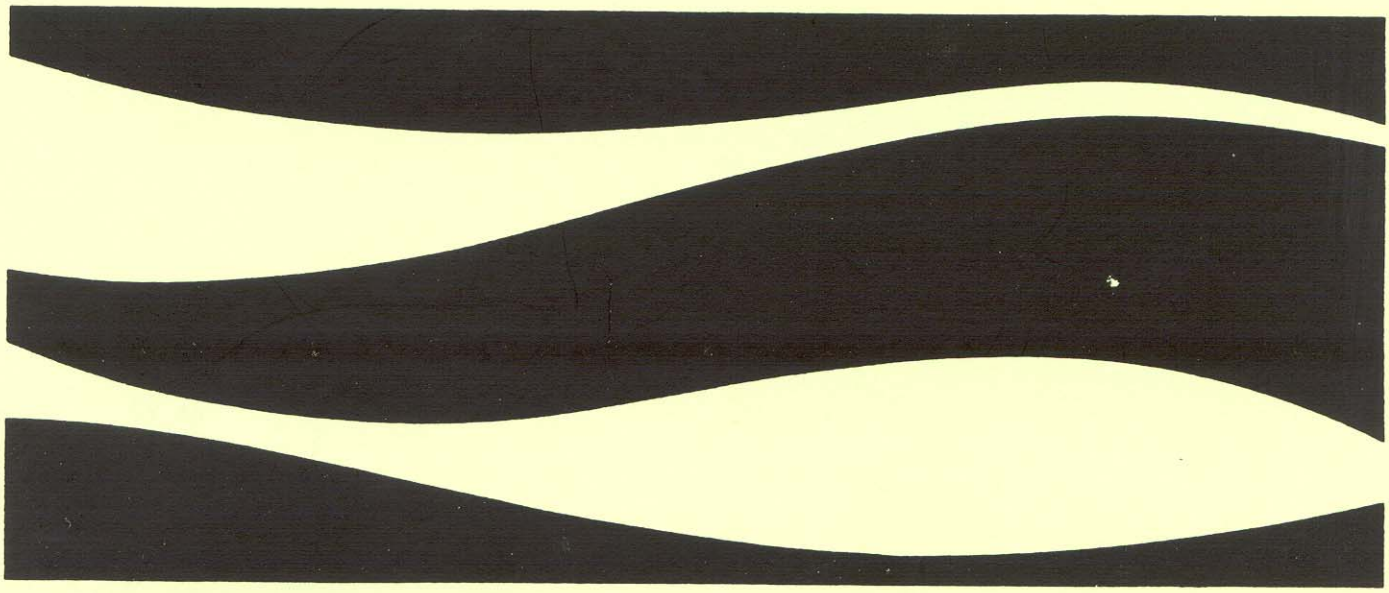
Kelp Inventory, 1988

Juan de Fuca Strait

IEC Collaborative Marine Research
and Development Ltd.

Province of British Columbia
Ministry of Agriculture and Fisheries
Aquaculture and Commercial Fisheries Branch



KELP INVENTORY, 1988

JUAN DE FUCA STRAIT

prepared by

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ABSTRACT

A modification of the Kelp Inventory Method (KIM-1) developed by Foreman (1975) was used to estimate the total standing crop biomass of Nereocystis luetkeana along the Canadian shore of Juan de Fuca Strait for August, 1988. Estimates of kelp bed area were produced for N. luetkeana and Macrocystis integrifolia. Results indicated that 50,148 tonnes of N. luetkeana were present. Total bed surface area was estimated to be 511 hectares, of which less than 2% was M. integrifolia. Six charts are presented which show the position, extent, species, and density of every discernable kelp bed within the survey area. For management purposes the area is divided to permanent, numbered, kilometer wide blocks.

ACKNOWLEDGEMENTS

The author wishes to thank Michael Coon, Bob Cox and Ted Pobran who braved the elements to collect kelp biomass data. Michael Coon and Bob Cox also reviewed most of the manuscript. Thanks are also due to Bill Roland for his suggestions regarding mean biomass per plant calculations.

INTRODUCTION

Nereocystis luetkeana (Mertens) Postels and Ruprecht and Macrocystis integrifolia Bory form beds along extensive portions of the British Columbia coast. In 1975 the Provincial Government 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). Since that time major kelp stocks have been inventoried throughout the province (Coon, 1981. Coon et al, 1977, 1979, 1980, 1981, 1982. Field et al., 1975, 1977, 1978).

This report contains the results of a 1988 survey of the Vancouver Island shore of Juan de Fuca Strait by the Aquaculture and Commercial Fisheries Branch of the Ministry of Agriculture and Fisheries. The Ministry provided field sampling data and aerial photography under contract to IEC Collaborative Marine Research and Development Ltd. for completion of the inventory.

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, kelp inventory charts and data will be of value to those preparing environmental impact statements, or conducting surveys of herring spawn, abalone and sea urchins (Coon, 1977).

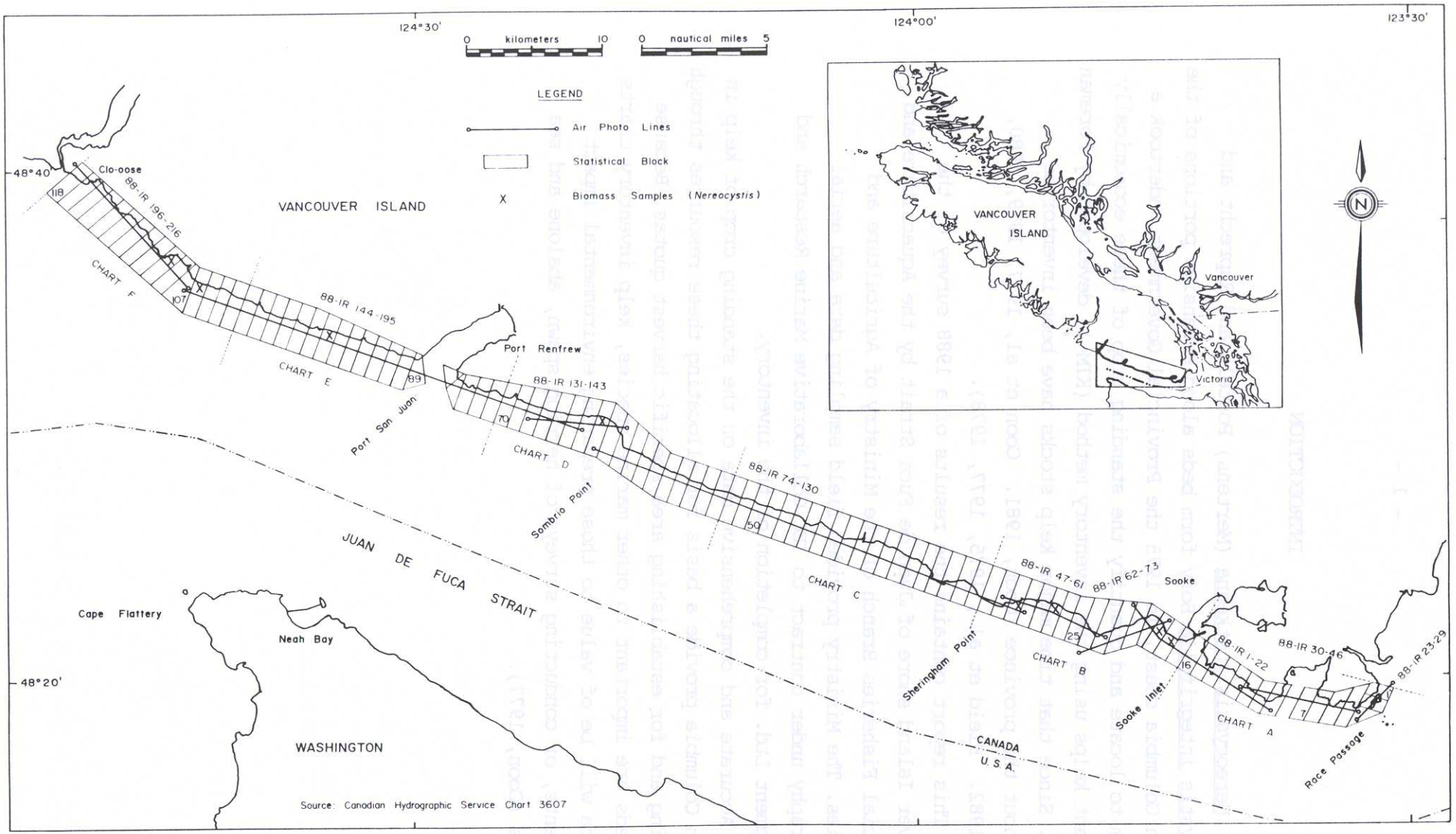

Figure 1: The Strait of Juan de Fuca, showing the area inventoried for floating kelp resources and the mode of division of this area into inventory charts (see Appendix). Also indicated are the layout of statistical blocks, aerial photographic flight lines and locations of biomass sampling stations.

METHODS

The standing crop biomass of Nereocystis and kelp bed areas of both Nereocystis and Macrocystis were estimated by a modification of 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. A further change was introduced in this inventory by estimating the total standing crop biomass of Nereocystis rather than the harvestable biomass at various cutting levels. This method was first used in the Porcher Island area by Coon (1981).

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. The black and white IR negatives are used to prepare charts of the coastline and offshore kelp beds. On these charts the survey area is divided to 1 kilometer wide statistical blocks. Bed areas for each of the six bed types described 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 kelp biomass per block is determined by multiplying the mean weight per plant or frond values by the observed plant or 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 or mixed (42% Nereocystis and 58% Macrocystis; Foreman, 1975); and

b) plant or frond density - low density (less than 10 plants or fronds per 10 square meters) or high (greater than 10 plants or fronds per 10 square meters).

The kelp bed area and density estimates given in this report are derived from August 27, 1988 photography. Local tidal characteristics combined with the large distances covered by this inventory resulted in photography of the more easterly area at 1 meter lower than the optimal

level (MWL+.6m), the central area at the optimal, and the westerly area when the tide was 1 meter higher than the optimal.

All water depth and tidal height calculations were based on Becher Bay, Point No Point and Port Renfrew tidal stations. Actual Bamfield tidal measurements provided by the Federal Department of Fisheries and Oceans were converted to Port Renfrew values. Predicted values were used for Becher Bay and Point No Point. The geographic locations of change from MWL-1 to MWL, and from MWL to MWL+1 were calculated using photography times for each section of coastline and interpolating between tidal stations. The tidal heights, at the time of photography and at the time of depth measurements during biomass sampling, are required to determine the density conversion factors used to calculate the total number of plants in the survey area.

The main departure from the KIM-1 method centers on the absence of vertical biomass distribution data for Nereocystis. Prior to the 1981 work at Porcher Island (Coon, 1981), this data was used to produce estimates of biomass at various harvesting depths relative to MWL. In order to minimize costly field work, the time consuming weighing of each 1 meter increment of Nereocystis plants was discontinued.

Wet weight and total length were determined for each plant sampled at 8 stations in the survey area (Figure 1). The mean biomass per plant statistic used in subsequent calculations is derived from the wet weight measurements. Length measurements merged relative to MWL were used to produce a table of cumulative percents of plants in 1 meter increments above and below MWL. These cumulative percentages were used to convert the density observed from the photography to total or bottom density by the following equation:

$$\text{Total Density}_{\text{(at bottom)}} = (\text{Conversion factor}) \times (\text{Density from photography}),$$

where the conversion factor $= \dfrac{100}{\text{mean percent of plants in samples extending to surface at tidal ht. at photo. time.}}$

Plant density was derived using the KIM-1 point-intercept method (Foreman, 1975). An updated point-intercept to density regression as developed by Foreman and Cabot (1979) was employed in this inventory.

RESULTS

Charts A through F (Appendix) illustrate the disposition of kelp bed resources by bed type along the Canadian shore of Juan de Fuca Strait. Coverage extends from Race Passage to Clo-oose. It will be noted from the charts and Figure 1 that portions of the coastlines of Becher Bay and Port San Juan are not represented. This is due to incomplete photographic coverage. Sufficient space and block numbers have been reserved for these areas should the need arise for their inclusion in a later inventory.

Table 1 presents the field-determined mean biomass per plant (wet weight) estimate obtained from means of eight sampling stations in the inventory area September 12, 13 and 14, 1988. A total of 110 plants were sampled.

A summary of cumulative numbers of Nereocystis plants collected in the above sampling is expressed as percent of sample totals in Table 2. This table shows the vertical distribution of kelp numbers in 1 meter increments above and below mean water level (MWL), and was used to calculate the density correction factors.

A summary of the tide level at the time of photography and the conversion factor used to change the observed density to total (or bottom) density for each block is presented in Table 3.

Tables 4 to 9 present estimates of kelp bed areas, density and total Nereocystis biomass for each block in Charts A through F (Figure 1, and Appendix). Macrocystis density measurements and biomass samples were not taken for this area due to the small quantity present, but bed area has been reported. Macrocystis accounted for only 9.5 hectares, or slightly less than 2%, of the total kelp bed area of 510.6 hectares.

1: Nereocystis mean biomass per plant estimate from September 12, 13 and 14, 1988 field samples - used to calculate biomass estimates for the 1988 Juan de Fuca Strait inventory area.

Nereocystis mean biomass/plant = 4.9 kg. 8 stations SD = 1.8

Table 2: Cumulative percent of plants present at one meter increments relative to mean water (MWL) for samples of Nereocystis from the inventory area September 12, 13 and 14, 1988.

Station:	1	2	3	4	5	6	7	8	Mean Percent Plants in increment
Meter									
+6	8								1
+5	8								1
+4	46								6
+3	77								10
+2	85	7				7			12
+1	92	36			5	7	45	33	27
MWL	92	93	54	56	38	50	73	80	67
-1	92	100	100	89	57	71	91	87	86
-2	92	100	100	100	81	93	100	93	95
-3	100	100	100	100	86	100	100	100	98
-4	100	100	100	100	86	100	100	100	98
-5	100	100	100	100	90	100	100	100	99
-6	100	100	100	100	90	100	100	100	99
-7	100	100	100	100	90	100	100	100	99
-8	100	100	100	100	100	100	100	100	100
-9	100	100	100	100	100	100	100	100	100
-10	100	100	100	100	100	100	100	100	100

Table 3: The tidal level at the time of photography and the Nereocystis conversion factors used to convert density values observed on the photography to total density as used in biomass calculations.

Block Nos.	Tidal Level(m)	Conversion Factor
1-7, 9-20	-1	1.16
21-65	MWL	1.49
66-75, 89-118	+1	3.70

Mixed beds were not found in this region. Tables 10, 11 and 12 summarize the bed area and biomass estimates by bed type, by percent Nereocystis biomass and by percent composition of bed area for each bed bed type in each Chart area, respectively.

A total of 50,148 tonnes of Nereocystis were estimated to lie along the 104 kilometers of shoreline inventoried. The major concentrations were found to be at Muir Point (Blocks 17-19; 6,262 tonnes), Orveas Bay (Blocks 28,29; 2,707 tonnes), immediately west of Sambrio Point (Blocks 62-64; 6,827 tonnes) and near Bonilla Point (Blocks 102-106; 11,807 tonnes).

It should be noted that large biomass figures reported for Blocks 66 to 75 and 89 to 118 are largely the result of the application of the conversion factor from Table 3. This is evident in the density increase between the "Photo $\bar{x}D$" and the "Bottom $\bar{x}D$" figures reported in Tables 8 and 9. A high proportion of Nereocystis plants in the biomass samples were found to extend only to MWL or lower (see Table 2), a situation more typical of early to mid summer. Only 27% of the plants sampled extended to the MWL+1 tide level. This has resulted in the large conversion factor of 3.70 for the +1 level (Table 3). According to this method, Charts E and F contain 43% of the biomass but only 30% of the area for Nereocystis in this inventory.

Table Estimates of kelp bed area and biomass for the Canadian shore of Juan de Fuca Strait: Race Passage to Sooke Inlet, August, 1988. See Chart A (Appendix). D = Density (no. of plants/hectare) B = Biomass (metric tonnes) ha = hectare

CHART A	Nereocystis - Low Density					Nereocystis - High Density					Macrocystis		Total	Nereo. Total
Block	Photo. $\bar{x}$D	Bottom $\bar{x}$D	Area (ha)	$\bar{x}$B/ha	B	Photo. $\bar{x}$D	Bottom $\bar{x}$D	Area (ha)	$\bar{x}$B/ha	B	Low D Area (ha)	High D Area (ha)	Area (ha)	B
1	6,480	7,520	12.86	36.8	473.9	22,000	25,520	2.95	125.0	368.9			15.81	842.8
2	6,750	7,830	13.12	38.4	503.4	22,000	25,520	2.00	125.0	250.1			15.12	753.5
3	6,630	7,690	.98	37.7	36.9	22,000	25,520	.61	125.0	76.3			1.59	113.2
4	6,630	7,690	3.47	37.7	130.8	22,000	25,520	1.71	125.0	213.8			5.18	344.6
5	6,630	7,690	3.42	37.7	128.9	23,980	27,820	1.40	136.3	190.8			4.82	319.7
6	6,630	7,690	6.71	37.7	252.8	23,980	27,820	1.51	136.3	205.8			8.22	458.7
7	5,990	6,950	1.29	34.1	43.9	23,980	27,820	.74	136.3	100.9			2.03	144.8
9	5,990	6,950	8.47	34.1	288.4	32,040	37,170	.74	182.1	134.8			9.21	423.2
10	5,990	6,950	2.07	34.1	70.5	32,040	37,170	.10	182.1	18.2			2.17	88.7
11	5,990	6,950	3.46	34.1	117.8	32,040	37,170	.79	182.1	143.9			4.25	261.7
12	5,990	6,950	1.54	34.1	52.4	32,040	37,170	1.93	182.1	351.5			3.47	404.0
13	5,990	6,950	1.68	34.1	57.2	32,040	37,170	2.11	182.1	384.3			3.79	441.5
14	5,990	6,950	2.62	34.1	89.2	32,040	37,170	1.28	182.1	233.1			3.90	322.4
15	5,930	6,880	4.01	33.7	135.2	32,040	37,170	.41	182.1	74.7			4.42	209.9
16	5,930	6,880	3.87	33.7	130.5	32,040	37,170	.75	182.1	136.6			4.62	267.1
Chart A Totals:			69.57		2,511.9			19.03		2,883.8	0	0	88.60	5,395.6

Table 5. Estimates of kelp bed area and biomass for the Canadian Shore of Juan de Fuca Strait: Sooke Inlet to Sheringham Point, August, 1988. See Chart B (Appendix). D = Density (no. of plants/hectare) B = Biomass (metric tonnes) ha = hectare

CHART B	Nereocystis - Low Density					Nereocystis - High Density					Macrocystis		Total	Nereo. Total
Block	Photo. $\bar{x}$D	Bottom $\bar{x}$D	Area (ha)	$\bar{x}$B/ha	B	Photo. $\bar{x}$D	Bottom $\bar{x}$D	Area (ha)	$\bar{x}$B/ha	B	Low D Area (ha)	High D Area (ha)	Area (ha)	B
17	5,940	6,890	23.88	33.8	806.3	22,540	26,150	7.06	128.1	904.6		2.29	33.23	1,710.9
18	6,950	8,060	32.47	39.5	1,282.4	20,390	23,650	13.10	115.9	1,518.1		2.63	48.20	2,800.5
19	6,700	7,770	25.90	38.1	986.1	20,830	24,160	6.46	118.4	764.8		.05	32.41	1,750.9
20	6,700	7,770	.75	38.1	28.6								.75	28.6
21	6,700	9,983	1.92	48.9	93.9	20,830	31,040	.29	152.1	44.1			2.21	138.0
22	7,130	10,620	.64	52.0	33.3	20,830	31,040	.54	152.1	82.1			1.18	115.4
23	7,130	10,620	.31	52.0	16.1	20,060	29,890	.07	146.5	10.3			.38	26.4
24														
25	7,800	11,620	.34	56.9	19.4	20,060	29,890	.44	146.5	64.4			.78	83.8
26	7,800	11,620	1.51	56.9	86.0	20,060	29,890	.57	146.5	83.5			2.08	169.5
27	7,800	11,620	5.21	56.9	296.6	20,060	29,890	.79	146.5	115.7			6.00	412.4
28	7,450	11,100	16.87	54.4	917.6	18,950	28,240	10.90	138.4	1,508.3			27.77	2,425.9
29	7,800	11,620	2.62	56.9	149.2	20,490	30,530	.88	149.6	131.6		.04	3.54	280.8
30														
31	7,800	11,620	.64	56.9	36.4	20,490	30,530	.17	149.6	25.4			.81	61.9
32														
Chart B Totals:			113.06		4,751.8			41.27		5,253.0	0	5.01	159.34	10,004.8

Table 6. Estimates of kelp bed area and biomass for the Canadian shore of Juan de Fuca Strait: Sheringham Point to approx. Magdalena Point, August, 1988. See Chart C (Appendix). D = Density (no. of plants/hectare) B = Biomass (metric tonnes) ha = hectare

CHART C	Nereocystis - Low Density					Nereocystis - High Density					Macrocystis		Total	Nereo. Total
Block	Photo. $\bar{x}$D	Bottom $\bar{x}$D	Area (ha)	$\bar{x}$B/ha	B	Photo. $\bar{x}$D	Bottom $\bar{x}$D	Area (ha)	$\bar{x}$B/ha	B	Low D Area (ha)	High D Area (ha)	Area (ha)	B
33	6,100	9,090	1.17	44.5	52.1	20,490	30,530	.06	149.6	9.0			1.23	61.1
34	6,100	9,090	4.14	44.5	184.4	20,490	30,530	2.45	149.6	366.5			6.59	550.9
35														
36	6,100	9,090	.18	44.5	8.0								.18	8.0
37	6,100	9,090	.21	44.5	9.4	20,490	30,530	.02	149.6	3.0			.23	12.3
38	6,100	9,090	.47	44.5	20.9								.47	20.9
39	6,100	9,090	1.21	44.5	53.9								1.21	53.9
40	6,100	9,090	4.71	44.5	209.8								4.71	209.8
41	6,100	9,090	2.65	44.5	118.0	20,490	30,530	.14	149.6	20.9			2.79	139.0
42	6,100	9,090	3.86	44.5	171.9	20,490	30,530	.13	149.6	19.4	.28	.11	4.38	191.4
43	6,100	9,090	4.01	44.5	178.6	20,490	30,530	.07	149.6	10.5	.32	.78	5.18	189.1
44	5,870	8,750	7.81	42.9	334.9	20,490	30,530	.78	149.6	116.7	.02	.35	8.96	451.5
45	5,540	8,260	2.39	40.5	96.7							.09	2.48	96.7
46														
47	5,540	8,260	1.16	40.5	46.9	20,490	30,530	.17	149.6	25.4			1.33	72.4
48	5,540	8,260	.67	40.5	27.1								.67	27.1
49	5,540	8,260	.19	40.5	7.7						.18		.37	7.7
50	5,540	8,260	.37	40.5	15.0	20,490	30,530	.04	149.6	6.0	.23		.64	21.0
51	5,540	8,260	2.31	40.5	93.5	27,760	41,360	.07	202.7	14.2	.55	.75	3.68	107.7
52	5,540	8,260	1.18	40.5	47.8	27,760	41,360	.05	202.7	10.1	.3	.48	2.01	57.9
Chart C Totals:			38.69		1,676.6			3.98		601.8	1.88	2.56	47.11	2,278.4

able 7. stimates of kelp bed area and biomass for the Canadian shore of Juan de Fuca Strait: Magdalena Point to rovidence Cove, August, 1988. See Chart D (Appendix). D = Density (no. of plants/hectare)
. = Biomass (metric tonnes) ha = hectare

CHART D Block	Nereocystis - Low Density					Nereocystis - High Density					Macrocystis		Total	Nereo. Total
	Photo. $\bar{x}$D	Bottom $\bar{x}$D	Area (ha)	$\bar{x}$B/ha	B	Photo. $\bar{x}$D	Bottom $\bar{x}$D	Area (ha)	$\bar{x}$B/ha	B	Low D Area (ha)	High D Area (ha)	Area (ha)	B
53	5,540	8,260	.40	40.5	16.2								.40	16.2
54	6,790	10,120	.32	49.6	15.9								.32	15.9
55	6,790	10,120	1.26	49.6	62.5	27,760	41,360	.10	202.7	20.3			1.36	82.7
56	6,790	10,120	.10	49.6	5.0	27,760	41,360	.04	202.7	8.1			.14	13.1
57														
58														
59	6,790	10,120	.75	49.6	37.2	27,760	41,360	.11	202.7	22.3			.86	59.5
60	6,790	10,120	2.03	49.6	100.7	27,760	41,360	.35	202.7	70.9			2.38	171.6
61	6,790	10,120	.51	49.6	25.3	27,760	41,360	.32	202.7	64.9			.83	90.1
62	6,790	10,120	9.92	49.6	491.9	27,760	41,360	12.04	202.7	2,440.1			21.96	2,932.0
63	6,790	10,120	8.40	49.6	416.5	29,260	43,600	10.30	213.6	2,200.5			18.7	2,617.0
64	6,790	10,120	2.10	49.6	104.1	30,390	45,280	5.29	221.9	1,173.7			7.39	1,277.8
65	6,790	10,120	1.85	49.6	91.7	34,990	52,140	.59	255.5	150.7			2.44	242.5
66	6,790	25,120	1.12	123.1	137.9	34,990	129,460	.14	634.4	88.8			1.26	226.7
67	6,790	25,120	.97	123.1	119.4	34,990	129,460	.34	634.4	215.7			1.31	335.1
68	6,790	25,120	.97	123.1	119.4	34,990	129,460	1.82	634.4	1,154.5			2.79	1,273.9
69	6,790	25,120	1.15	123.1	141.6	34,990	129,460	1.89	634.4	1,198.9			3.04	1,340.5
70	6,790	25,120	1.89	123.1	232.6	34,990	129,460	.28	634.4	177.6			2.17	410.3
Chart D Totals:			33.74		2,117.8			33.61		8,987.0	0	0	67.35	11,104.8

Table 8. Estimates of kelp bed area and biomass for the Canadian shore of Juan de Fuca Strait: Providence Cove to Walbran Creek, August, 1988. See Chart E (Appendix). D = Density (no. of plants/hectare)
B = Biomass (metric tonnes) ha = hectare

CHART E Block	Nereocystis - Low Density					Nereocystis - High Density					Macrocystis		Total	Nereo. Total
	Photo. $\bar{x}$D	Bottom $\bar{x}$D	Area (ha)	$\bar{x}$B/ha	B	Photo. $\bar{x}$D	Bottom $\bar{x}$D	Area (ha)	$\bar{x}$B/ha	B	Low D Area (ha)	High D Area (ha)	Area (ha)	B
71	6,790	25,120	1.21	123.1	148.9	28,100	103,970	1.15	509.5	585.9			2.36	734.8
72	6,790	25,120	2.44	123.1	300.3	28,100	103,970	2.95	509.5	1,502.9			5.39	1,803.2
73	6,790	25,120	4.76	123.1	585.9	28,100	103,970	2.17	509.5	1,105.5			6.93	1,691.4
74	6,790	25,120	1.08	123.1	132.9	28,100	103,970	.53	509.5	270.0			1.61	402.9
75	6,790	25,120	1.22	123.1	150.2	28,100	103,970	.18	509.5	91.7			1.40	241.9
89	6,790	25,120	1.42	123.1	174.8	28,100	103,970	.16	509.5	81.5			1.58	256.3
90	6,790	25,120	1.43	123.1	176.0	21,860	80,880	.11	396.3	43.6			1.54	219.6
91	5,440	20,130	1.77	98.6	174.6	21,860	80,880	.07	396.3	27.7			1.84	202.3
92	5,440	20,130	.95	98.6	93.7	21,860	80,880	.40	396.3	158.5			1.35	252.2
93	5,440	20,130	.66	98.6	65.1								.66	65.1
94	5,440	20,130	3.72	98.6	366.9	21,860	80,880	.51	396.3	202.1			4.23	569.0
95	5,440	20,130	3.24	98.6	319.6								3.24	319.6
96	5,440	20,130	2.92	98.6	288.0	21,860	80,880	.16	396.3	63.4			3.08	351.4
97	5,440	20,130	.29	98.6	28.6								.29	28.6
98														
99														
100														
101	5,440	20,130	.77	98.6	76.0								.77	76.0
102	5,660	20,940	8.45	102.6	867.0	21,860	80,880	.32	396.3	126.8			8.77	993.8
Chart E Totals:			36.33		3,948.6			8.71		4,259.7	0	0	45.04	8,208.3

Table 9. Estimates of kelp bed area and biomass for the Canadian shore of Juan de Fuca Strait: Walbran Creek to Clo-oose, August, 1988. See Chart F (Appendix). D = Density (no. of plants/hectare)
B = Biomass (metric tonnes) ha = hectare

CHART F	Nereocystis - Low density					Nereocystis - High density					Macrocystis low d	Macrocystis high d	Total	Nereo. Total
Block	Photo. $\bar{x}D$	Bottom $\bar{x}D$	Area (ha)	$\bar{x}B/ha$	B	Photo. $\bar{x}D$	Bottom $\bar{x}D$	Area (ha)	$\bar{x}B/ha$	B	Area (ha)	Area (ha)	Area (ha)	B
103	5,660	20,940	8.28	102.6	849.6	21,860	80,880	1.56	396.3	618.2			9.84	1,467.8
104	5,760	21,310	27.57	104.4	2,878.8	21,860	80,880	2.17	396.3	860.0			29.74	3,738.8
105	6,630	24,530	22.63	120.2	2,720.1	21,860	80,880	2.02	396.3	800.6			24.65	3,520.6
106	6,520	24,120	12.79	118.2	1,511.6	21,860	80,880	1.45	396.3	574.7			14.24	2,086.3
107	6,520	24,120	.60	118.2	70.9								.60	70.9
108														
109	5,340	19,758	4.26	96.8	412.4						.09		4.35	412.4
110	5,340	19,758	3.68	96.8	356.3								3.68	356.3
111	5,340	19,758	1.37	96.8	132.6								1.37	132.6
112														
113	5,670	20,980	2.17	102.8	223.1								2.17	223.1
114	5,670	20,980	1.69	102.8	173.7								1.69	173.7
115	4,720	17,460	6.56	85.6	561.2								6.56	561.2
116	4,720	17,460	4.17	85.6	356.8								4.17	356.8
117						21,860	80,880	.14	396.3	55.5			.14	55.5
118														
Chart F Totals:			95.77		10,247.2			7.34		2,908.9	.09	0	103.20	13,156.1
Totals Charts A-F: (Tables 4-9)			387.16		25,253.8			113.94		24,894.2	1.97	7.57	510.64	50,148.0

Table 10: Summary of biomass and kelp bed area estimates by chart area (see Figure 1) and bed type for the Canadian shore of Juan de Fuca Strait.

Chart	Geographic area	Biomass (metric tonnes)	Area (hectares)
	Low Density *Nereocystis*		
A	Race Passage to Sooke In.	2,512	69.6
B	Sooke In. to Sheringham Pt.	4,752	113.1
C	Sheringham Pt. to Magdalena Pt.	1,676	38.7
D	Magdalena Pt. to Providence C.	2,118	33.7
E	Providence C. to Walbran Cr.	3,948	36.3
F	Walbran Cr. to Clo-oose	10,247	95.8
	High Density *Nereocystis*		
A	Race Passage to Sooke In.	2,884	19.0
B	Sooke In. to Sheringham Pt.	5,253	41.3
C	Sheringham Pt. to Magdalena Pt.	602	4.0
D	Magdalena Pt. to Providence C.	8,987	33.6
E	Providence C. to Walbran Cr.	4,260	8.7
F	Walbran Cr. to Clo-oose	2,909	7.3
	Low and High Density *Macrocystis*		
A	Race Passage to Sooke In.	N/A	.0
B	Sooke In. to Sheringham Pt.	N/A	5.0
C	Sheringham Pt. to Magdalena Pt.	N/A	4.4
D	Magdalena Pt. to Providence C.	N/A	.0
E	Providence C. to Walbran Cr.	N/A	.0
F	Walbran Cr. to Clo-oose	N/A	.1
	Totals by species		
	Nereocystis	50,148	501.1
	Macrocystis	N/A	9.5

Table 11: Percent composition of low and high density Nereocystis biomass in each chart. The last column gives percent composition of the total Nereocystis biomass for the Juan de Fuca Strait inventory area.

Chart:	A	B	C	D	E	F	Combined
Nereocystis							
-low density	46.6	47.5	73.6	19.1	48.1	77.9	50.4
-high density	53.4	52.5	26.4	80.9	51.9	22.1	49.6

Table 12: Percent composition of low and high density Nereocystis and Macrocystis bed estimates of surface area in each Chart. The last column gives percent composition of total bed area for the Juan de Fuca Strait inventory area.

Chart:	A	B	C	D	E	F	Combined
Nereocystis							
-low density	78.5	71.0	82.2	50.1	80.7	92.8	75.8
-high density	21.5	25.9	8.5	49.9	19.3	7.1	22.3
Macrocystis							
-low density	nil	nil	4.0	nil	nil	.1	.4
-high density	nil	3.1	5.4	nil	nil	nil	1.5

DISCUSSION

The largest kelp beds were located at Muir Point, Orveas Bay, Sombrio Point and Bonilla Point. Within the inventory area, 55% of the kelp bed area and 55% of the estimated Nereocystis biomass lie in these beds. The primary canopy forming kelp was Nereocystis, but small areas of Macrocystis were located at Muir Point and in the vicinity of San Simon Point.

Narrow fringe beds follow the majority of the shoreline from Race Passage to Sooke Inlet. With the exception of the large Muir Point and Orveas Bay beds, only occasional small beds are found between Sooke Inlet and Sombrio Point. Westward from the large Sombrio Point bed, a narrow fringe again follows the shore as far as Cullite Creek. From Cullite Creek to the end of the inventory area near Clo-oose, occasional beds, of which the Bonilla Point bed is the largest, extend out from shore.

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APPENDIX

Charts A through F are enclosed in the following envelope.