during field sampling, while attempting to untangle such clumps.

No evidence of an "uncharted reef" with some 10,500 tons (9,520 tonnes) of *Nereocystis* reported by the B.C. Research Council (1948) was ever found in the waters of Estevan Sound, and particularly not in the position indicated on their resource map. The only reefs of any size in the vicinity are Cartwright and Logan Rocks, located about six kilometers southeast, and these do not appear to be of a size capable of supporting 9,520 tonnes of *Nereocystis*; the present inventory estimates less than 1,500 tonnes. The same report located 1,056 tons (958 tonnes) along the west side of Campania Island; the 1976 estimate is 14,321 tonnes (this does not include the northern half of the Island), or nearly fifteen times as much. The beds are large and dense in contrast to the fringe beds noted in 1947. Although the 1947 survey techniques were fairly crude and relied heavily on subjective observation, a discrepancy of this magnitude cannot reasonably be attributed solely to their methodology. Either the beds have enlarged considerably since then, or the older survey somehow missed seeing them.

Summary:

1) Using Foreman's KIM-1 technique 47,300 tonnes (at MWL) of *Nereocystis luetkeana*, 219 tonnes of *Macrocystis integrifolia*, and 415 tonnes in mixed kelp beds were located in 82 kilometer-wide statistical blocks along the coasts of Campania Island and the Estevan Group. One large bed of an estimated 8,423 tonnes was found in a large semi-protected bay at the south end of the Estevan Group, and another of 12,112 tonnes along the lower west coast of Campania Island.

2) Various tables are presented to provide block by block and regional estimates of biomass and kelp bed area for each species and density type, the vertical distribution of kelp biomass and conversion factors for estimating biomass at tide levels other than MWL.

3) Five charts are included which detail the position, size, density and species of kelp found in the inventory area.

4) A comparison between kelp stock estimates of 1947 and 1976 for the west side of Campania Island showed discrepancies and anomalies which could not be totally attributed to differences in technique, assuming equal coverage of the areas inventoried. Either the size of the beds had changed considerably (some reduced in size, others enlarged), or the earlier inventory missed seeing significant beds.

Acknowledgements:

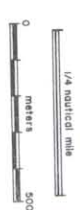
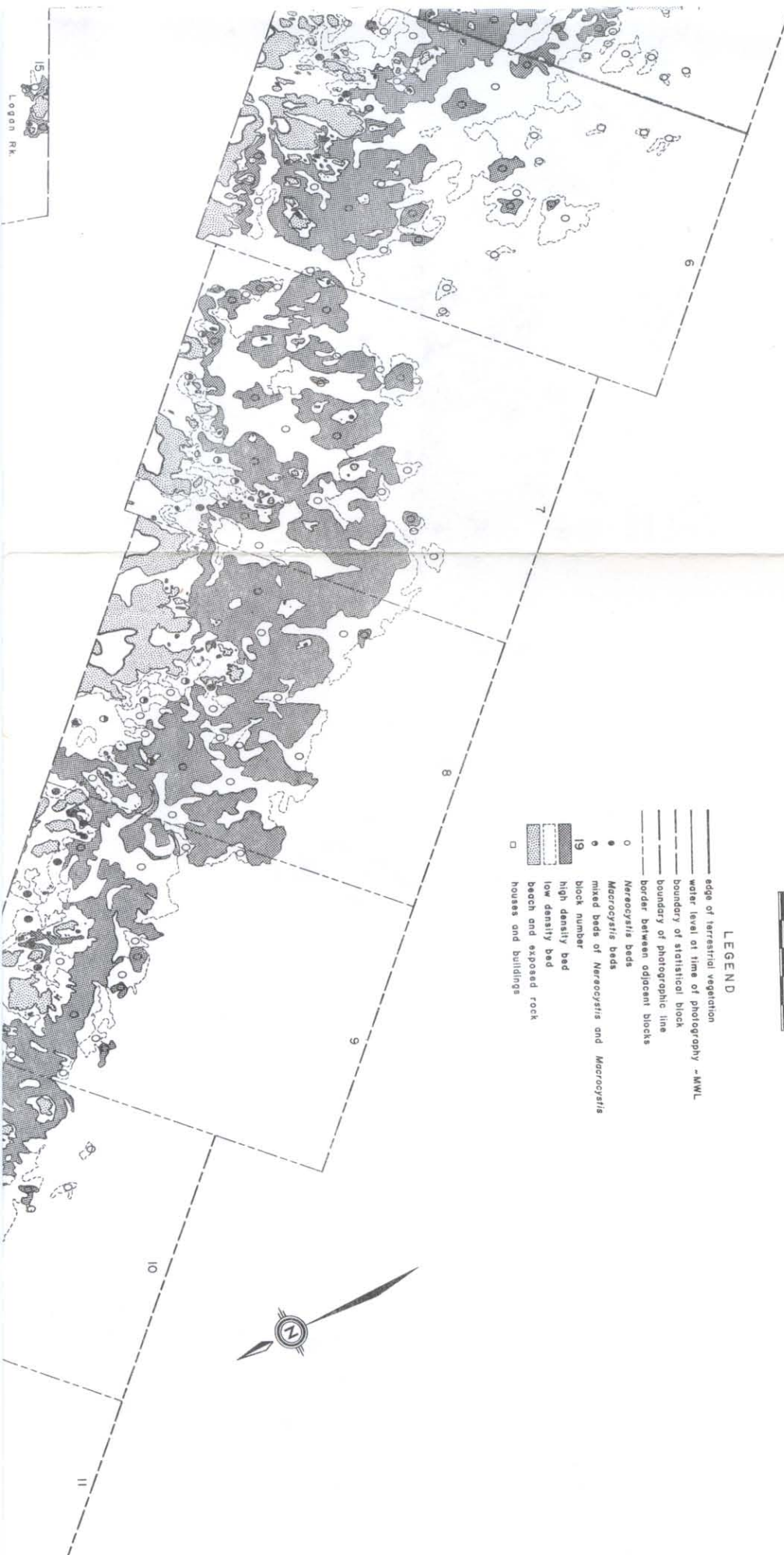
We would like to express our appreciation to all those who took part or assisted us in the gathering, reducing and presentation of the data contained in this report: John Boome and Zbigniew (Spino) Pakula for their part in collecting and processing biomass samples when the weather was so perfect for other, less tedious, activities. Reprographics service of the Ministry of Environment, particularly Bernie Alde, provided us with invaluable advice on cutting corners during our drafting of charts, and showed great patience as we slowly worked out our printing requirements for them. Many thanks also to Gwenn Burley, who expertly typed the manuscript and accepted all our revisions cheerfully.

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- B.C. Research Council. 1947. Marine plants of economic importance in British Columbia coastal waters. Part II. B.C. Research Council Tech. Bull., No. 10.
- Coon, L.M., E.J. Field and Canadian Benthic Ltd. 1976. Nootka Sound kelp inventory, 1975. B.C. Marine Resources Branch, Fish. Management Rep. No. 2.
- Foreman, R.E. 1975. KIM-1. A method for inventory of floating kelps and its application to selected areas of Kelp Licence Area 12. BERP Report 75-1. Report to Federal Fisheries and Marine Service and Provincial Marine Resources Branch.

# CHART A



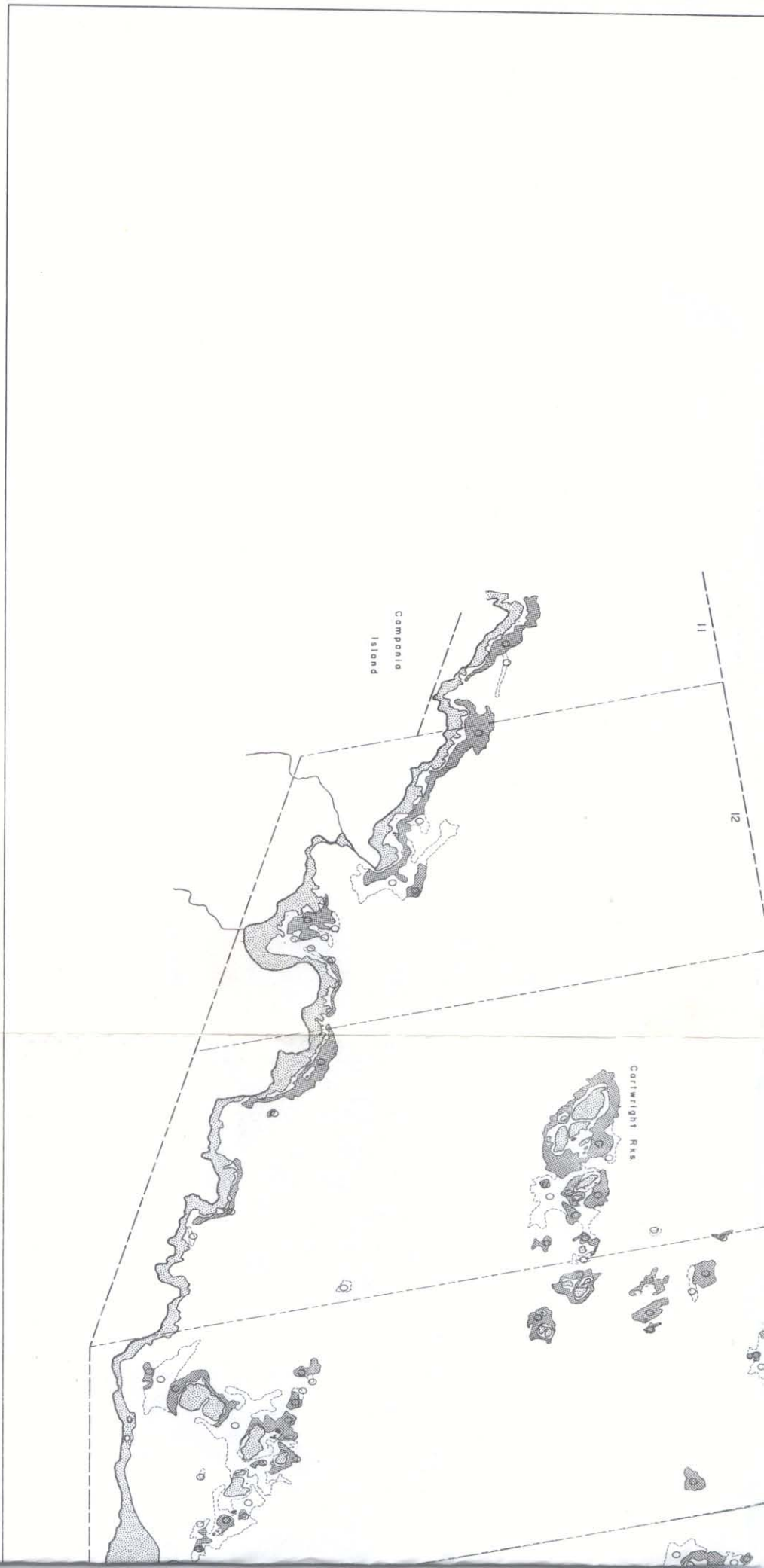


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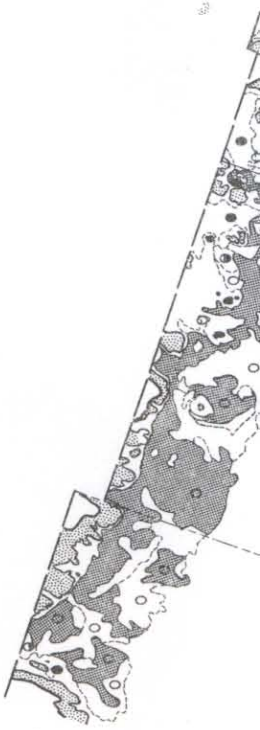
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- boundary of statistical block
- boundary of photographic line
- border between adjacent blocks
- Macrocytis beds
- Macrocytis beds
- mixed beds of *Neracystis* and *Macrocytis*
- block number
- high density bed
- low density bed
- beech and exposed rock
- houses and buildings



15  
Logan Rk.





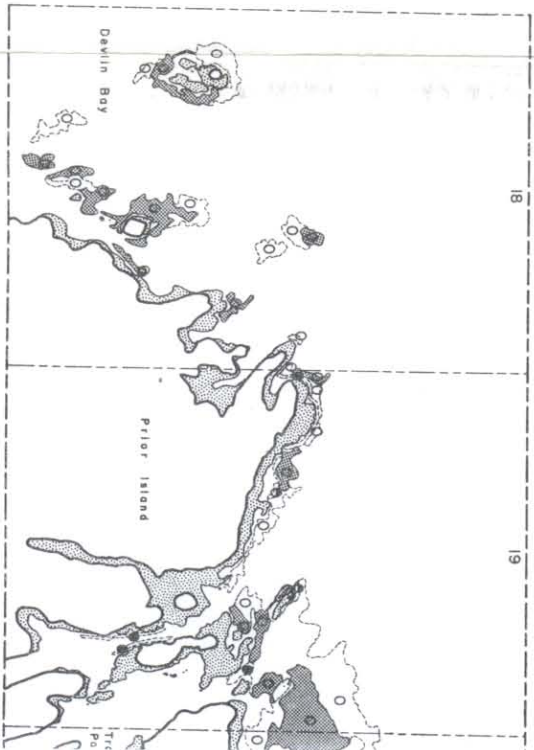


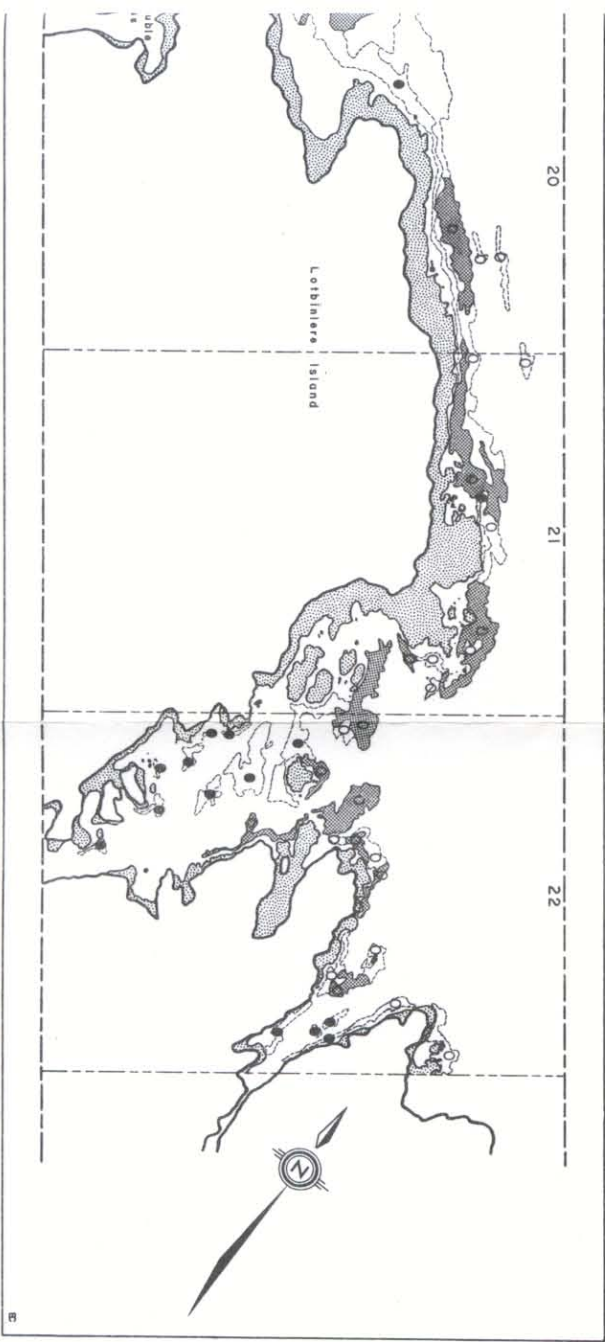
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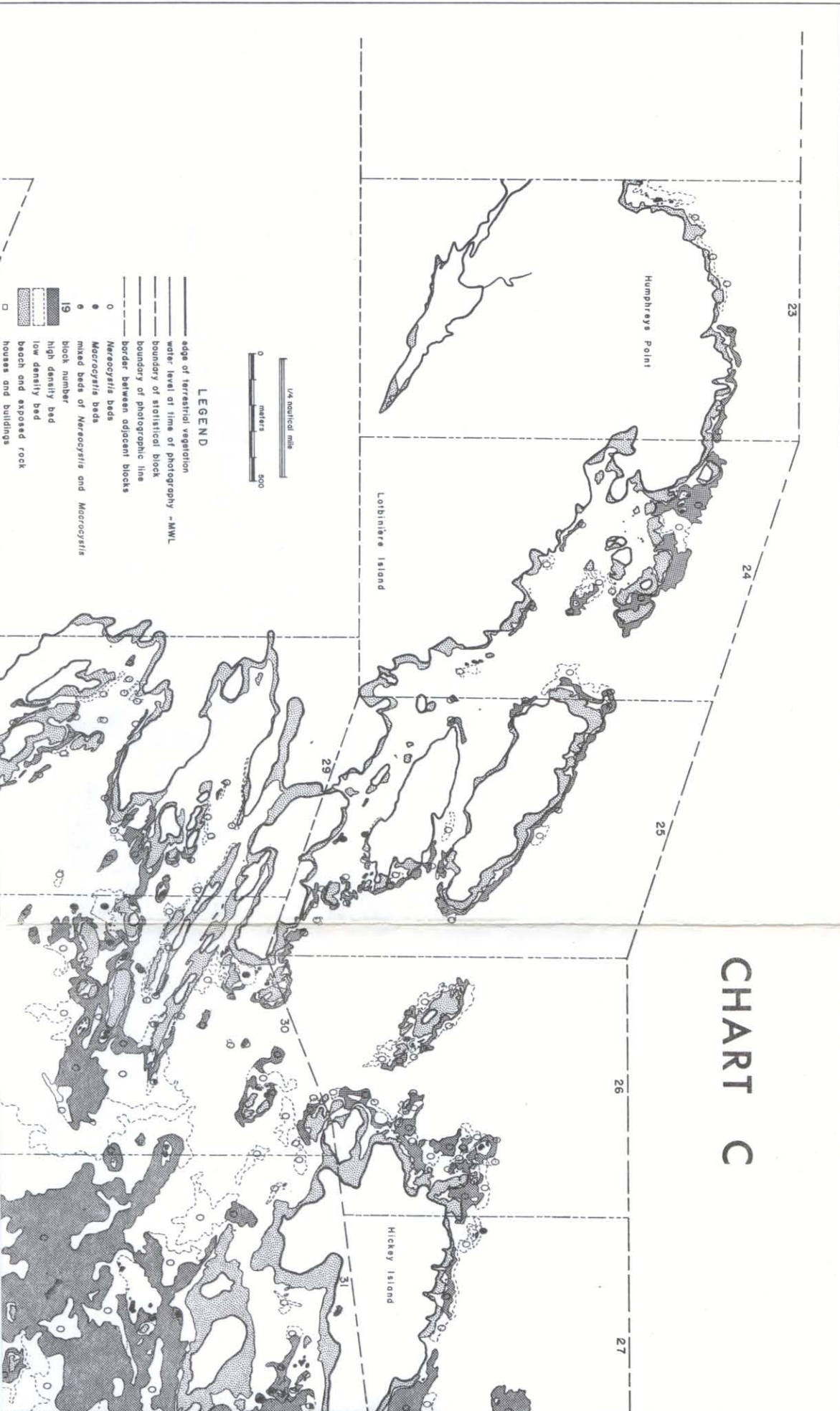
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- border between adjacent blocks
- *Neorocystis* beds
- *Macrocyctis* beds
- mixed beds of *Neorocystis* and *Macrocyctis*
- 19 block number
- high density bed
- low density bed
- beach and exposed rock
- houses and buildings





# CHART C

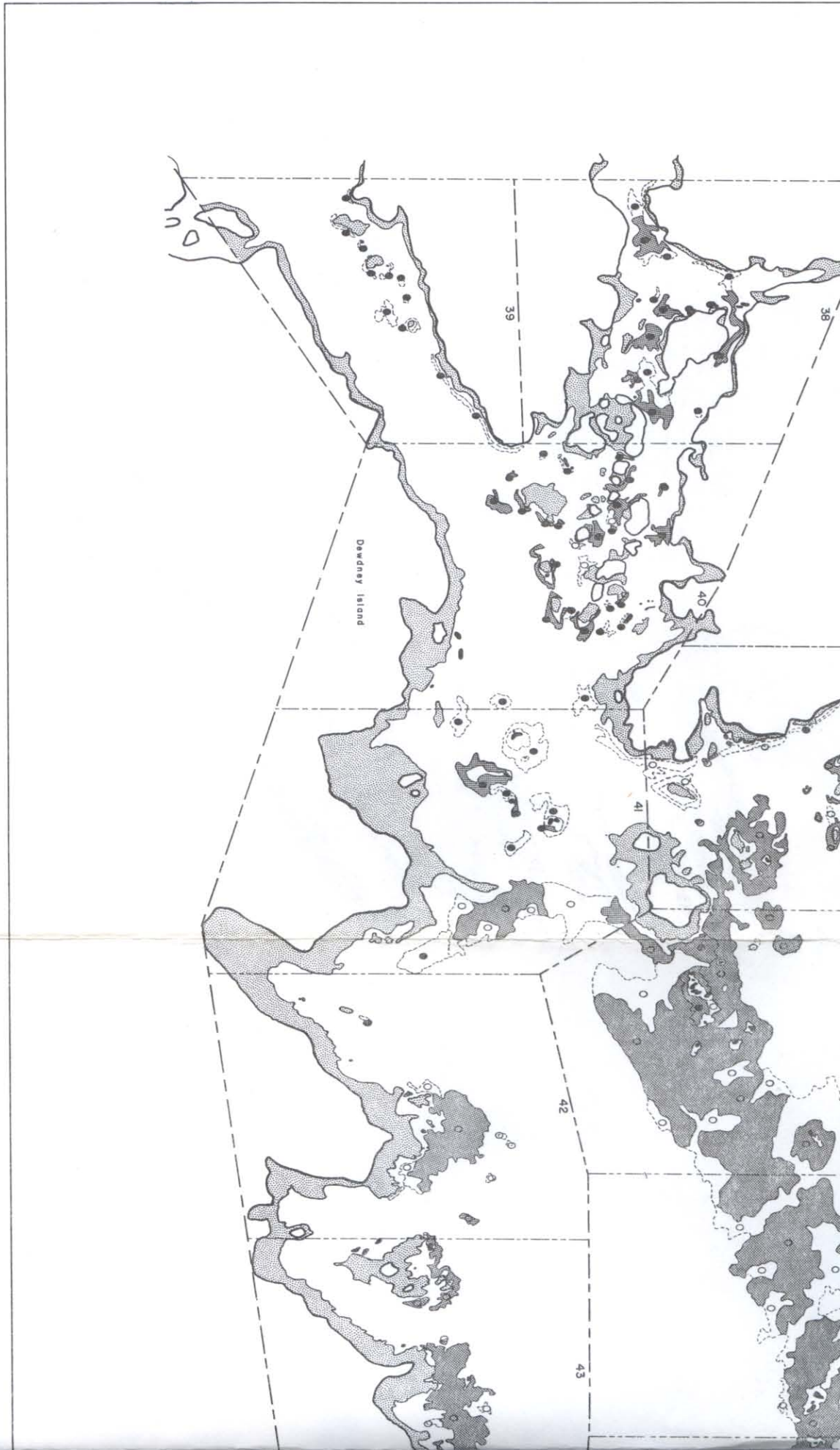


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- water level at time of photography - MWL
- boundary of statistical block
- boundary of photographic line
- border between adjacent blocks
- Macrocyttis beds
- Macrocyttis beds
- mixed beds of *Nerocystis* and *Macrocyttis*
- 19 block number
- high density bed
- low density bed
- beach and exposed rock
- houses and buildings







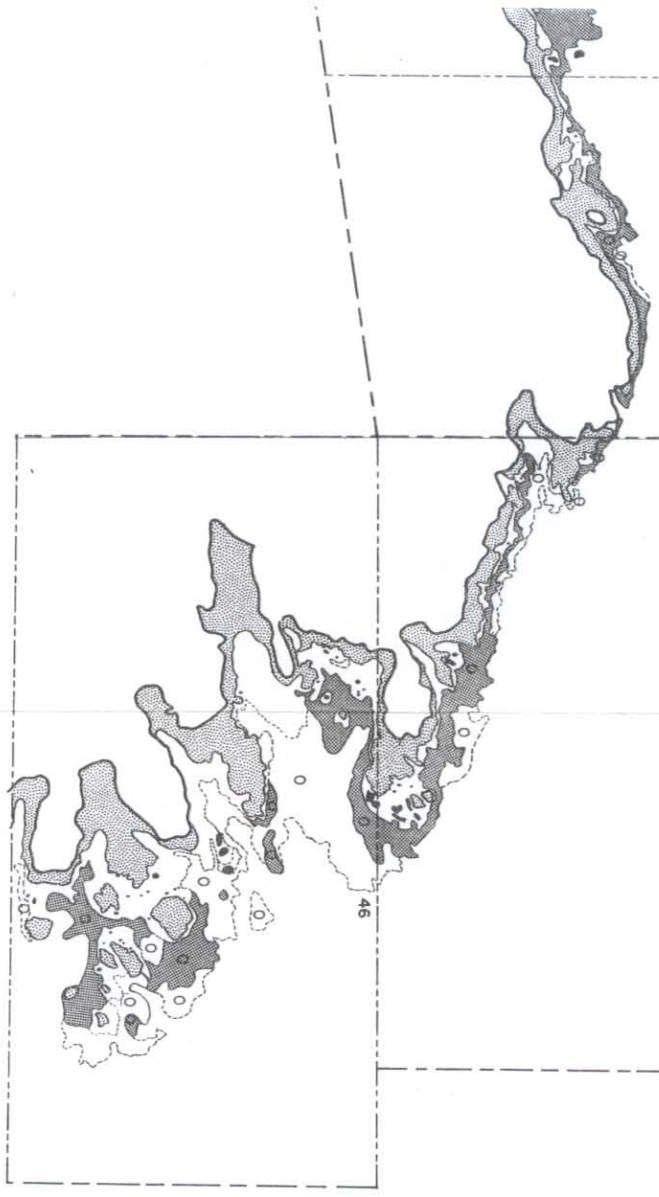


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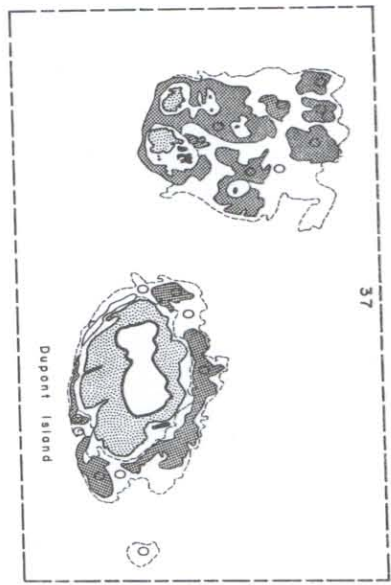
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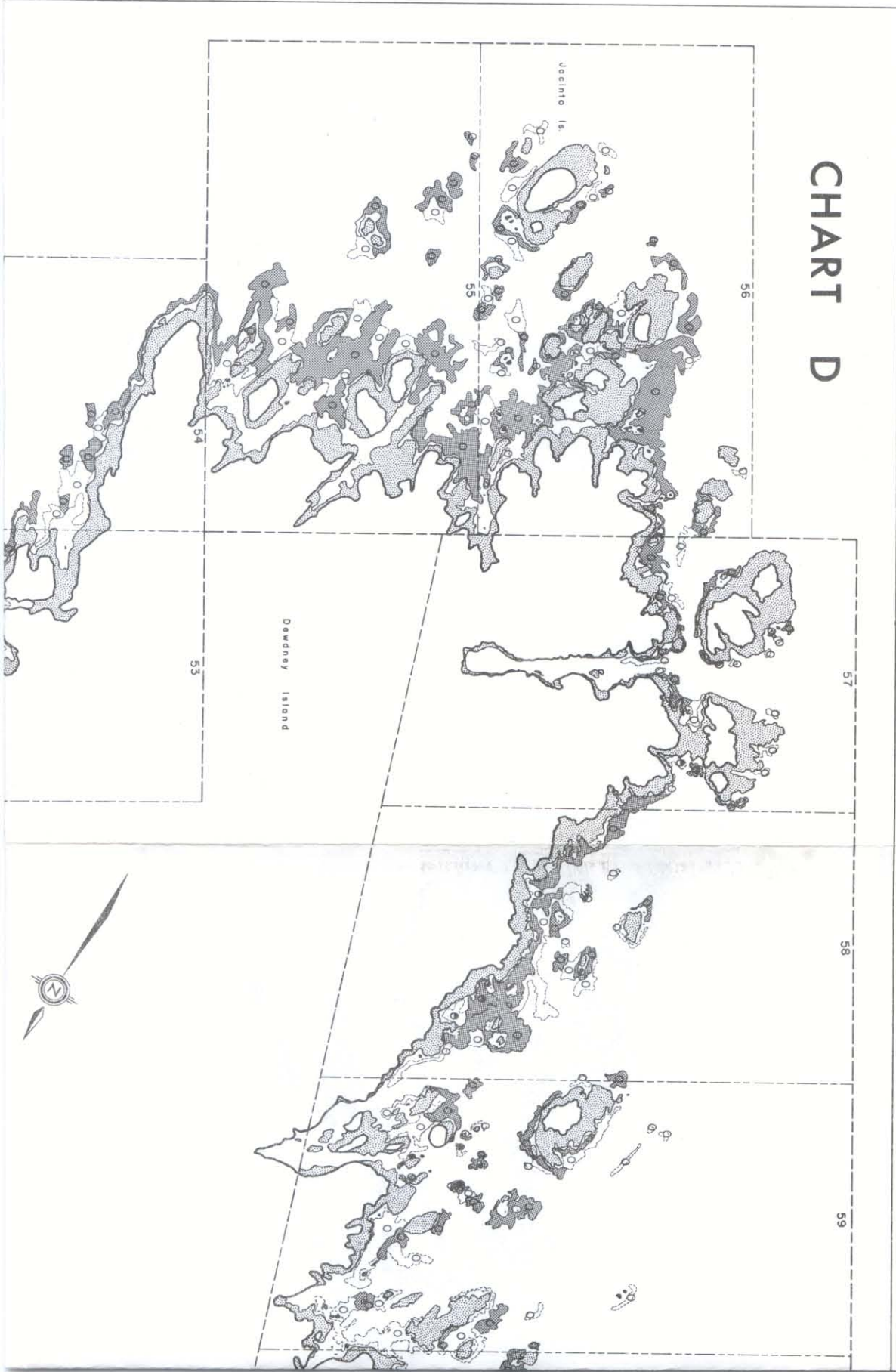


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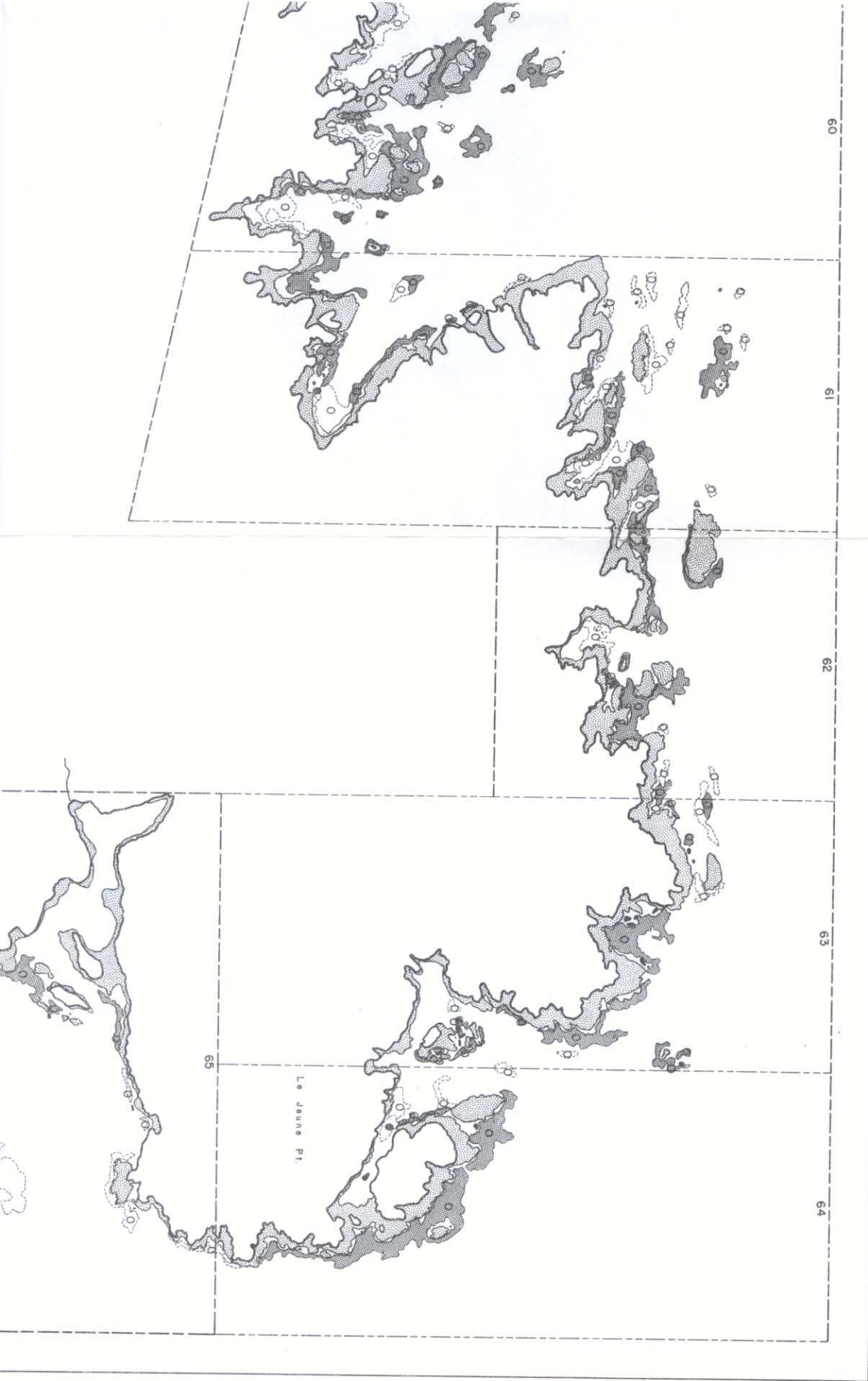


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# CHART D



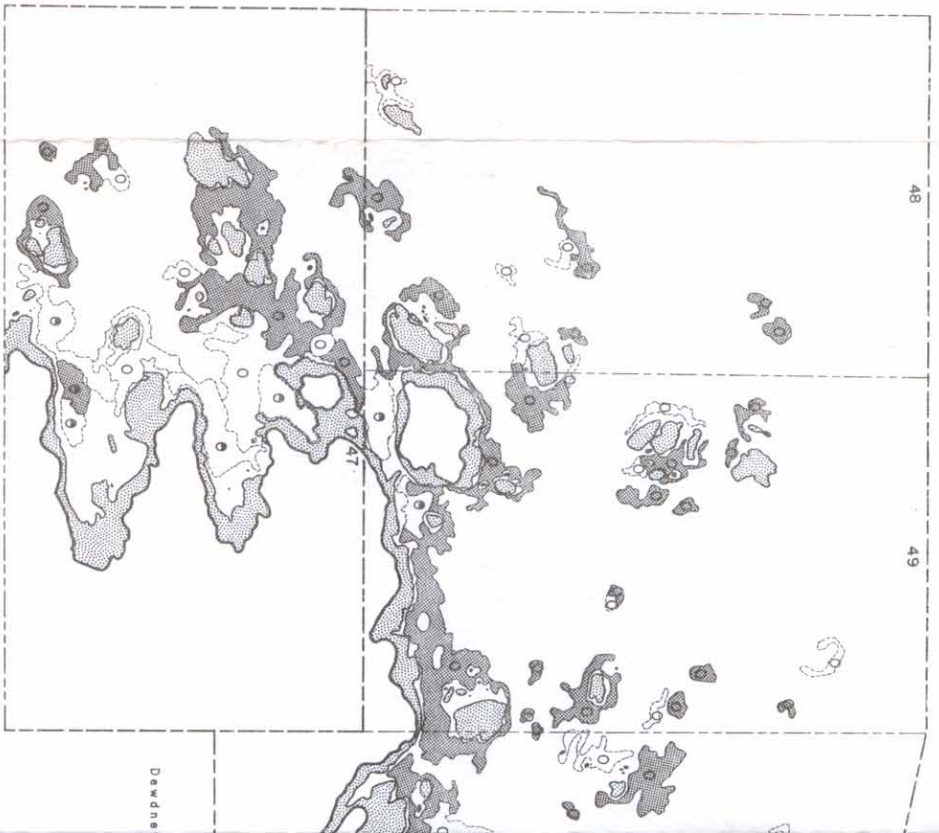


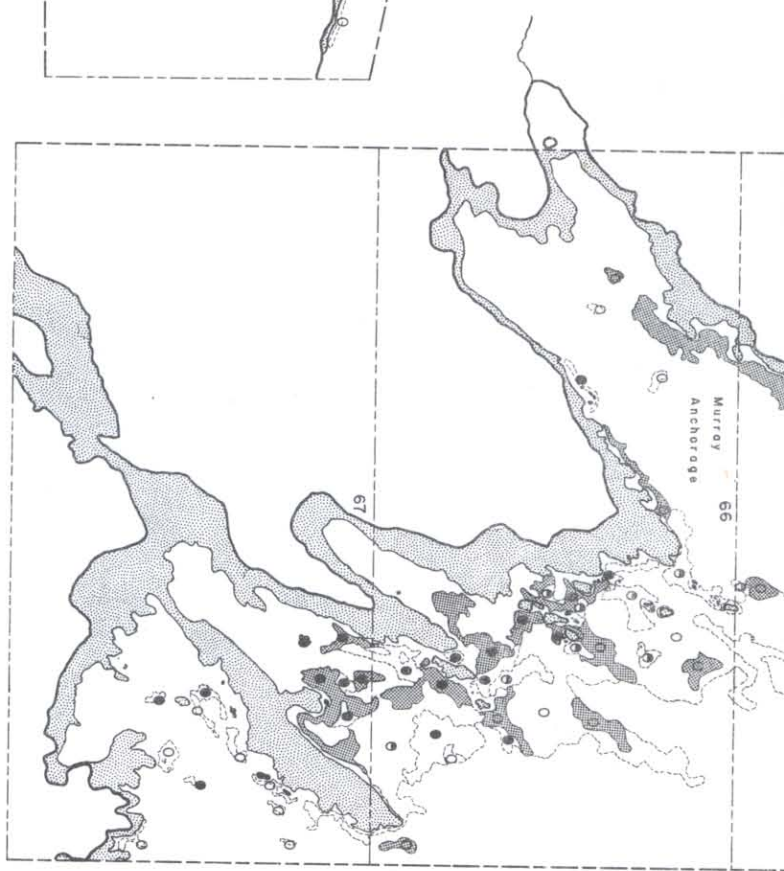
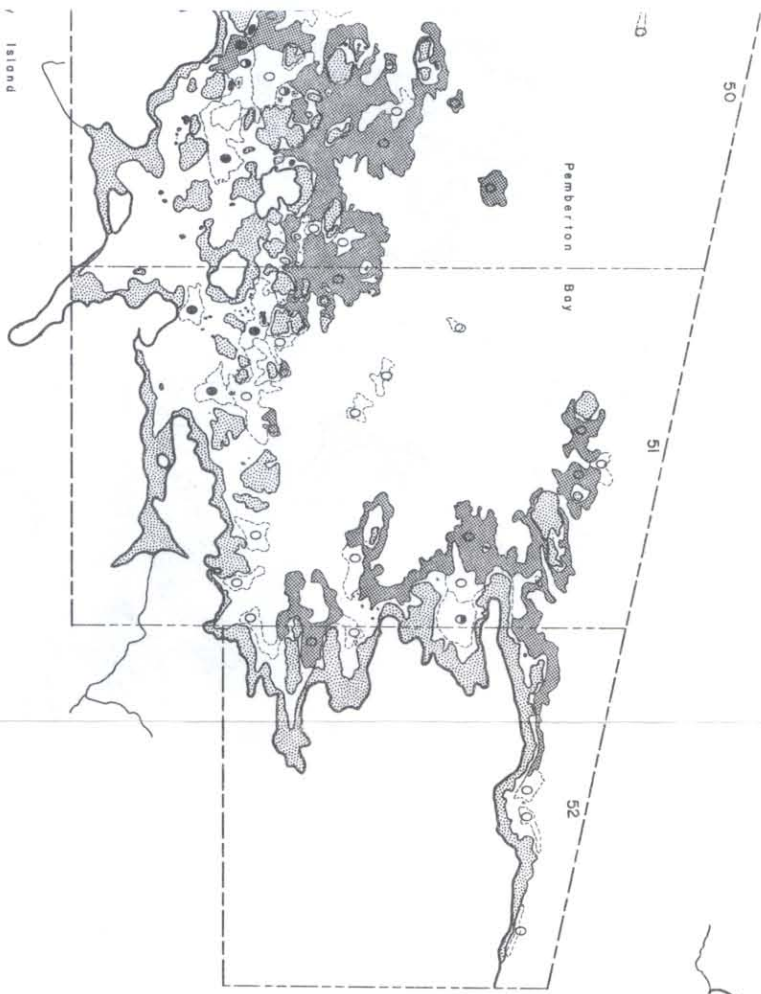




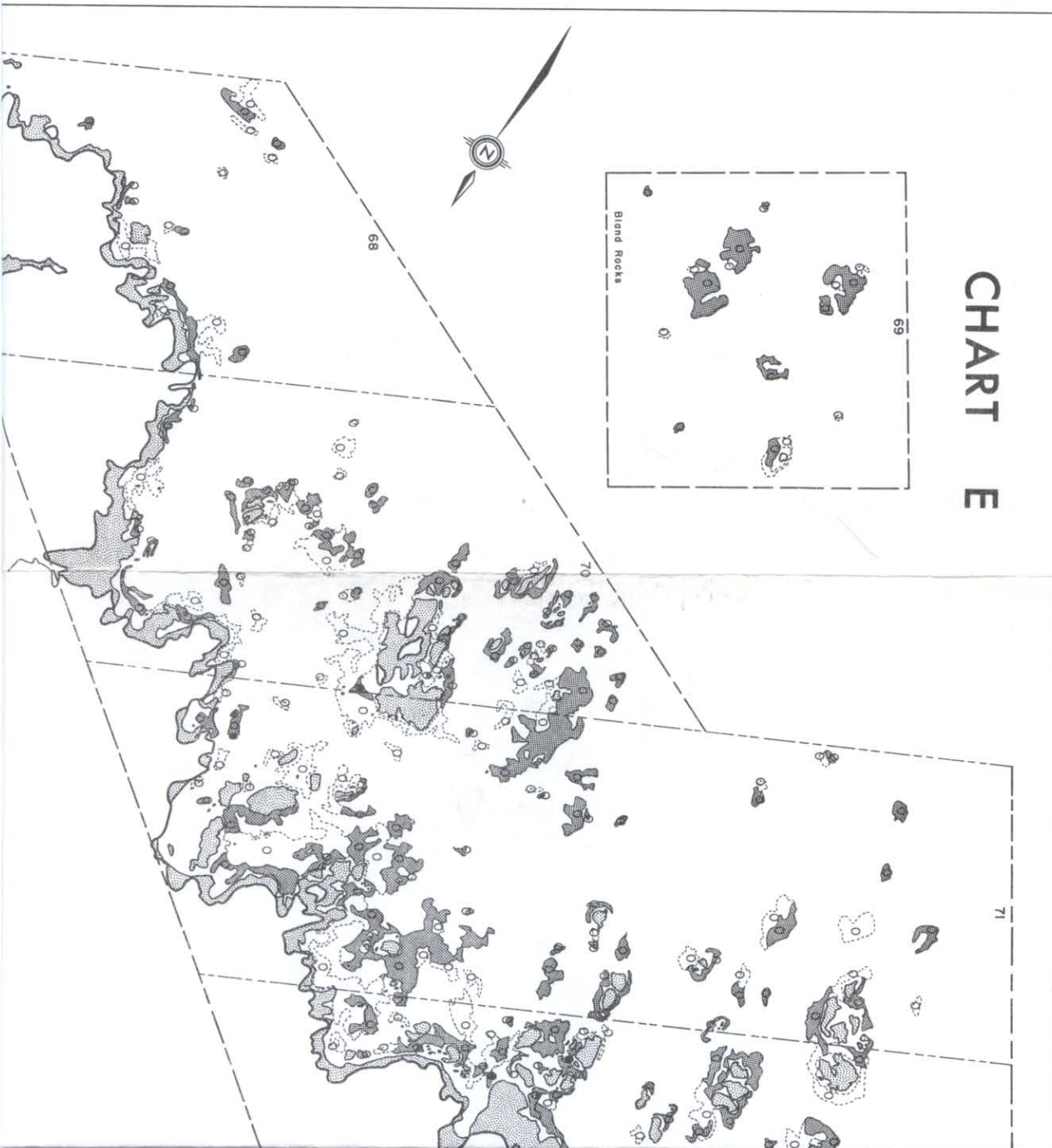
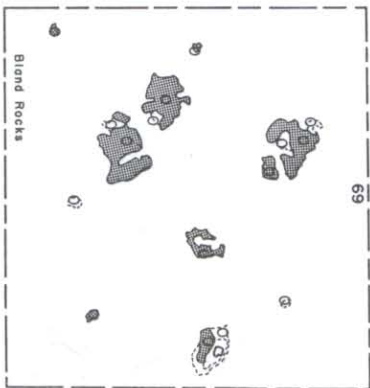
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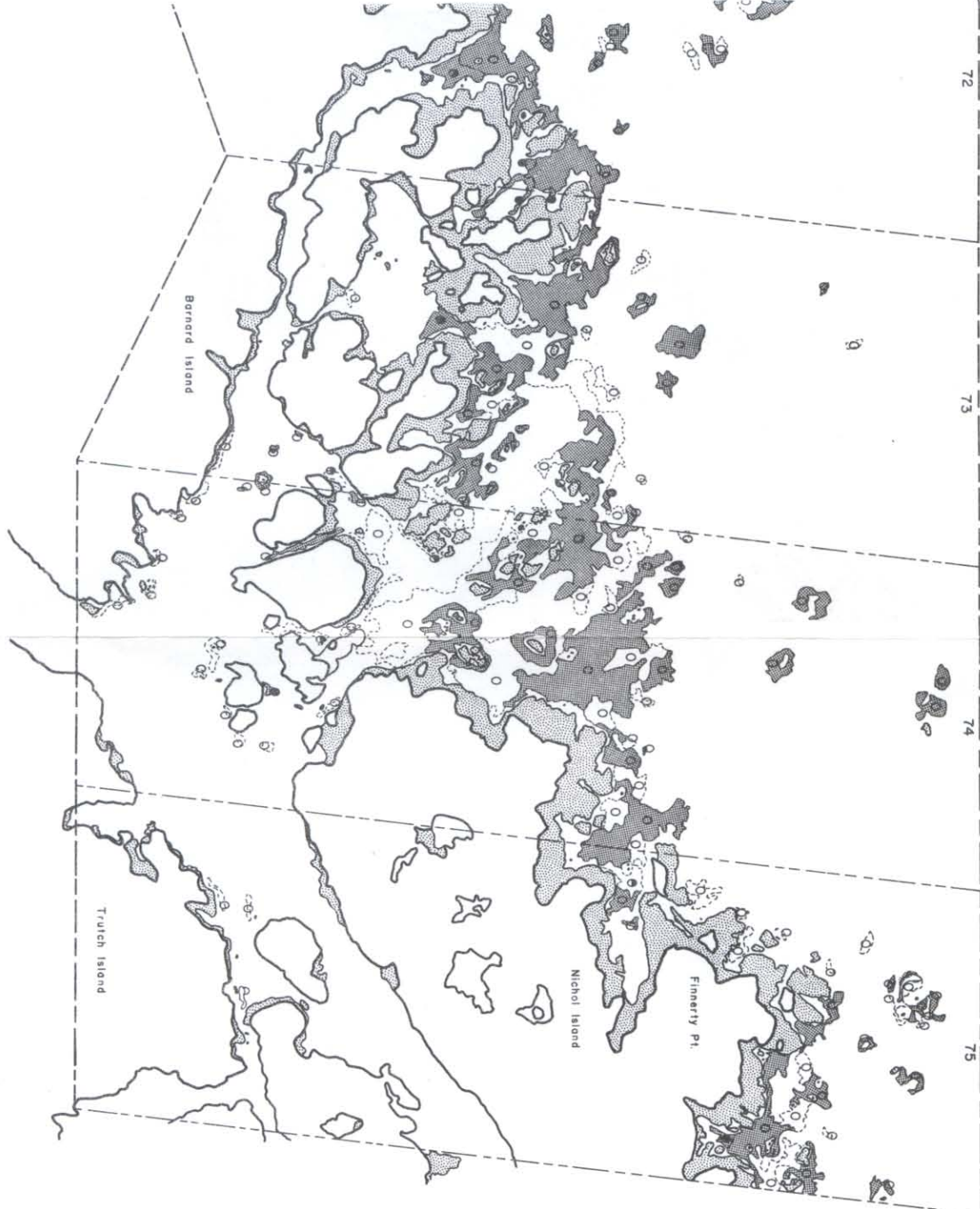
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- water level at time of photography - MWL
- boundary of statistical block
- boundary of photographic line
- border between adjacent blocks
- Nereocystis beds
- Macrocoystis beds
- mixed beds of Nereocystis and Macrocoystis
- 19 block number
- ▨ high density bed
- ▩ low density bed
- ▧ beach and exposed rock
- houses and buildings





# CHART E





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73

74

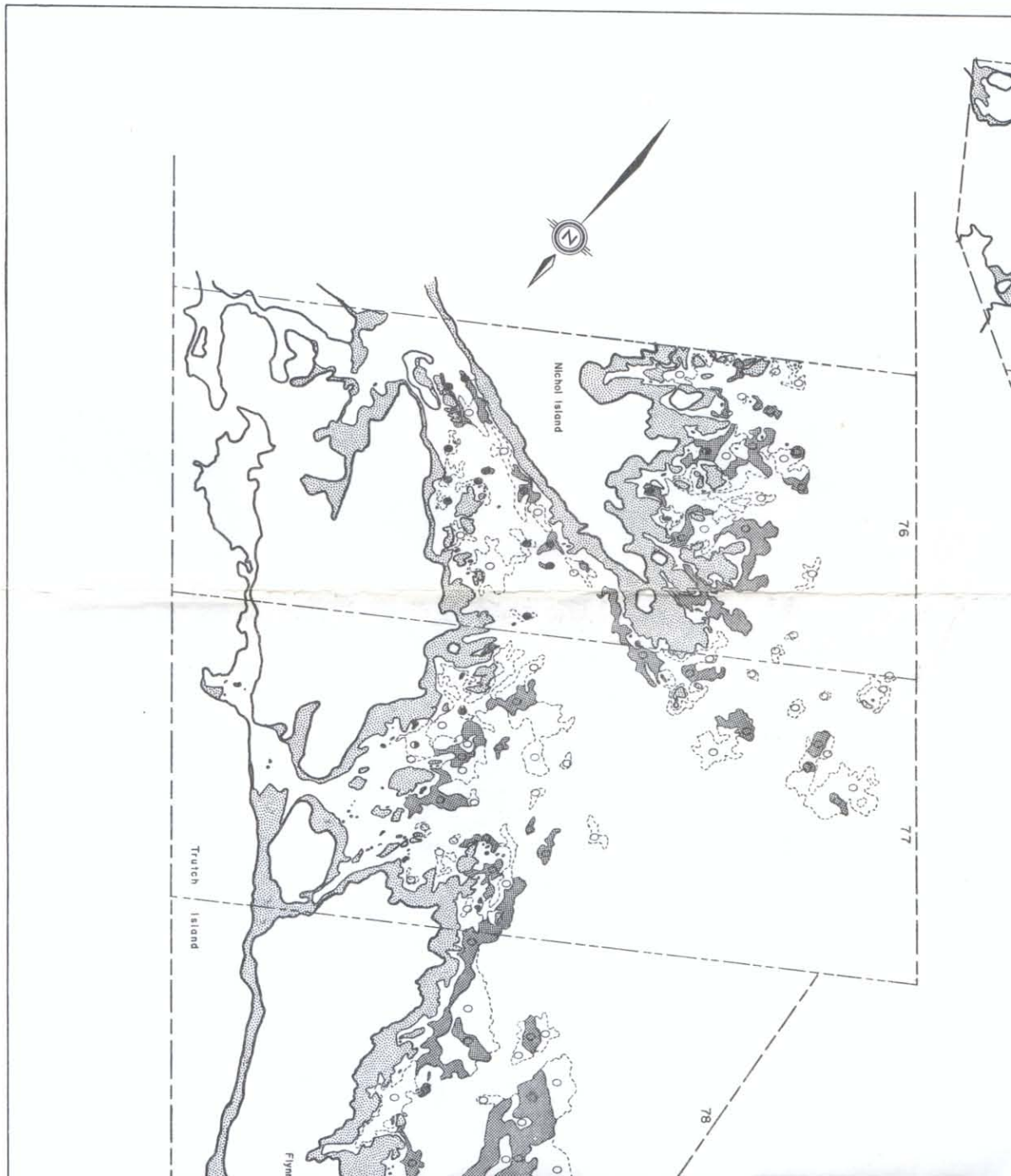
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Bernard Island

Truich Island

Nichol Island

Finerly Pt.





LEGEND

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- water level at time of photography - MWL
- 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
- ▧ beach and exposed rock
- houses and buildings

