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Fish and Fish Habitat Impact Study of Seven British Columbia Coastal Marinas, 1984

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ABSTRACT

Seven coastal marinas in the Strait of Georgia were studied to determine the impact of marinas on fish and fish habitat. During the fall of 1984, the following parameters were measured at each marina: water quality (O_2 level), trace metal and PCB concentrations, fecal coliform concentrations, benthos and meiobenthos distribution, zooplankton distribution, vegetation percent coverage, large marine invertebrate populations, fish populations and fish gut contents. Results were analyzed to determine whether the marinas studied enhanced or were detrimental to fish production and whether accompanying facilities such as full floats detracted from the marinas' capability to provide food and shelter for fish.

RÉSUMÉ

On a mené une étude de sept ports de plaisance du détroit de Géorgie afin de déterminer leur incidence sur le poisson et son habitat. À l'automne 1984, on a quantifié les paramètres suivants dans chaque port: qualité de l'eau (taux d'O_2), concentrations d'oligo-métaux, de BCP et de coliformes fécaux, répartition de la macrofaune benthique et du zooplancton, couvert (%) végétal, grandes populations d'invertébrés marins, populations de poissons et contenus stomacaux. L'analyse des résultats visait à déterminer si les ports étudiés étaient bénéfiques ou nuisibles à la production piscicole et si les installations auxiliaires, comme les réservoirs à carburant flottants, diminuaient la capacité des ports pour ce qui est de la fourniture de nourriture et d'un abri pour les poissons.

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This study was the combined effort of the Federal Fisheries (Habitat Management Division) staff and the participants of the FRED project #BC/PFF/PAC/028. I would like to thank all those involved with this project.

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Perry Holmes (Project Manager)

FISH AND FISH HABITAT IMPACT STUDY OF SEVEN BRITISH COLUMBIA COASTAL MARINAS

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Introduction

During the 1960's and 1970's there was a large increase in the development of small craft harbours in the Strait of Georgia. The population in the greater Vancouver Regional District grew by 20% from 1966 to 1976; boat ownership increased about 60% in the shorter period 1966 to 1974 (Alley and Ferguson 1976). During the 1980's marina construction continues leading to further harbour development in sheltered bays and inlets. The purpose of this study is to describe the fish habitat provided by marinas, thereby, assisting the Department of Fisheries and Oceans in management of sensitive foreshore areas.

To date, very little biophysical habitat information concerning marinas has been collected. Fisheries and Marine Service conducted a marina impact study in 1976/77 (An Environmental Overview of Six British Columbia Coastal Marinas). In order to augment the existing biophysical information this study was undertaken in the fall of 1984, to assess benthos productivity, fish presence and utilization of marinas (Table 1, 1a). Also, water quality, sediment chemistry, aquatic vegetation distribution and macroinvertebrate distribution were assessed.

Six operational marinas were selected for this study: French Creek Marina, Nanaimo Marina, Comox Marina, Canoe Cove Marina, Beach Gardens Marina and Freshwater Marina (for location of marinas see figure 1). The selection of the operational marinas was based on the presence or absence of a variety of environmental impact parameters: storm sewer outlets, fueling stations, liveaboards, and commercial boat repair facilities. The age, previous documentation of the site, recency of dredging and design of the marina were also considerations in the selection. Saanichton Bay was included in this study because a resident/tourist marina facility is proposed for the area. The control sites were selected to approximate the biophysical condition of each marina site prior to construction (Figures 2a - 2g).

TABLE 1a: SAMPLING DATES WITH LOCATION AND PARAMETERS MEASURED (AT CONTROL SITES)

SAMPLE	FRENCH CREEK CONTROL SITE	NANAIMO CONTROL SITE #1	NANAIMO CONTROL SITE #2	COMOX CONTROL SITE	CANOE COVE CONTROL SITE	BEACH GARDENS CONTROL SITE	FRESHWATER CONTROL SITE
Dissolved Oxygen Test	Nov. 12	Oct. 15	Oct. 16	Nov. 13	Sept. 26	Oct. 23	Nov. 6
Sediment Chemistry	Sept. 7	Oct. 16	Oct. 16	Sept. 18	Oct. 1	Oct. 26	Nov. 10
Fecal Coliform	Sept. 7	Oct. 16	Oct. 16	Sept. 18	Oct. 1	Oct. 26	Nov. 10
Control Site Benthos	Oct. 18	Oct. 17	Oct. 17	Sept. 11	Sept. 25	Oct. 23	Nov. 6
	Oct. 29	--	--	Nov. 13	Sept. 27	--	--
Outside Breakwater Fauna							
Sample	Nov. 12	--	--	Nov. 8	--	--	--
Zooplankton Tow	Nov. 20	Nov. 19	--	Nov. 21	--	--	--
Vegetation Survey							
Outside Breakwater	Nov. 12	--	--	Nov. 8	--	Oct. 25	--
Macroinvertebrate Survey							
Outside Breakwater	Nov. 12	--	--	Nov. 8	--	Oct. 25	--
Fish							
Fish Survey	Sept. 5	--	--	Nov. 29	--	Oct. 25	--
	Nov. 27	--	--	--	--	--	--
Stomach Sample	Aug. 30	--	--	Nov. 8	--	--	--
	Nov. 27	--	--	Nov. 29	--	--	

TABLE 1: SAMPLING DATES WITH LOCATION AND PARAMETERS MEASURED (INSIDE MARINA)

SAMPLE	SAANICHTON BAY PROPOSED MARINA	FRENCH CREEK MARINA	NANAIMO MARINA	COMOX MARINA	CANOE COVE MARINA	BEACH GARDENS MARINA	FRESHWATER MARINA
Dissolved Oxygen Test	Aug. 21	Aug. 28	Oct. 9	Sept. 12	Sept. 26	Oct. 23	Nov. 6
Sediment Chemistry	Aug. 21	Sept. 5	Oct. 9	Sept. 17	Sept. 24	Oct. 26	Nov. 10
Fecal Coliform	Aug. 21	Sept. 5	Oct. 9	Sept. 17	Sept. 24	Oct. 26	Nov. 10
Marina Basin Benthos	Aug. 21	Aug. 28	Oct. 9	Sept. 11	Sept. 25	Nov. 23	Nov. 6
	Sept. 20	Sept. 6	--	--	--	--	--
Piling Fauna Sample	--	Aug. 29	Oct. 11	Sept. 12	--	--	--
Wharf Fauna Sample	--	Aug. 29	Oct. 11	Sept. 12	--	--	--
Inside Breakwater	--	Sept. 14	Oct. 11	Sept. 12	--	--	--
Zooplankton Tow		Nov. 20	Nov. 19	Nov. 21			
Vegetation Survey							
Marina Basin	Aug. 22	Aug. 29	Oct. 10	Sept. 12	Oct. 3	Oct. 24	Nov. 7
Pilings	--	Aug. 29	Oct. 11	Sept. 12	Oct. 2	Oct. 24	Nov. 7
Inside Breakwater	--	Sept. 14	Oct. 11	Sept. 13	--	Oct. 25	--
Macroinvertebrate Survey							
Marina Basin	Aug. 23	Aug. 29	Oct. 10	Sept. 12	Oct. 3	Oct. 24	Nov. 7
Pilings	--	Aug. 29	Oct. 11	Sept. 12	Oct. 2	Oct. 24	Nov. 7
Wharfs	--	Aug. 29	Oct. 11	Sept. 12	Oct. 2	Oct. 24	Nov. 7
Inside Breakwater	--	Sept. 14	Oct. 11	Sept. 13	--	Oct. 25	--
Fish							
Fish Survey	Aug. 23	Aug. 29	Nov. 22	Sept. 12	Sept. 24-27	Oct. 24	Nov. 6-8
	--	Sept. 14	Nov. 23	Sept. 13	--	--	--
	--	Dec. 3	--	Dec. 6	--	--	--
Stomach Sample	--	Sept. 4	Nov. 22	Sept. 13	--	--	--
	--	Dec. 3	Nov. 23	Dec. 6	--	--	--
	--	Sept. 14	--	--	--	--	--

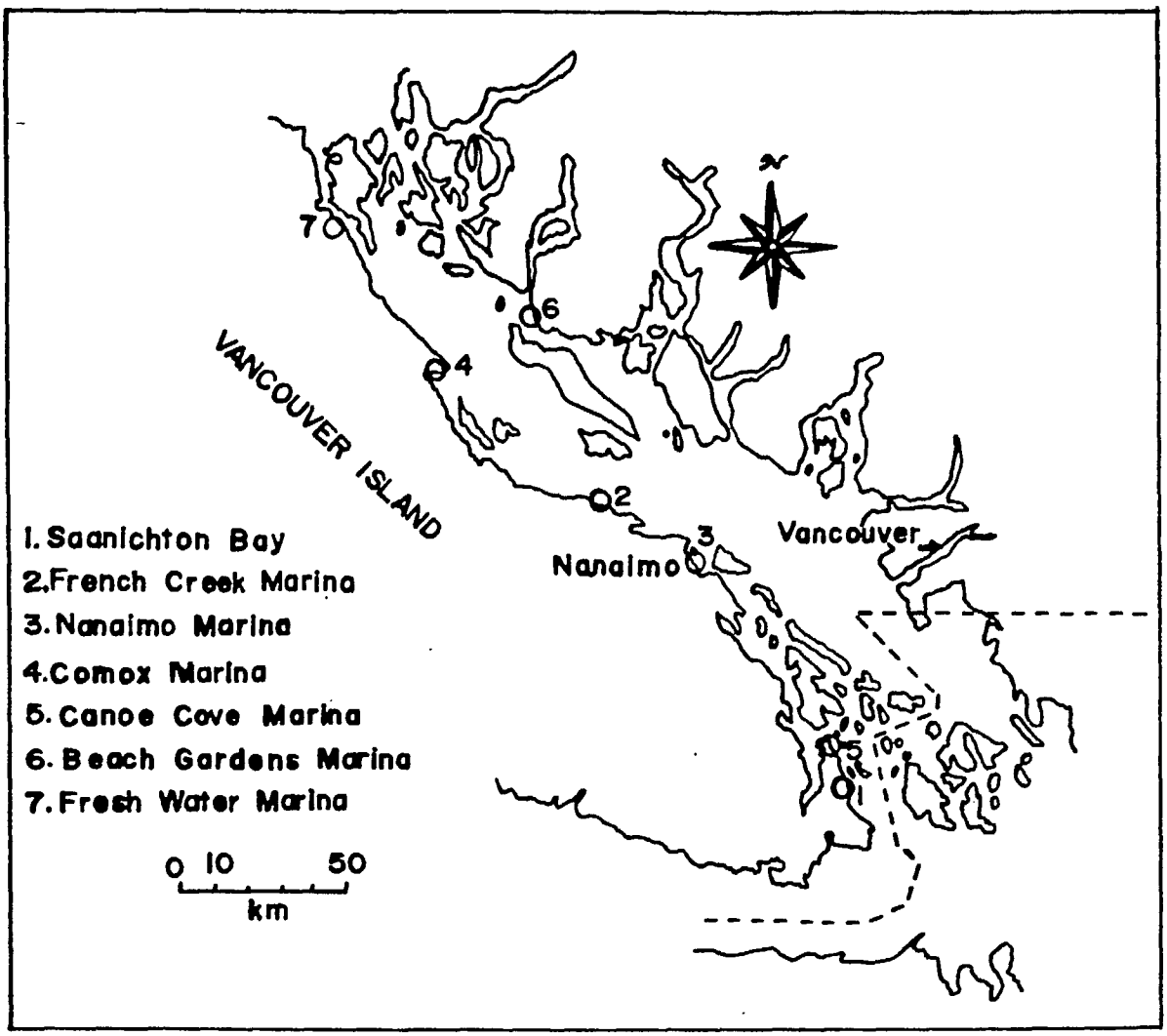

FIGURE 1. LOCATIONS OF THE SEVEN MARINAS STUDIED.

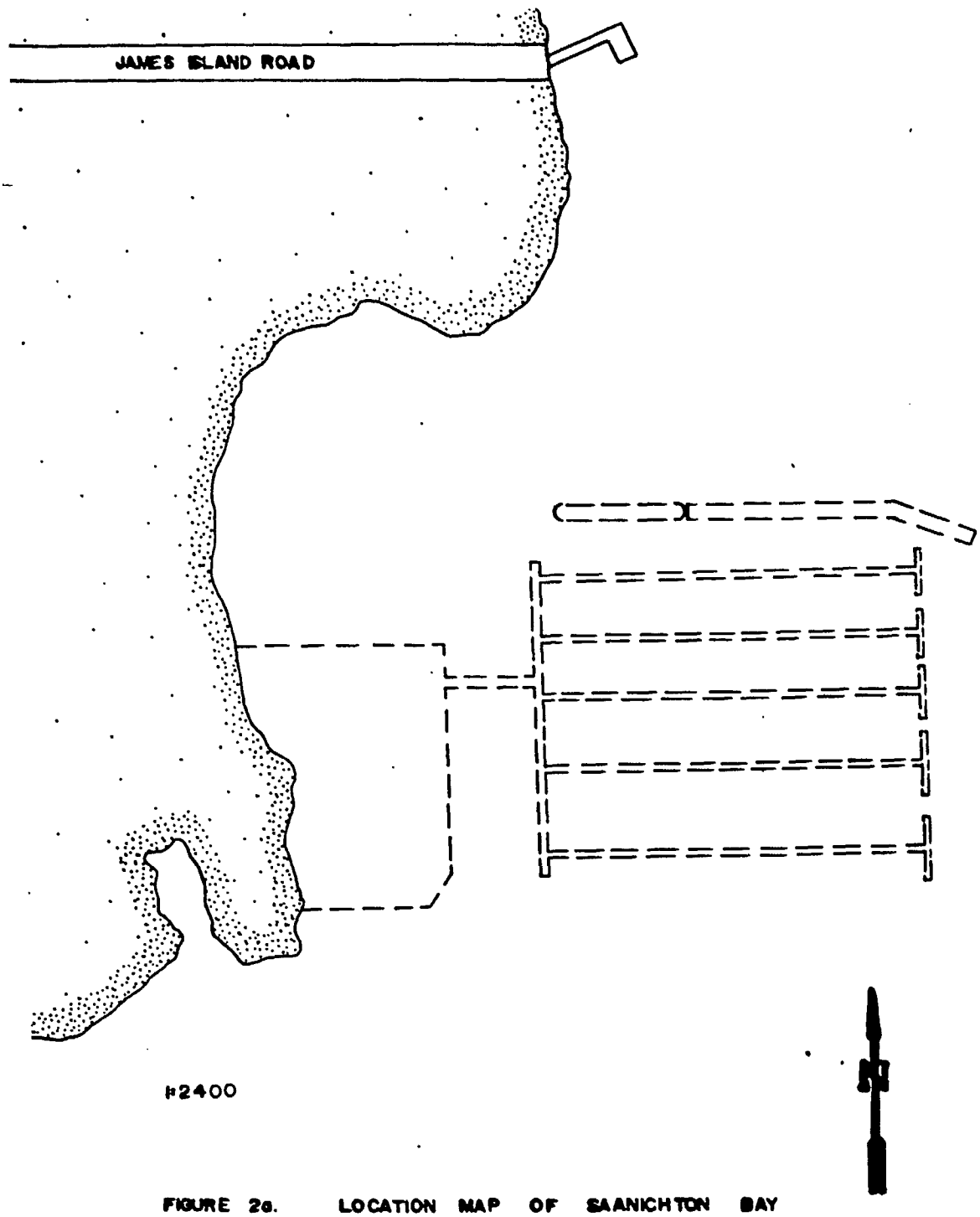

FIGURE 2a. LOCATION MAP OF SAANICHTON BAY PROPOSED MARINA.

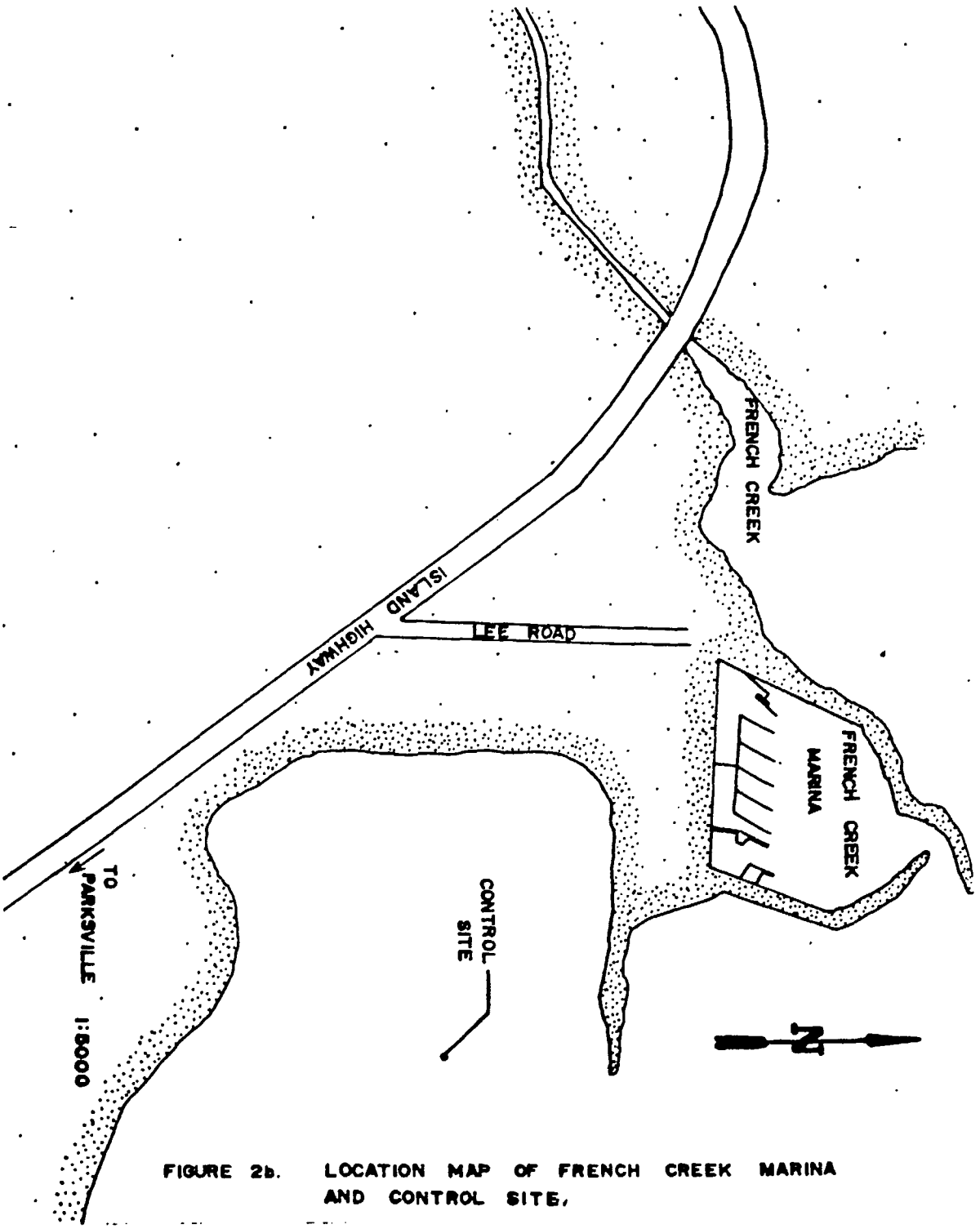

FIGURE 2b. LOCATION MAP OF FRENCH CREEK MARINA AND CONTROL SITE.

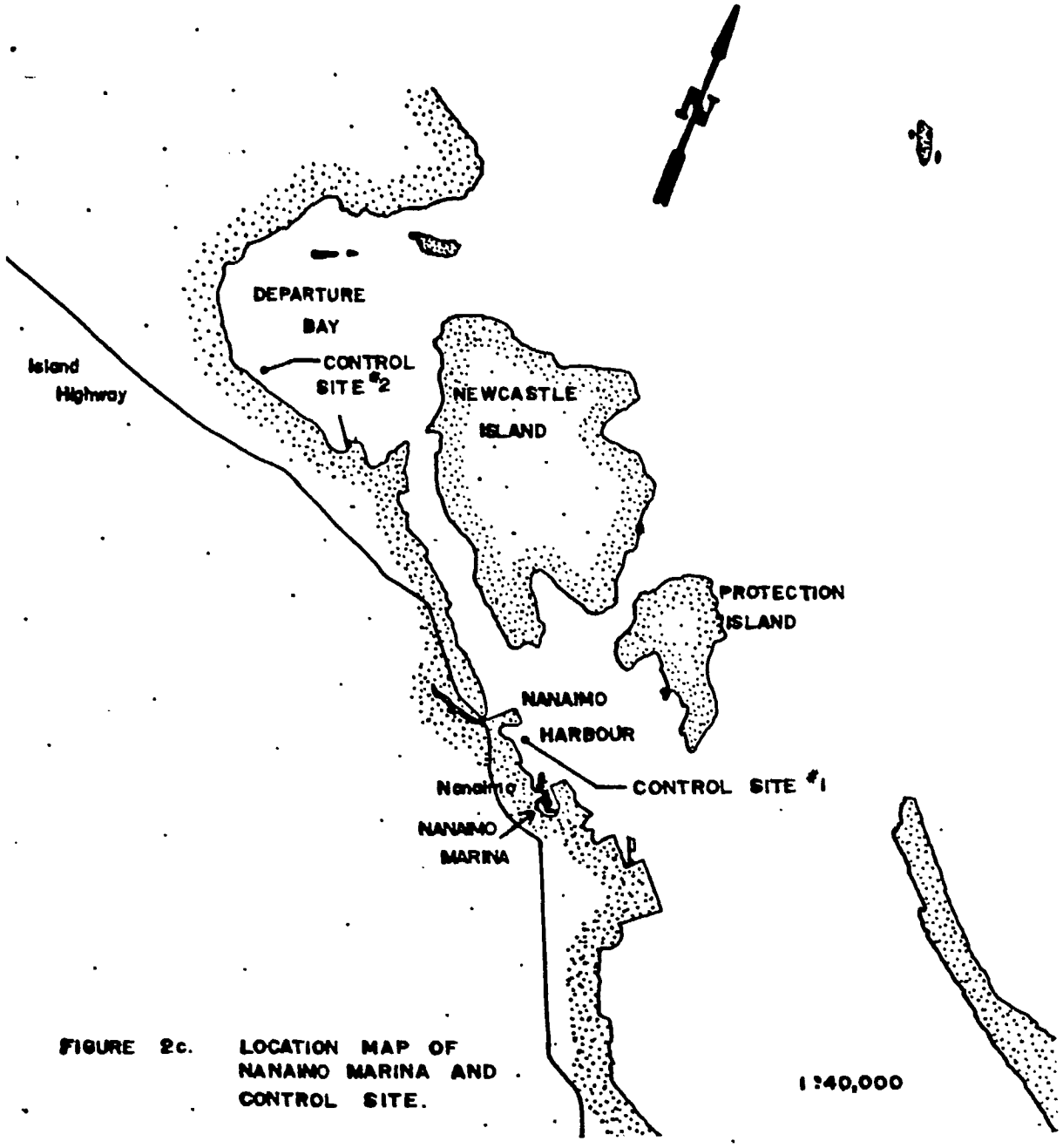

FIGURE 2c. LOCATION MAP OF NANAIMO MARINA AND CONTROL SITE.

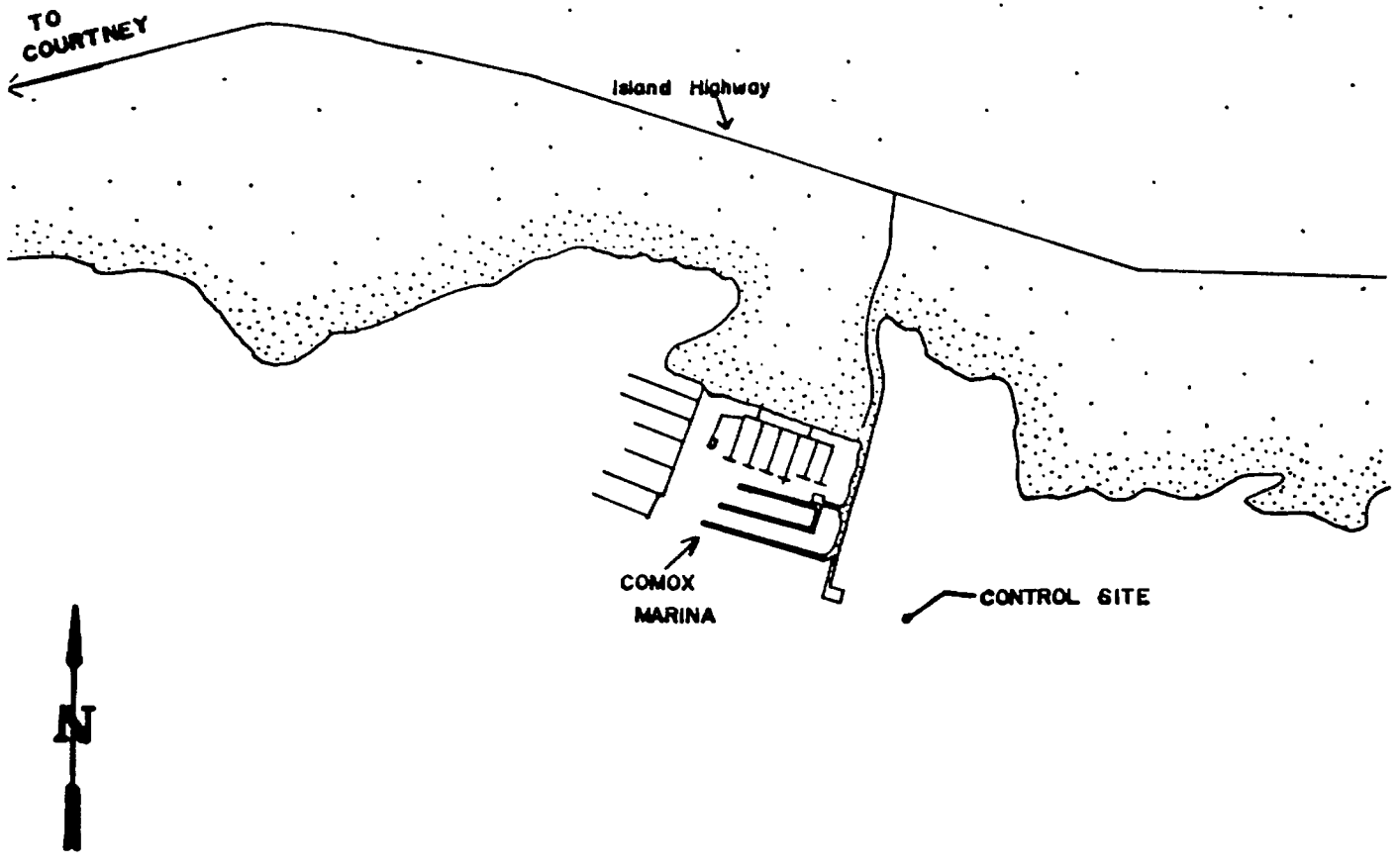

FIGURE 2d. LOCATION MAP OF COMOX MARINA AND CONTROL SITE.

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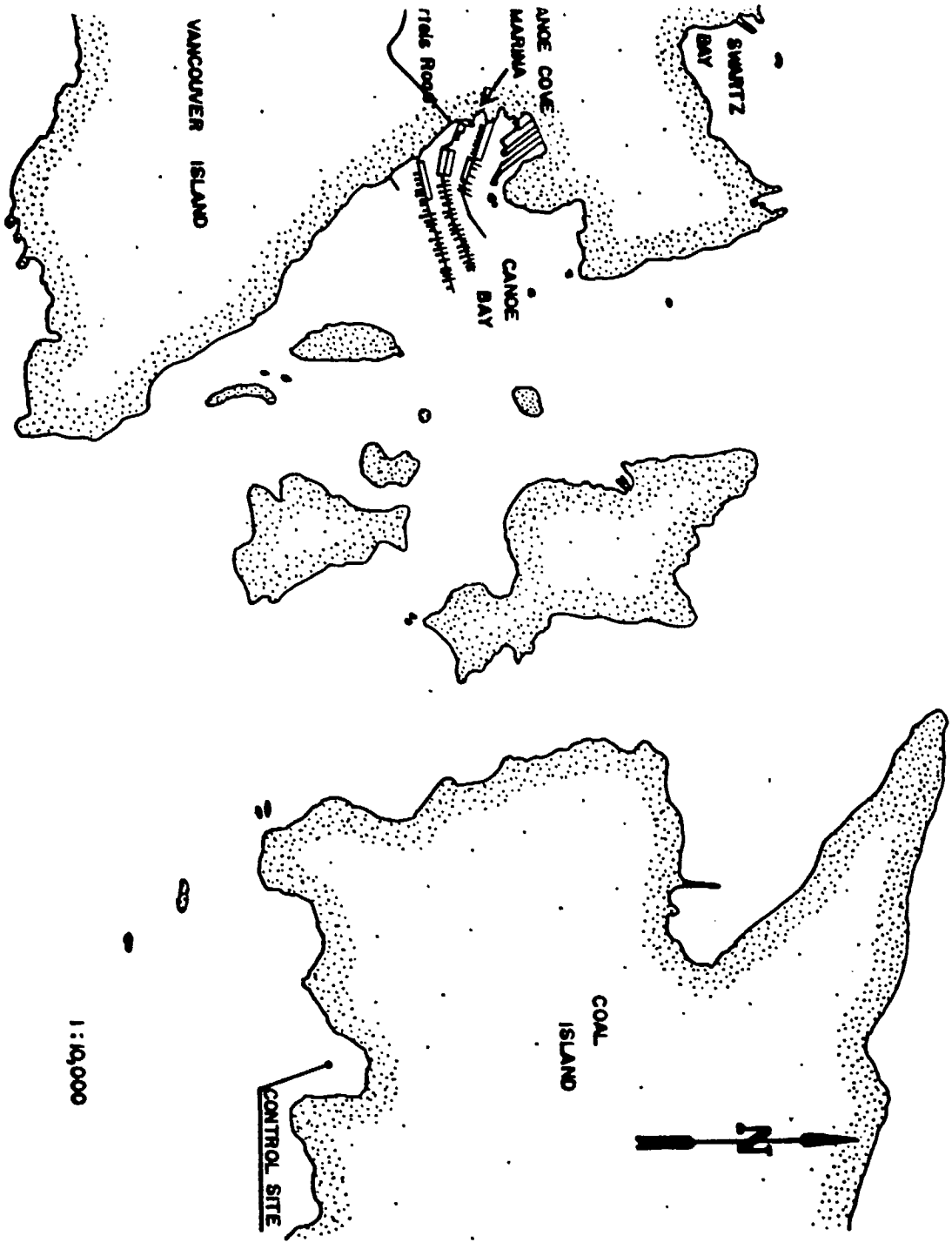


FIGURE 2e. LOCATION MAP OF CANOE COVE MARINA AND CONTROL SITE.

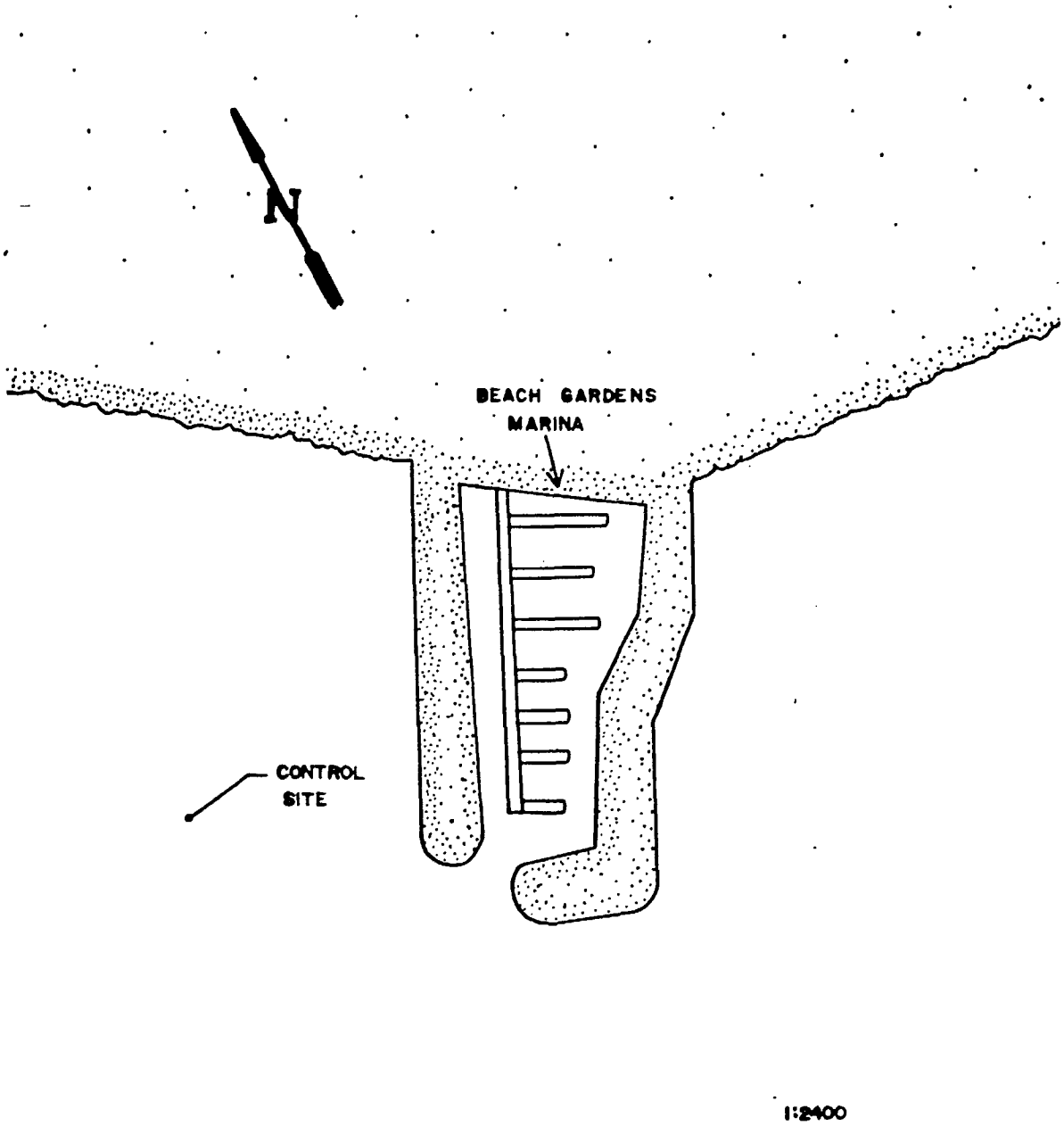


FIGURE 21. LOCATION MAP OF BEACH GARDENS MARINA AND CONTROL SITE.

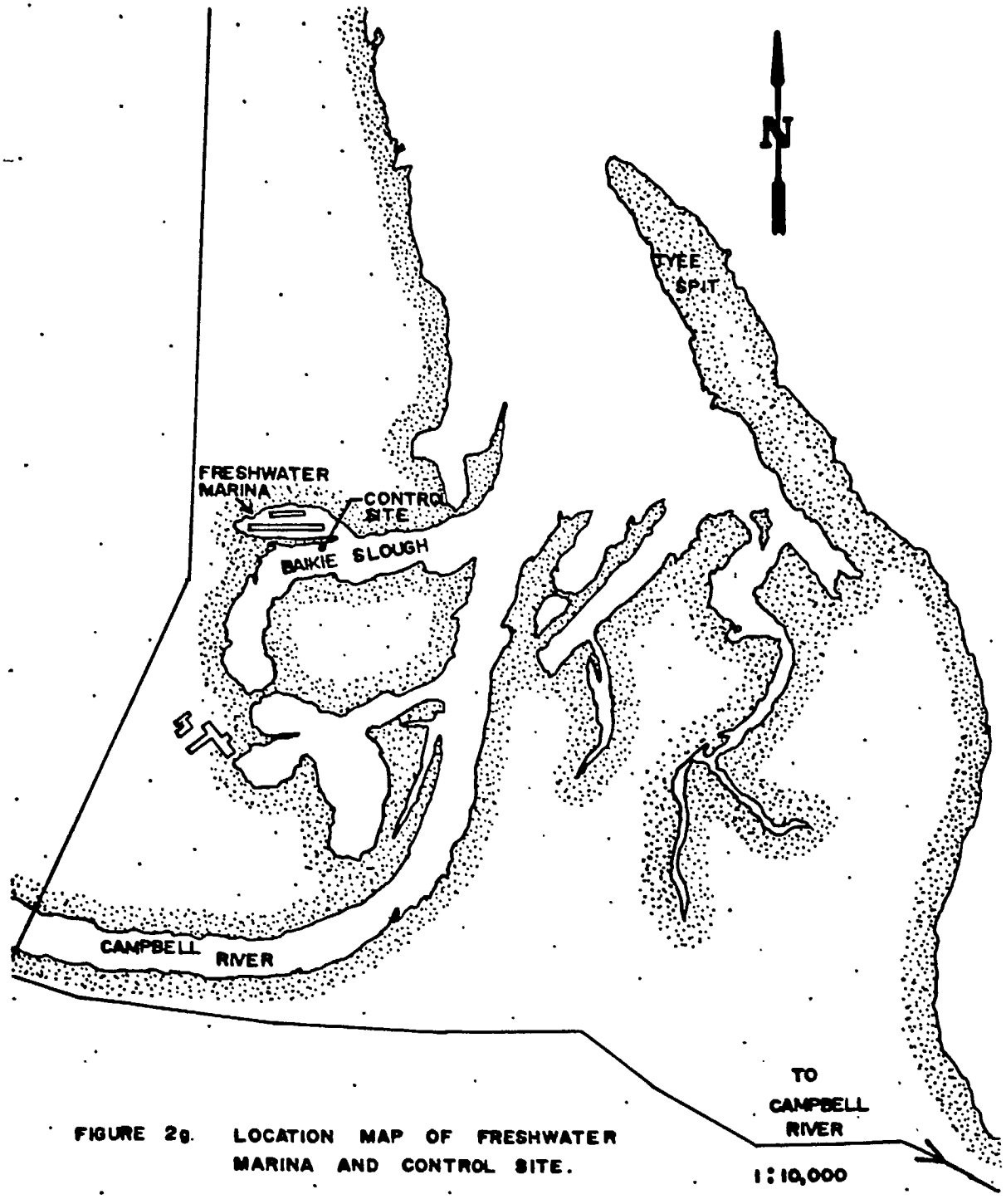


FIGURE 2g. LOCATION MAP OF FRESHWATER MARINA AND CONTROL SITE.

1. DESCRIPTION OF MARINAS STUDIED

Saanichton Bay - Proposed Marina

The proposed resident/tourist marina facility is located approximately 20 km north of Victoria on the east coast of the Saanich Peninsula. The 4.0 hectare marina basin would be located in an excellent fish habitat of sea grasses and large kelps that are thought to be extensively utilized by juvenile salmonids. An estimated 1.5 hectares of foreshore would be filled to provide parking for the facility.

French Creek Marina

French Creek Marina is located adjacent to the small French Creek estuary about 5 km north of Parksville. The harbour was constructed in 1949 and was last dredged during 1984, removing 115,000 m^3 of material. The wood and fiberglass floats provide moorage for 150 boats, but during peak season as many as 200 boats are rafted in the harbour. The majority of clientele are commercial fishermen, some of which liveaboard. Fisheries and Marine Service included this marina in their 1978 marina impact study (An Environmental Overview of Six British Columbia Coastal Marinas). The Lasqueti Island ferry terminal is located within the marina, and the fueling station sells approximately 400,000 liters of fuel annually. There is no pumpout facility at the marina. The marina is surrounded by an extensive breakwater.

Nanaimo Marina

Nanaimo Marina is a old facility located in the downtown core. The wood and fiberglass floats provide 220 berths: 75% are used by commercial fishermen and 25% are used by pleasure craft during nine months of the year. For the three month summer period, pleasure crafts account for 95% of the clientele. Liveaboards are allowed in the marina. The fueling station is supplied by four 18,000 liter underground storage tanks. There is no pumpout facility at the marina. A number of city storm drains empty directly into the marina basin.

Comox Marina

Comox Marina is a old facility located on the northeast side of Comox Harbour. The marina was last dredged in 1974. The marina provides 230 berths of which 90% are used by commercial fishermen and 10% are used by pleasure

craft. The adjacent Municipal Marina was constructed in 1974 and provides 400 berths that are strictly for pleasure craft. The Comox Marina has eight liveaboards presently, while the Municipal Marina does not allow any. The fueling station pumped 485,000 liters of fuel during 1983. There is no pumpout facility at either Comox Marina or the Municipal Marina. There is an extensive breakwater at the marina.

Canoe Cove Marina

Canoe Cove Marina is located on the north end of the Saanich Peninsula in Canoe Bay. The marina and shipyard were built in 1923. The marina basin has never been dredged. The shipyard provides full service, working on 500 boats a year. There are two boatways located in the intertidal zone. The marina provides 400 berths for a strictly pleasure craft resident clientele. Presently there are 20 liveaboards in the marina. The fueling station sold 506,000 liters of fuel from Feb/1983 to Jan/1984. There is no pumpout facility at the marina.

Beach Gardens Marina

Constructed in 1975, the marina is located approximately 10 km south of Powell River. There are extensive breakwaters surrounding the marina, and the fiberglass and wood floats provide 160 berths for a strictly pleasure craft clientele. About 35% of the berths are unassigned and available to transient boaters. The remaining 65% are assigned to residents. At present there is no fueling station or pumpout facility at the marina and liveaboards are not allowed. Fisheries and Marine Service included this marina in their 1978 marina impact study.

Freshwater Marina

Freshwater Marina is located in Baikies Slough on the lower Campbell River. The slough is an industrialized area providing log storage for a neighboring sawmill. The marina was constructed in 1968 and last dredged in 1976. The wood and fiberglass wharfs provide moorage for 224 boats: 70% are assigned to residents. The marina is tidally influenced. There are no fueling or pumpout facilities at the marina. Fisheries and Marine Service included this marina in their 1978 marina impact study.

2. METHODS

2.1 Dissolved Oxygen Sampling

Six dissolved oxygen samples were taken in each marina. The test sites were evenly distributed in each marina (Figures 3a - 3g) in an attempt to get an accurate mean value. In addition, six dissolved oxygen tests were conducted at each control site. The water samples were collected one meter above the substrate using a Nansen bottle. The samples were then analyzed on site by completing a simple titration with a portable Hach kit.

2.2 Sediment Chemistry Sampling

Twelve sediment chemistry samples were obtained (Figures 3a - 3g), six inside each marina and six at each control site. (Sample sites were distributed evenly in an attempt to obtain average sediment chemistry). A scuba diver scooped the upper 4 cm (approximately) of substrate into a three liter plastic jar. The sediment was then subsampled into labelled whirl-pak bags (Fisher Scientific Co.) and transferred to the D.F.O./E.P.S. lab in West Vancouver. The samples were analyzed for particle size, polychlorinated biphenyls, trace metals, mercury, oils, grease, hydrocarbons, T.V.R. and T.F.R..

2.3 Fecal Coliform Sampling

The sediments for bacteriological analysis were obtained at four locations inside each marina (Figures 3a - 3g) and at four locations at each control site. Exceptions occurred at French Creek (six sample locations in the marina and six at the control site) and at Saanichton Bay (six sample locations). A scuba diver scooped the upper 4 cm (approximately) of the substrate into a pre-treated sterile 350 ml glass jar. The samples were cooled with ice and shipped within twenty-four hours to the Environmental Protection Services Laboratory in North Vancouver. A fifty gram extraction from each sample was analyzed for fecal coliform bacteria.

2.4 Marina Basin Benthos Sampling

Six benthos samples were taken in each marina and at each control site (sample sites were evenly distributed in an attempt to represent the average benthos populations, Figures 3a - 3g). The benthos samples were obtained by a

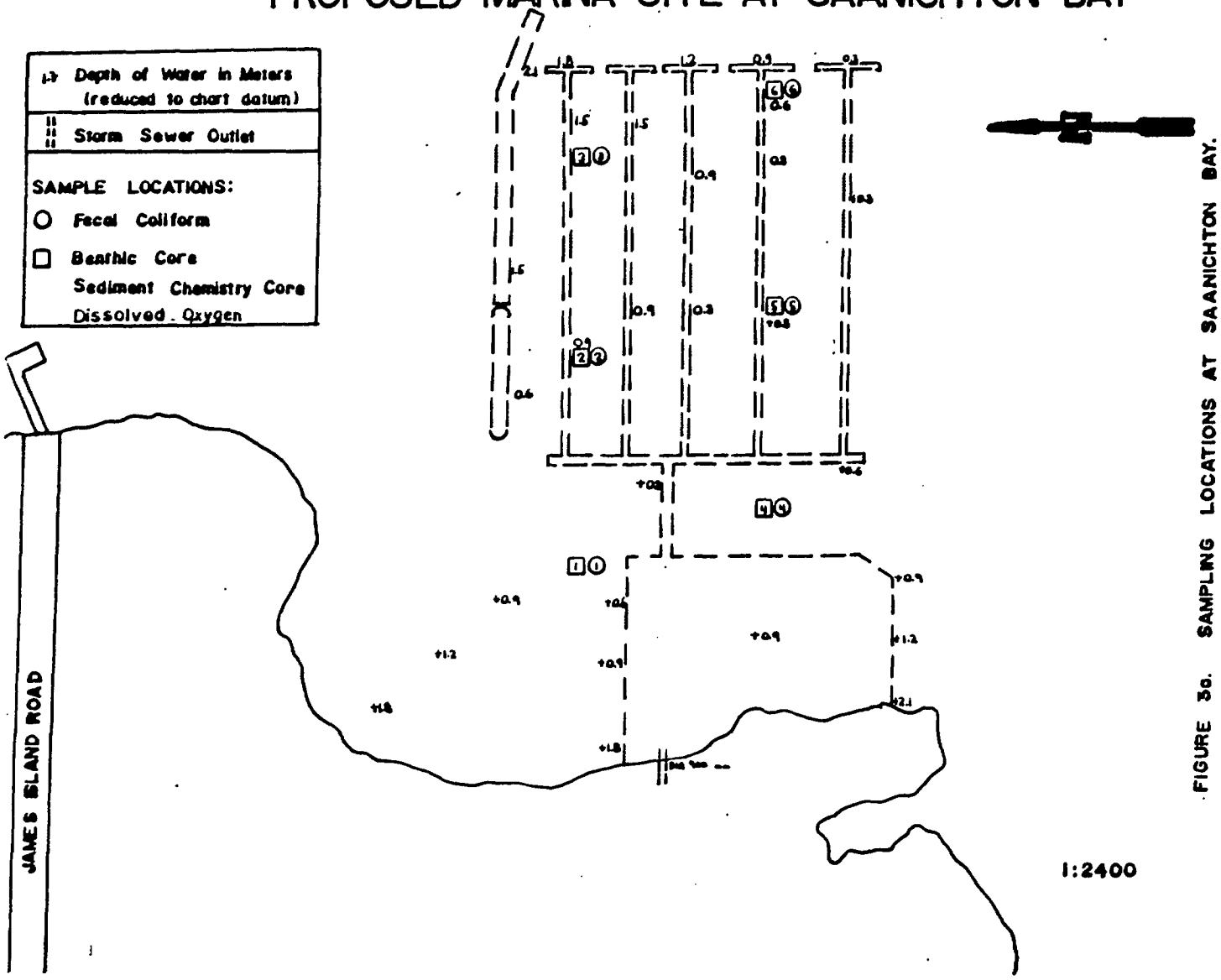


FIGURE 3a. SAMPLING LOCATIONS AT SAANICHTON BAY.

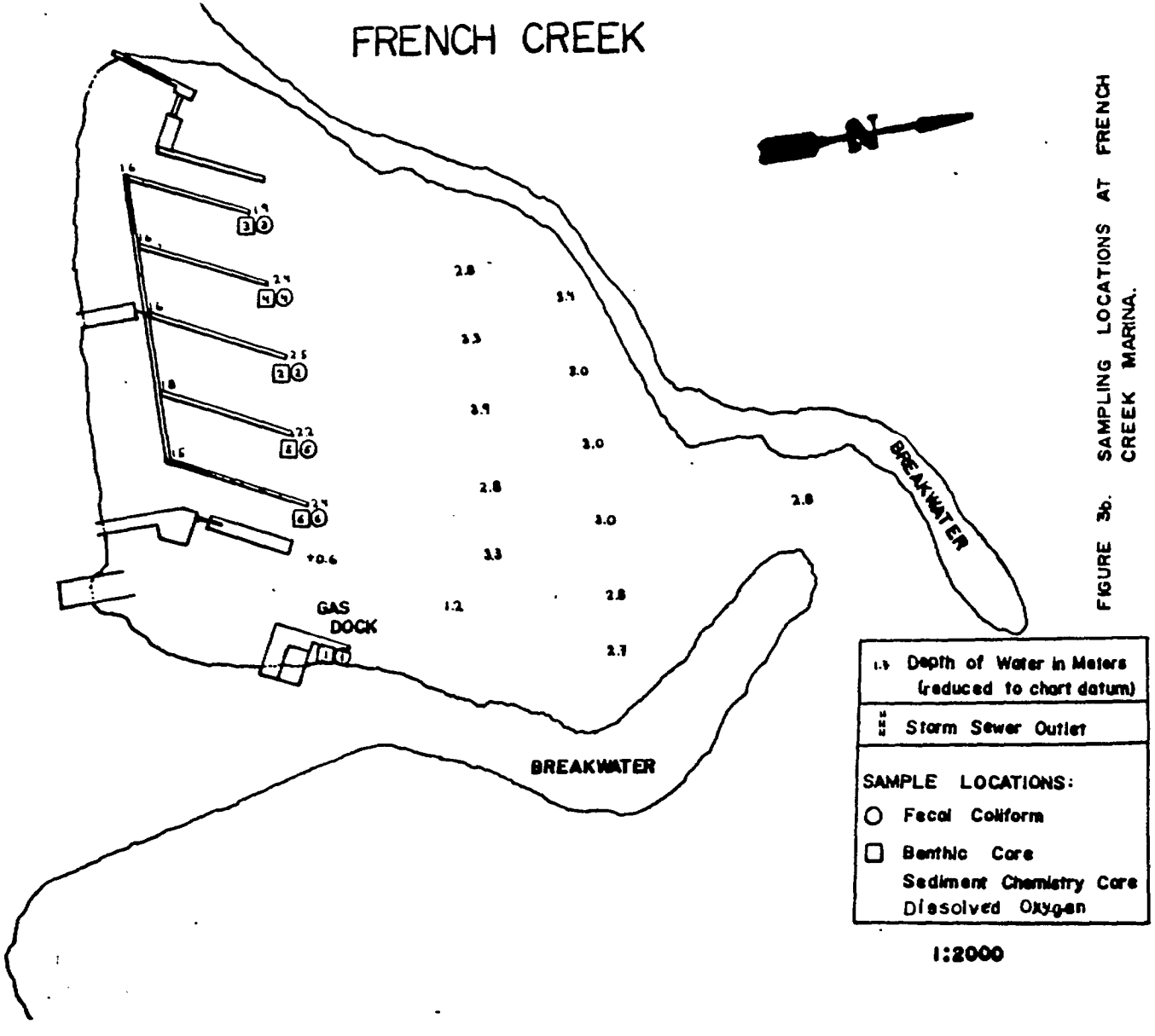


FIGURE 3b. SAMPLING LOCATIONS AT FRENCH CREEK MARINA.

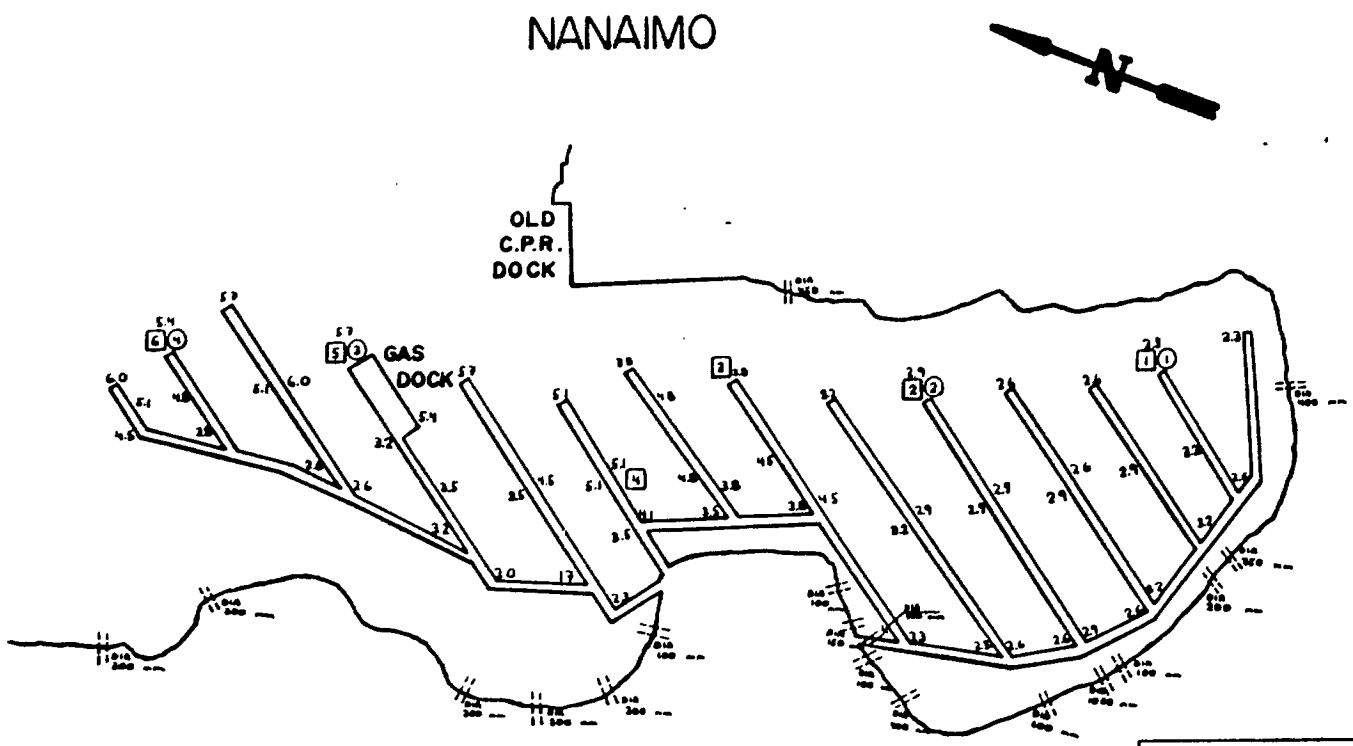


FIGURE 3c. SAMPLING LOCATIONS AT NANAIMO MARINA.

1.7 Depth of Water in Meters (reduced to chart datum)
Storm Sewer Outlet
SAMPLE LOCATIONS:
○ Fecal Coliform
□ Benthic Core
Sediment Chemistry Core
Dissolved Oxygen

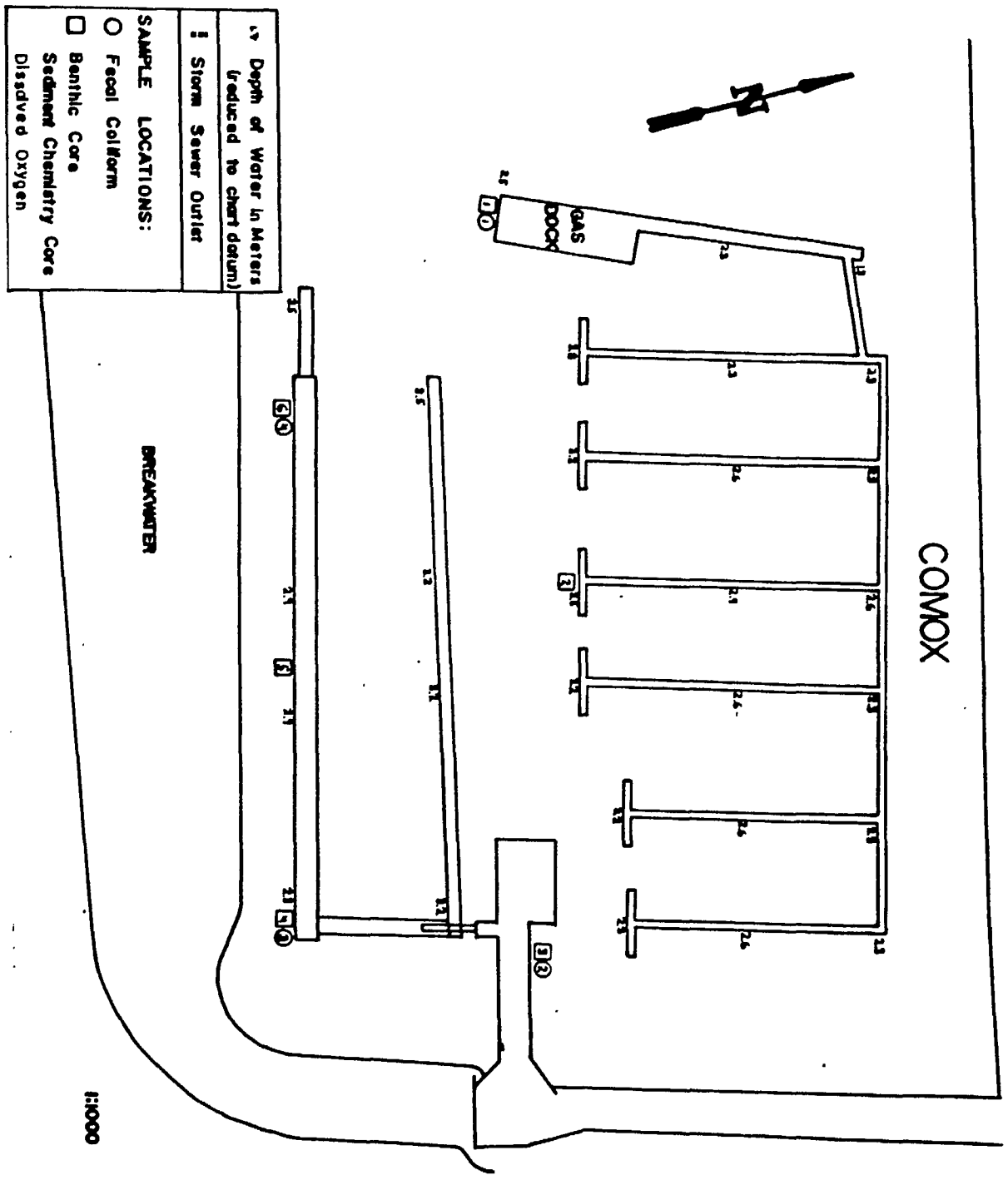


FIGURE 3d. SAMPLING LOCATIONS AT COMOX.

CANOE COVE

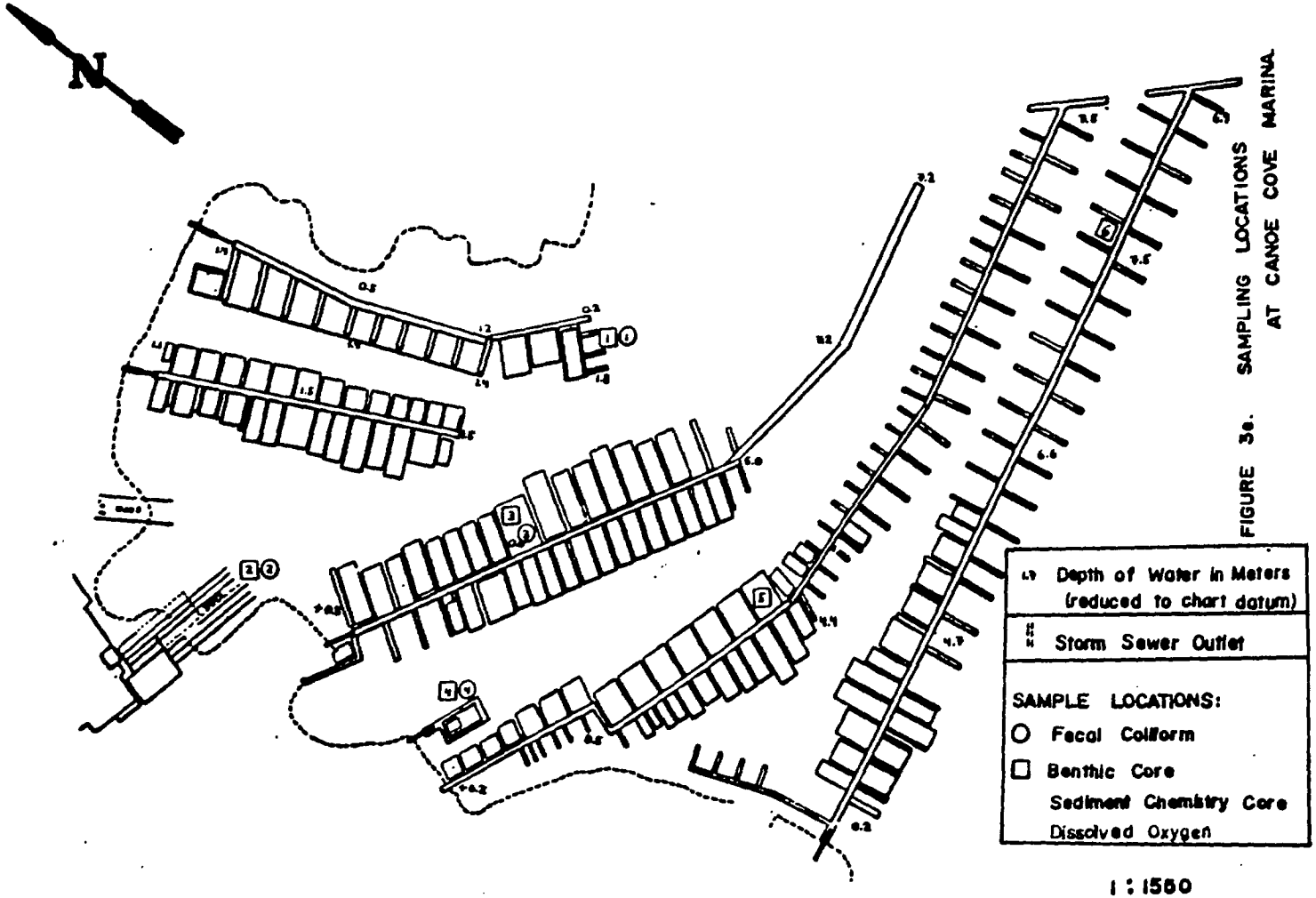
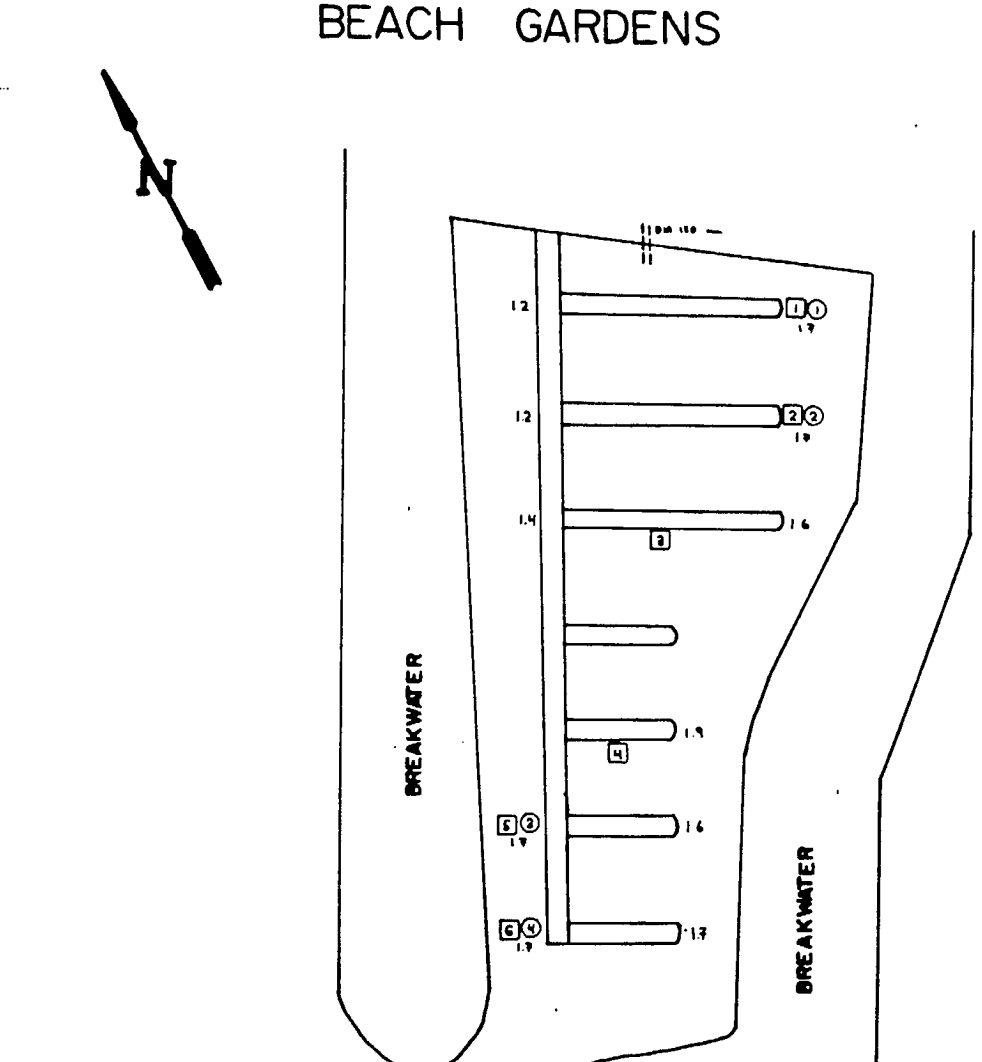


FIGURE 3e. SAMPLING LOCATIONS AT CANOE COVE MARINA

BEACH GARDENS



1.9 Depth of Water in Meters (reduced to chart datum)

Storm Sewer Outlet

SAMPLE LOCATIONS

- Fecal Coliform
- Benthic Core
- Sediment Chemistry Core
- Dissolved Oxygen

1:1200

FIGURE 3f. SAMPLING LOCATIONS AT BEACH GARDENS.

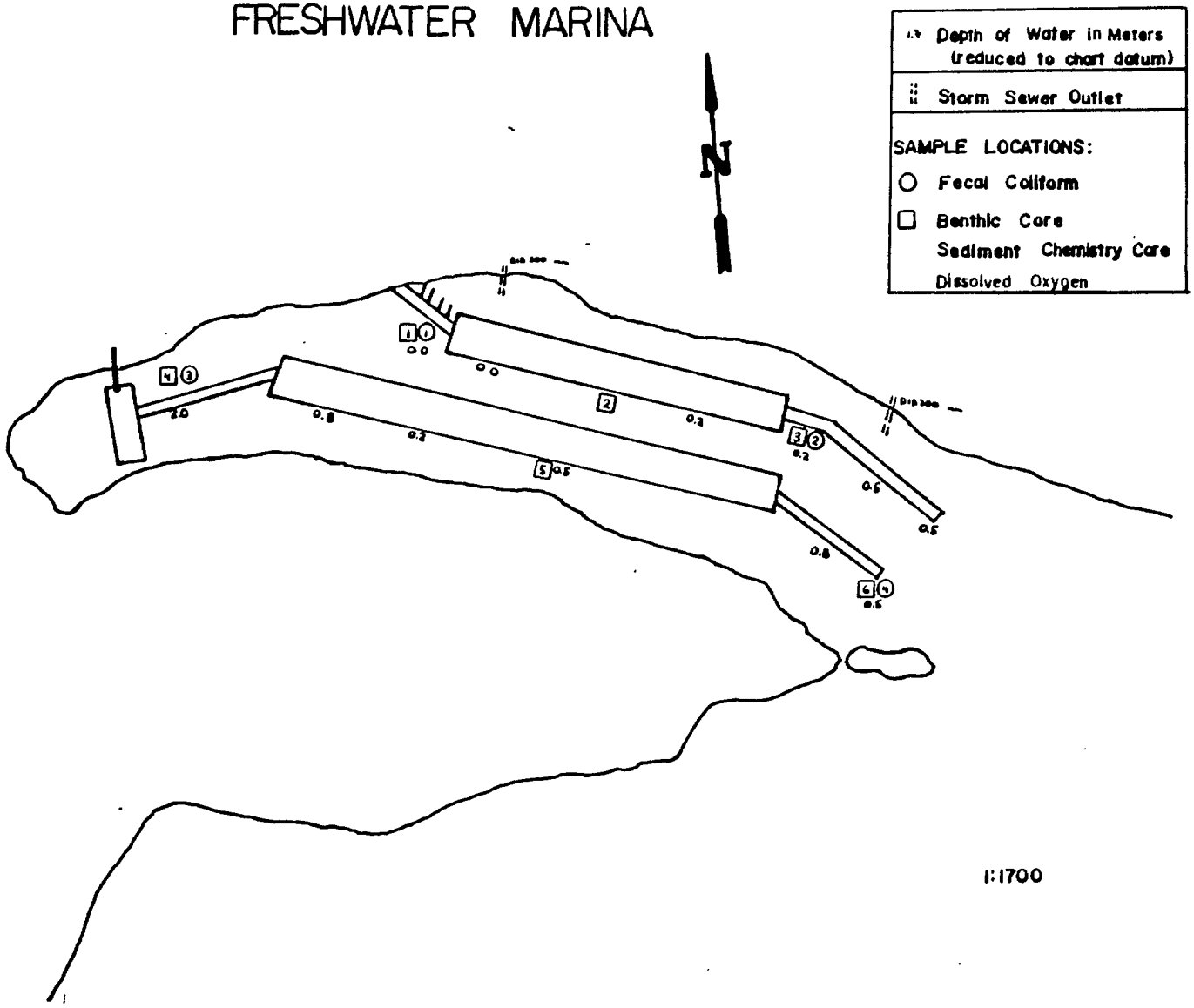


FIGURE 3g. SAMPLING LOCATIONS AT FRESHWATER MARINA.

scuba diver using a device invented for this project (figure 4). A weighted (8 kg) 1 meter piece of 10 cm diameter P.V.C. pipe with an air valve attached to a capped end was released into the water by a boat tender. After the open end of the pipe had penetrated the substrate, a scuba diver forced the sampler 10 cm into the sediment. The diver created a vacuum when he opened the air valve and released all contained air. He pushed his hand into the soft substrate, covered the open end of the pipe and lifted the sample out of the sediment. The open end of the pipe was capped with a plastic lid, and the sample was brought to the surface. The boat tender sieved the contents using a 0.250 mm mesh screen, carefully emptying all solids into 3 liter plastic jars. The sample was preserved in 40% isopropyl alcohol and dyed with rose bengal stain.

In the lab the samples were washed through a 1 mm mesh screen separating the detritus and macrobenthos from the meiobenthos. The macroinvertebrates were decanted off and put into a container. The rest of the sample was washed through a 0.250 mm mesh screen and the meioinvertebrates were decanted into a container. The contents of both containers were viewed in sorting trays under a dissecting microscope. Individual orders were identified and counted. The meiobenthos and macrobenthos results were combined. No samples were split.

2.5 Piling, Wharf and Breakwater Fauna Sampling

Replicate quadrat scraping samples were taken from the pilings, wharfs and breakwaters at French Creek Marina, Nanaimo Marina, and Comox Marina. At each marina three samples were taken from the pilings and breakwaters; each sample from a different zone of growth. At each marina three samples were taken from the wharfs; each sample was widely separated in an attempt to represent the average density of growth. All samples were obtained by one scuba diver scraping clean (with a wire brush) all visible growth in a 0.09 m^2 area. A second scuba diver captured the material in a 0.253 mm mesh net using an immersible bilge pump. The samples were brought to the surface, emptied into 350 ml glass jars, immediately preserved in 40% isopropyl alcohol and dyed with rose bengal stain. The meioinvertebrates and macroinvertebrates were identified to the order level using a dissecting microscope (using previously described lab methods section 2.4).

2.6 Zooplankton Sampling

Twelve zooplankton tows were made in each marina basin and control site at



FIGURE 4. BENTHIC SAMPLER IN USE UNDERWATER.

French Creek Marina, Nanaimo Marina and Comox Marina. All tows were taken during Nov 19 to Nov 21, sampling for one day at each marina. At each control site and marina basin (during a similar portion of the tidal cycle) three different water levels were sampled four times each to best estimate the average biological characteristic of each area (Hopkin, 1963). All planktors were captured in a 0.253 mm mesh net by towing a miller sampler (mouth diameter 10 cm) for a duration of one minute at a constant speed (tow length approximately 70 m). The samples were immediately preserved in 40% isopropyl alcohol and dyed with rose bengal stain. In the lab the samples were sieved using a 0.125 mm screen and identified to the order level using a dissecting microscope.

2.7 Vegetation Survey

2.7.1 Marina Basin

Using weighted 100 m transect lines and natural navigation, scuba divers mapped the location of the predominant algaes in each marina basin. The scuba divers recorded the percent coverage of the substrate by the individual algaes. Where possible the algaes were identified to the species level.

2.7.2 Pilings

A scuba diver recorded the percent coverage of the dominant algaes on the pilings. The range of depth in which the algaes occurred was recorded using a U.S. Diver (model 7404-00) depth gauge (all depths reduced to chart datum). Where possible the algaes were identified to the species level. At all of the marinas studied no substantial algae growth was observed on the wharfs.

2.7.3 Breakwaters

A scuba diver recorded the percent coverage of the dominant algaes on the inside and outside breakwaters at French Creek Marina, Nanaimo Marina, Comox Marina, and Beach Gardens Marina. The range of depths in which the algaes occurred was recorded using a U.S. Diver (model 7404-00) depth gauge (all depths reduced to chart datum). Where possible the algaes were identified to the species level.

2.8 Macroinvertebrate Survey

2.8.1 Marina Basin

Using weighted 100 m transect lines and natural navigation, scuba divers estimated the number of macroinvertebrates/m^2 on the substrate in each marina basin. Where possible the organisms were identified to the species level. The scuba divers (because of physical limitations) could not observe all of the small macroinvertebrates. We estimate that organisms larger than 6 cm were accurately counted.

2.8.2 Pilings

Scuba divers estimated the number of macroinvertebrates/m^2 on the pilings in each marina. Where possible the organisms were identified to the species level. The range of depth in which the macroinvertebrates occurred was recorded using a U.S. Diver (model 7404-00) depth gauge (all depths reduced to chart datum). The scuba divers (because of physical limitations) could not observe all of the small macroinvertebrates. We estimate organisms larger than 2 cm were accurately counted.

2.8.3 Wharfs

Scuba divers estimated the number of macroinvertebrates/m^2 on the wharfs in each marina. Where possible the organisms were identified to the species level. The scuba divers (because of physical limitations) could not observe all of the small macroinvertebrates. We estimate organisms larger than 2 cm were accurately counted.

2.8.4 Breakwaters

Scuba divers estimated the number of macroinvertebrates/m^2 on the inside and outside breakwaters in each marina. Where possible the organisms were identified to the species level. The range of depth in which the macroinvertebrates occurred was recorded using a U.S. Diver (model 7404-00) depth gauge (all depths reduced to chart datum). The scuba divers (because of physical limitations) could not observe all of the small macroinvertebrates. We estimate organisms larger than 2 cm were accurately counted.

2.9 Fish

2.9.1 Fish Survey

In concert with the algae and macroinvertebrate surveys, the approximate number of fish observed was recorded. The numbers recorded should only be used as rough estimates. The fish were identified to the species level.

2.9.2 Stomach Sample Analysis

Fish were collected for gut analysis from the marina basins and breakwaters at French Creek Marina, Nanaimo Marina, and Comox Marina. The methods used for fish capture included spearfishing, beach seining, and setting gillnets. Repeated seining with a 24.4 m x 1.8 m beach seine (0.6 cm mesh bunt and 1.3 cm mesh wings) at French Creek Marina provided limited success. The setting of two 2.5 m x 15 m gillnets (1.3 cm - 7.6 cm mesh) in Nanaimo Marina yielded no fish. Spearfishing was the most productive method of collection providing 95% of the fish used for gut analysis. The captured fish were placed in 3 liter plastic jars and preserved in 10% formalin. In the lab the fork length was measured and the fish were identified to the species level. The stomachs were removed and the contents were washed into sorting trays for identification to the order level.

3. RESULTS

3.1 Dissolved Oxygen Sampling

A list of the mean dissolved oxygen levels recorded at each sample area is shown in table 2. All of the mean dissolved oxygen levels at the control sites were greater than or equal to the levels inside each corresponding marina. The highest dissolved oxygen readings were obtained at Nanaimo Control Site #2 ($\bar{x}$ = 10 mg/L) and Beach Gardens Control Site ($\bar{x}$ = 10 mg/L). The lowest dissolved oxygen readings were taken at Nanaimo Marina ($\bar{x}$ = 7.0 mg/L) and French Creek Marina ($\bar{x}$ = 7.0 mg/L).

3.2 Sediment Chemistry Sampling

Unfortunately, due to extenuating circumstances the sediment chemistry results could not be included in this report. The results will be published at a later date.

3.3 Fecal Coliform Sampling

The mean number of fecal coliforms/100 grams determined by sampling inside the marina basins and at the control sites is illustrated in figure 5 and figure 6 (Tables 3 and 3a fecal coliform/individual sample). Six of the seven control sites had lower mean fecal coliform counts than the counts inside the corresponding marina basins. Freshwater Marina Control Site ($\bar{x}$ = 563 fecal coliforms/100 grams) had a higher mean number of fecal coliforms/100 grams than Freshwater Marina ($\bar{x}$ = 85 fecal coliforms/100 grams). The highest mean number of fecal coliforms/100 grams were recorded at Comox Marina ($\bar{x}$ = 25,813 fecal coliforms/100 grams) and Comox Marina Control Site ($\bar{x}$ = 16,913 fecal coliforms/100 grams). The lowest mean number of fecal coliforms/100 grams were recorded at Beach Gardens Control Site ($\bar{x}$ = 20 fecal coliforms/100 grams) and Nanaimo Control Site #2 ($\bar{x}$ = 28 fecal coliforms/100 grams).

The most substantial difference in the mean number of fecal coliforms/100 grams between marina basins and control sites occurred at Beach Gardens Marina (B.G. marina $\bar{x}$ = 2,623 fecal coliforms/100 grams and B.G. Control Site $\bar{x}$ 20 fecal coliforms/100 grams). Beach Gardens does not allow liveaboards and the site was sampled (Oct. 26, 1984) two months after the peak tourist season. Two of the marinas that permitted liveaboards had much smaller differences in mean

TABLE 2: DISSOLVED OXYGEN AT 1 METER ABOVE SUBSTRATE

$\overline{X}$ O_2 Calculated from 6 individual samples taken at each location.

Location	$\overline{X}$ Dissolved Oxygen	Date Sampled
Saanichton Bay	9 mg/L	21/08/84
French Creek Marina	7 mg/L	28/08/84
French Creek Control Site	9 mg/L	12/11/84
Nanaimo Marina	7 mg/L	09/10/84
Nanaimo Control Site #1	9 mg/L	15/10/84
Nanaimo Control Site #2	10 mg/L	16/10/84
Comox Marina	8 mg/L	12/09/84
Comox Control Site	9 mg/L	13/11/84
Canoe Cove Marina	8 mg/L	26/09/84
Canoe Cove Control Site	8 mg/L	26/09/84
Beach Gardens Marina	9 mg/L	23/10/84
Beach Gardens Control Site	10 mg/L	23/10/84
Fresh Water Marina	9 mg/L	06/11/84
Fresh Water Control Site	9 mg/L	06/11/84

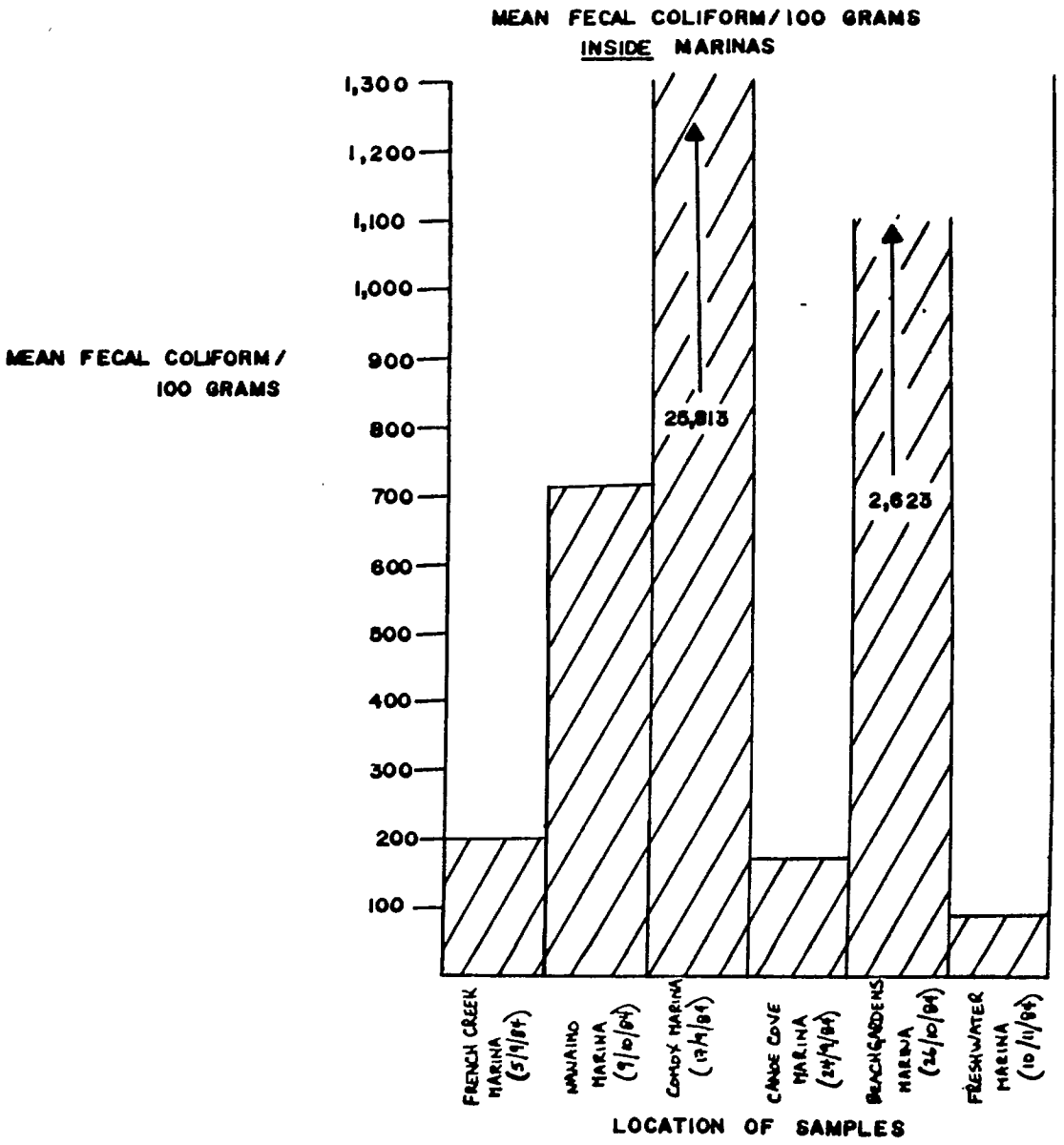


FIGURE 8. MEAN FECAL COLIFORM / 100 GRAMS INSIDE MARINAS.

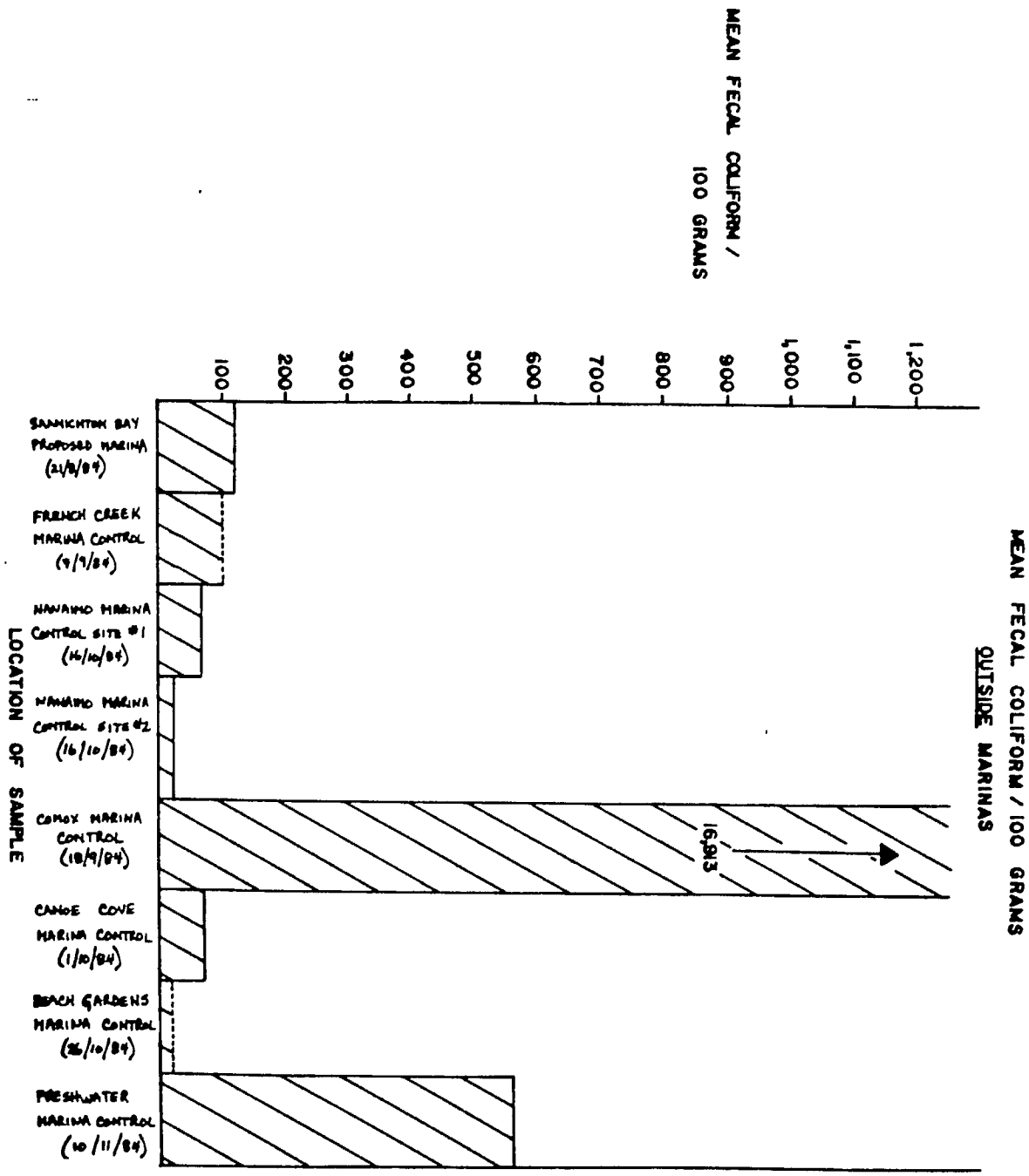


FIGURE 6. MEAN FECAL COLIFORM / 100 GRAMS OUTSIDE MARINAS.

TABLE 3: FECAL COLIFORM/100 GRAMS INSIDE MARINAS

SITE	DATE SAMPLED	SAMPLE NUMBER 1	2	3	4	5	6	MEAN $\bar{X}$ INSIDE MARINA
French Creek Marina	05/09/84	100	100	100	250	100	550	200
Nanaimo Marina	09/10/84	330	1,100	130	1,300			715
Comox Marina	17/09/84	100	650	17,500	85,000			25,813
Canoe Cove Marina	24/09/84	110	20	220	330			170
Beach Gardens Marina	26/10/84	1,100	3,500	490	5,400			2,623
Fresh Water Marina	10/11/84	20	20	220	80			85

TABLE 3a: FECAL COLIFORM/100 GRAMS OUTSIDE MARINAS

(CONTROL AREAS)

SITE	DATE SAMPLED	SAMPLE NUMBER 1	2	3	4	5	6	MEAN $\bar{X}$ OUTSIDE MARINA
Saanichton Bay (Proposed Marina)	21/08/84	100	250	100	100	100	100	125
French Creek Marina Control	07/09/84	100	100	100	100	100	100	100
Nanaimo Marina Control Site #1	16/10/84	80	20	130	20			63
Control Site #2	16/10/84	20	20	20	50			28
Comox Marina Control	18/09/84	65,000	2,450	100	100			16,913
Canoe Cove Marina Control	01/10/84	50	50	110	50			65
Beach Gardens Marina Control	26/10/84	20	20	20	20			20
Freshwater Marina Control	10/11/84	490	1,100	490	170			563

number of fecal coliforms/100 grams between the marina basins and their control sites (French Creek Marina $\bar{x}$ = 200 fecal coliforms/100 grams, French Creek Control Site $\bar{x}$ = 100 fecal coliforms/100 grams and Canoe Cove Marina $\bar{x}$ = 170 fecal coliforms/100 grams, Canoe Cove Control Site $\bar{x}$ = 65 fecal coliforms/100 grams).

3.4 Marina Basin Benthos Sampling

The mean total abundance/m^2 of benthic organisms from the core samples taken at the marina basins and control sites is shown in figure 7 and table 4. Four of the marina basins (French Creek Marina, Nanaimo Marina, Beach Gardens Marina, and Freshwater Marina) had greater mean total abundance/m^2 of benthic organisms from the core samples than their corresponding control sites. Sampling areas exhibiting the largest mean total abundance/m^2 of benthic organisms were Comox control site ($\bar{x}$ = 565,084 organisms/m^2) and Canoe Cove control site ($\bar{x}$ = 404,177 organisms/m^2). Sampling areas exhibiting the smallest mean total abundance/m^2 of benthic organisms were French Creek control site ($\bar{x}$ = 40,607 organisms/m^2) and Freshwater Marina control site ($\bar{x}$ = 44,224 organisms/m^2). The number of benthic organisms/m^2 recorded in each core sample taken at the marina basins and control sites is shown in Appendix I.

The number of orders of benthic organisms found by core sampling at the marina basins and control sites are presented in table 5. Sampling areas exhibiting the largest variety of orders of benthic organisms were Comox Marina (25 orders) and Canoe Cove Marina (25 orders). Sampling areas exhibiting the smallest variety of orders of benthic organisms were Nanaimo Marina (17 orders) and French Creek Marina (16 orders). The core samples from five of the seven control sites had a greater variety of orders of benthic organisms than their corresponding marinas.

Orders occurrence and abundance of benthic organisms determined by core sampling at the marina basins and control sites are presented in figure 8 and figure 9. Nematodes, polychaetes, oligochaetes, bivalves, and harpactacoids were the numerically predominant organisms present in the benthos at most of the marina basins and control sites (Appendix II.). Comparing marina basins, Freshwater Marina had a substantially lower number of polychaetes/m^2 and bivalves/m^2 and a substantially larger number of tanaidaceae/m^2 than any of the other marinas. Comparing control sites, Freshwater Marina control site had a substantially lower number of nemotodes/m^2, polychaetes/m^2, and bivalves/m^2.

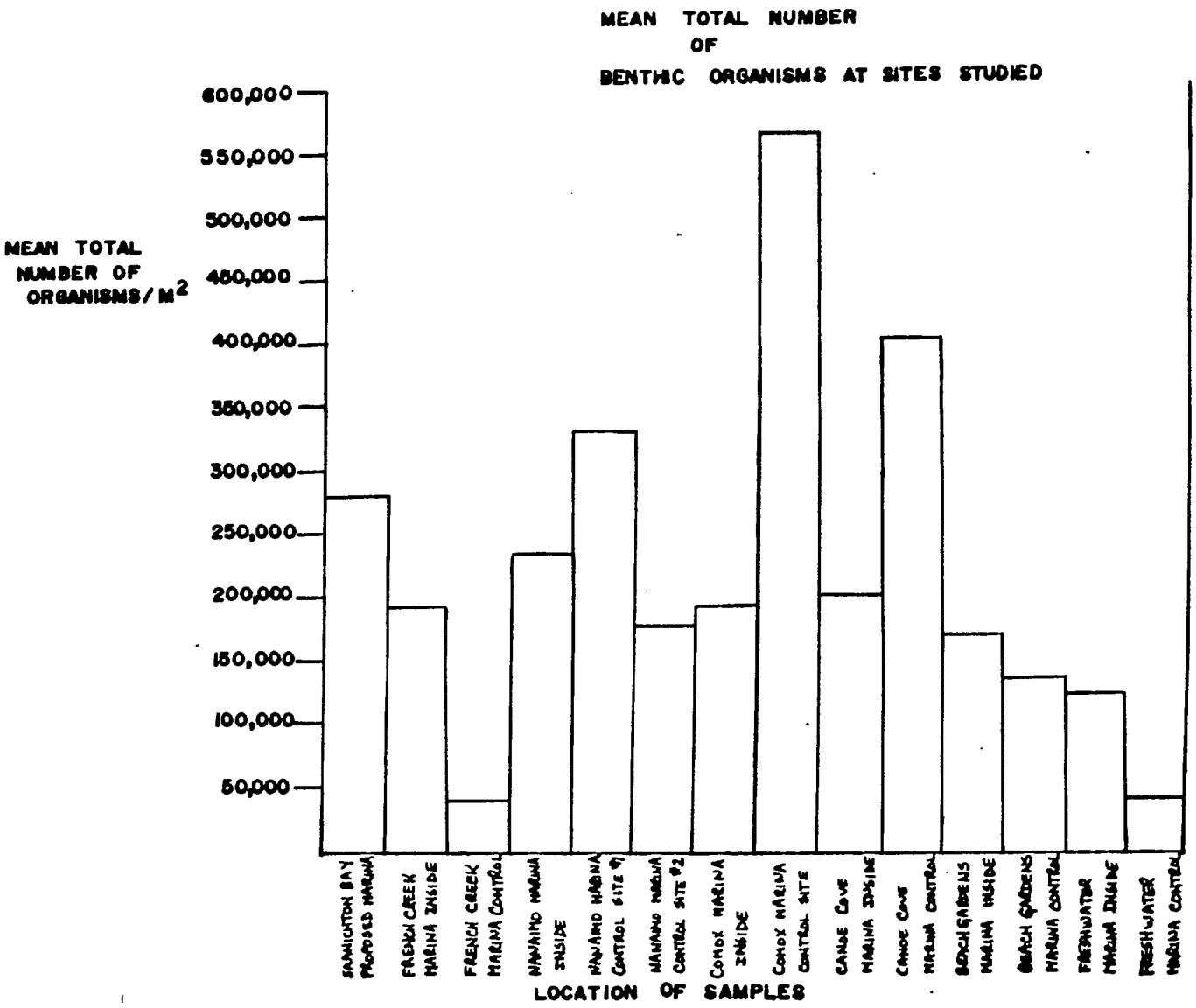


FIGURE 7. MEAN TOTAL NUMBER OF ORGANISMS / METER^2 AT SITES STUDIED.

TABLE 4: MEAN TOTAL ABUNDANCE OF BENTHIC ORGANISMS/m^2 IN BENTHOS SAMPLES

(n = 6)

SITE	INSIDE MARINA	CONTROL SITE	
Proposed Marina at Saanichton Bay (Proposed Marina)	$\bar{X}$ 276,378 Aug. 21, Sept 20		
French Creek Marina	$\bar{X}$ 194,219 Aug. 28, Sept. 6	$\bar{X}$ 40,607 Oct. 18, Oct. 29	
Nanaimo Marina	$\bar{X}$ 234,373 Oct. 9	Control Site #1 $\bar{X}$ 329,006 Oct. 17	Control Site #2 $\bar{X}$ 178,149 Oct. 17
Comox Marina	$\bar{X}$ 195,534 Sept. 11	$\bar{X}$ 565,084 Sept. 11, Sept. 13	
Canoe Cove Marina	$\bar{X}$ 200,772 Sept. 25	$\bar{X}$ 404,177 Sept. 25, Sept. 27	
Beach Gardens Marina	$\bar{X}$ 173,689 Oct. 23	$\bar{X}$ 132,835 Oct. 23	
Freshwater Marina	$\bar{X}$ 124,554 Nov. 6	$\bar{X}$ 44,224 Nov. 6	

TABLE 5: THE NUMBER OF ORDERS OF BENTHIC ORGANISMS IN BENTHOS SAMPLES

LOCATION OF SAMPLES

	Saanichton Proposed Marina	French Creek Marina Sites	Nanaimo Marina Sites	Comox Marina Sites	Canoe Cove Marina Sites	Beach Gardens Marina Sites	Fresh-Water Marina Sites
Marina	20	16	17	25	25	21	18
Control Site #1		22	19	21	21	22	22
Control Site #2			24				

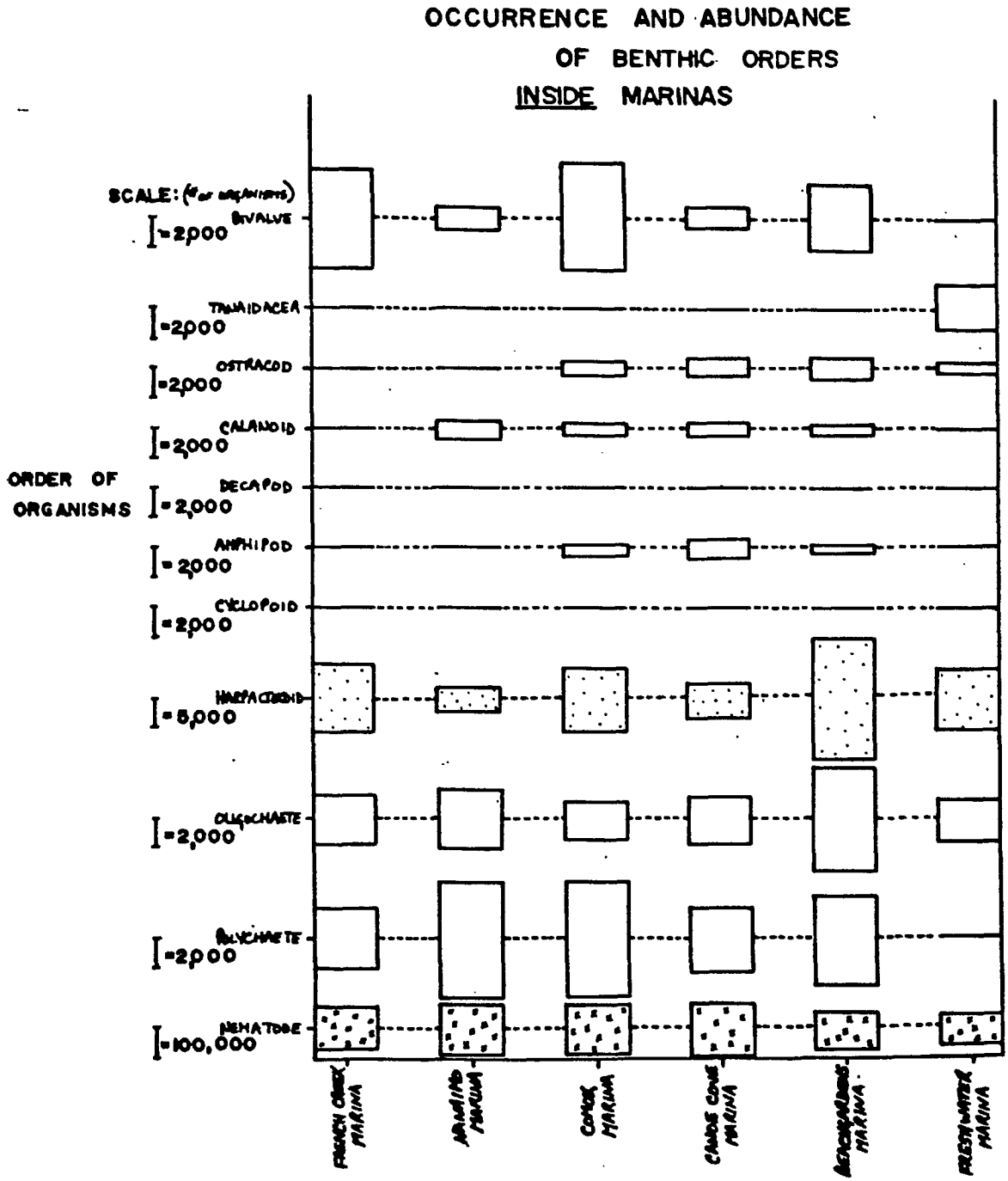


FIGURE 8. OCCURRENCE AND ABUNDANCE OF ORDERS INSIDE MARINAS.

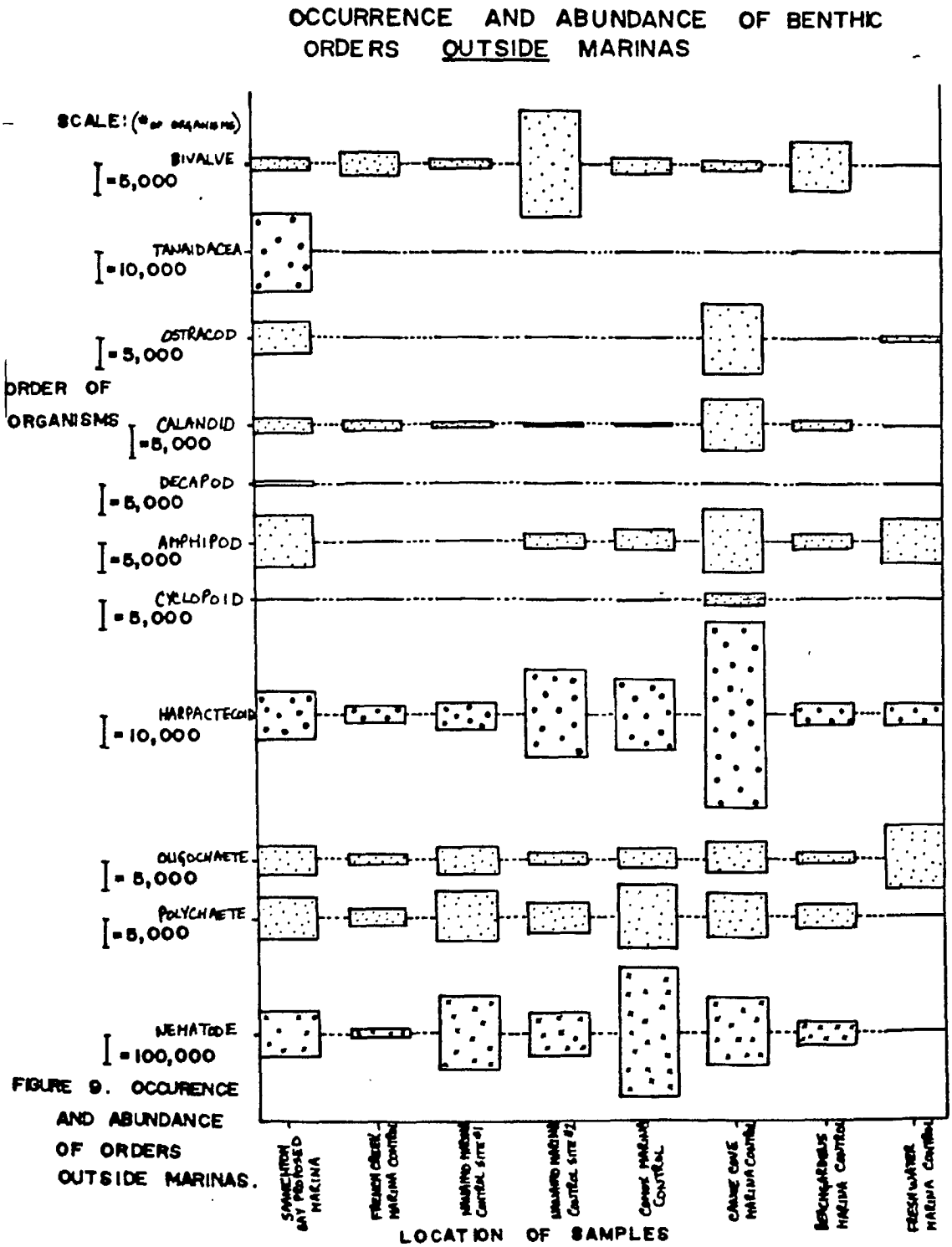


FIGURE 9. OCCURRENCE AND ABUNDANCE OF ORDERS OUTSIDE MARINAS.

The confidence limits (95%) for the mean numbers/m^2 of nemotodes, amphipods and decapods (important fish food) found by benthos core sampling at the marina basins and control sites is presented in figure 10, figure 11 and figure 12. The confidence limits are equal to or greater than most of their corresponding sample means (Appendix III).

3.5 Piling, Wharf and Breakwater Fauna Sampling

The number of orders of meiofauna and macrofauna organisms found in the scraping samples is shown in table 6. At the three marinas sampled, the pilings, wharfs, and breakwaters all had a large variety of orders of fouling organisms. The largest variety of orders of fouling organisms was recorded at the French Creek Marina pilings (25 orders) and the Nanaimo Marina pilings (23 orders). The smallest variety of orders of fouling organisms was recorded at the Nanaimo Marina inside breakwater (13 orders), Nanaimo Marina wharfs (17 orders) and the Comox Marina inside breakwater (17 orders). The number of meiofauna and macrofauna organisms/m^2 recorded in each scraping sample is listed in Appendix IV.

3.6 Zooplankton Sampling

The number of orders of zooplankton organisms found by miller tow sampling is presented in table 7. At the three marinas sampled the marina basins and control sites all had a large variety of orders of zooplankton organisms. The largest variety of orders of zooplankton organisms was recorded at Nanaimo Control Site #1 (24 orders). The smallest variety of orders of zooplankton organisms was recorded at French Creek Control Site (16 orders). The number of zooplankton organisms/m^3 recorded in each miller tow sample is listed in Appendix V.

3.7 Vegetation Survey

3.7.1 Marina Basins

The location and percent coverage of Laminaria (sp.), Zostera (sp.) and Ulva (sp.) in each marina basin is illustrated in figures 13a to 13f. Comparing operational marinas, Canoe Cove Marina basin had the greatest density of algae growth (figure 13d). The French Creek Marina basin was the only basin surveyed that did not contain algae growth. In July 1977, Fisheries and Marine Service documented substantial Zostera sp. (eel grass) growth in French Creek Marina. The area of the French Creek Marina basin which contained eelgrass in 1977 was partially dredged in 1984.

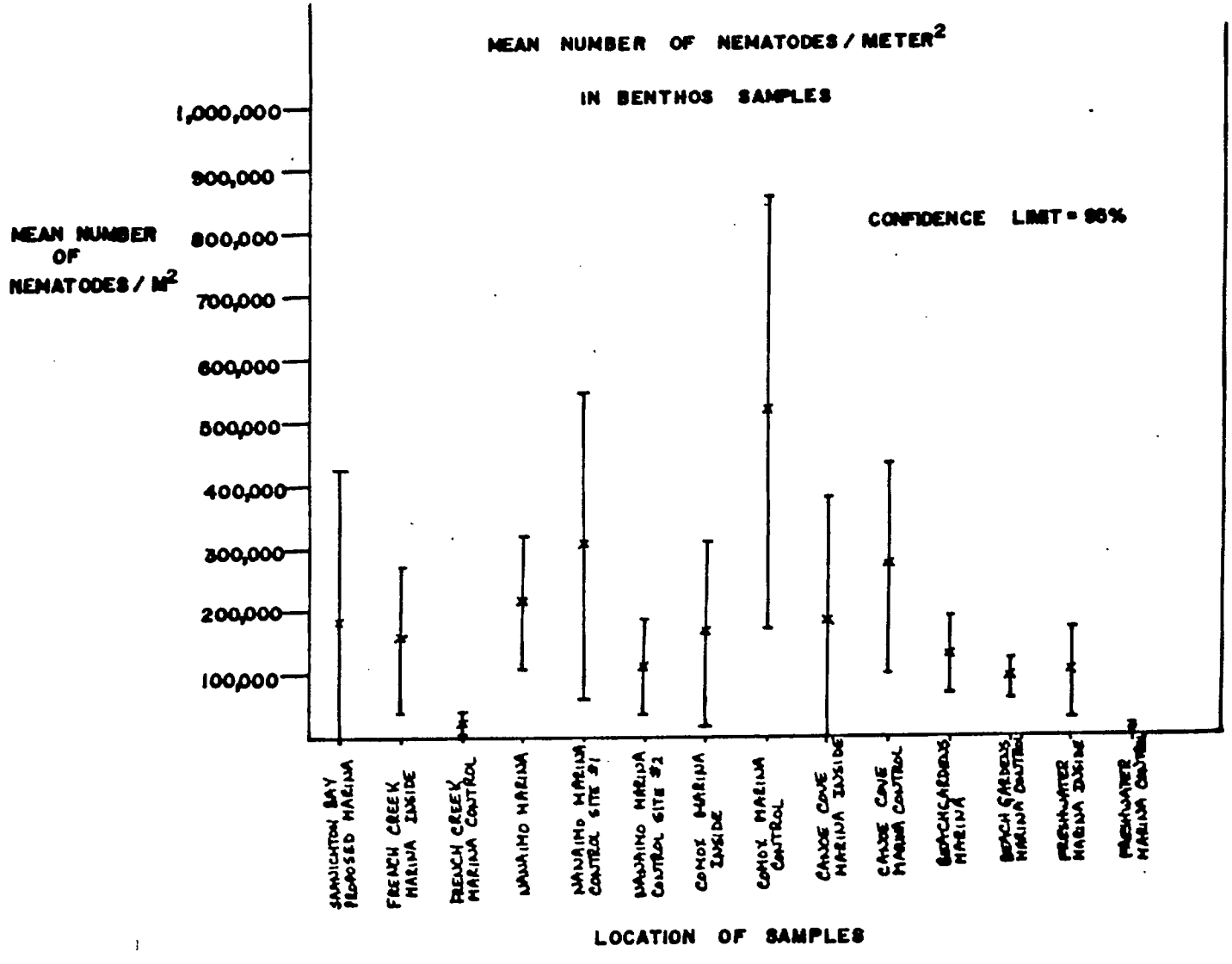


FIGURE 10. MEAN NUMBER OF NEMATODES / METER² IN BENTHOS SAMPLES.

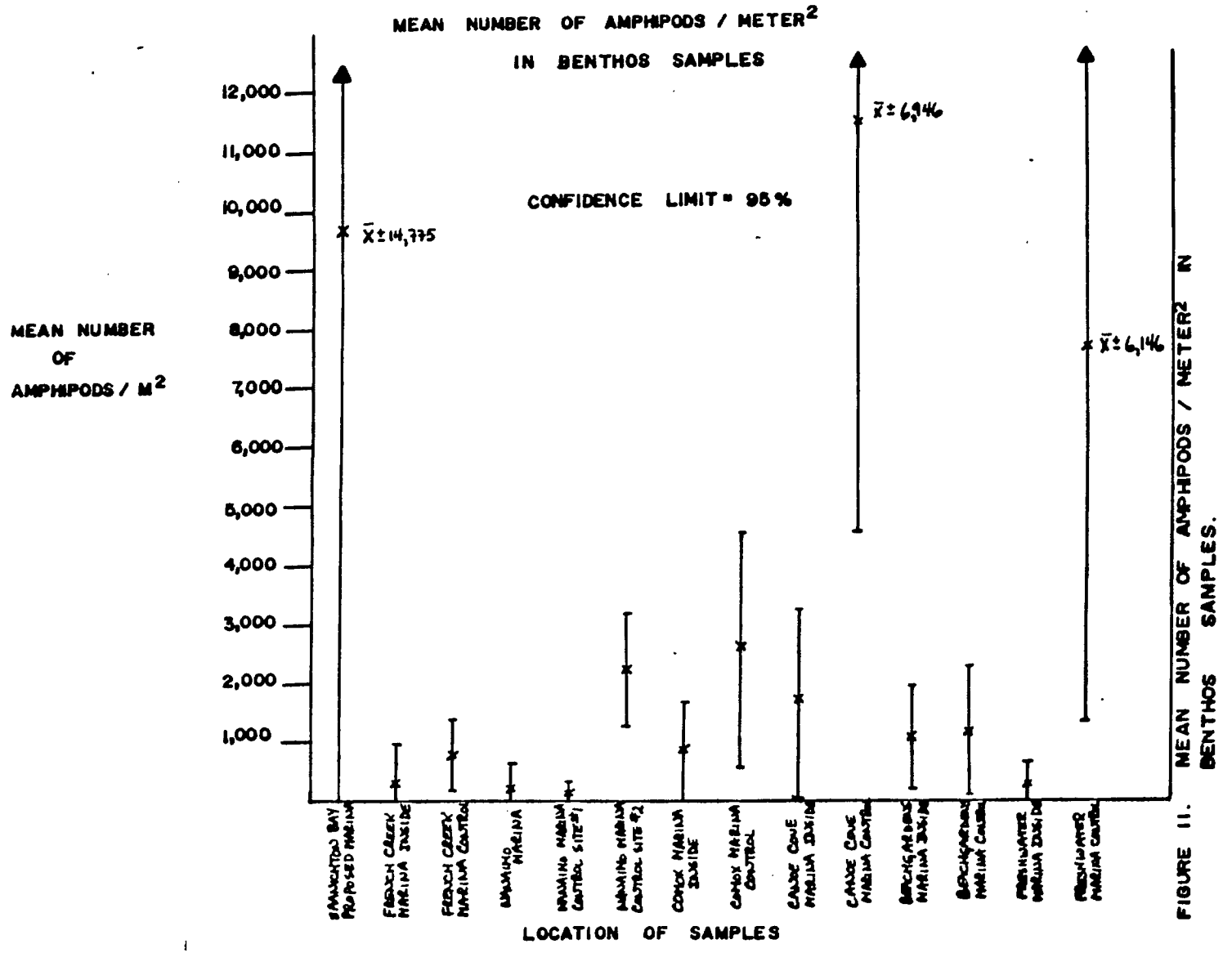


FIGURE 11. MEAN NUMBER OF AMPHIPODS / METER² IN BENTHOS SAMPLES.

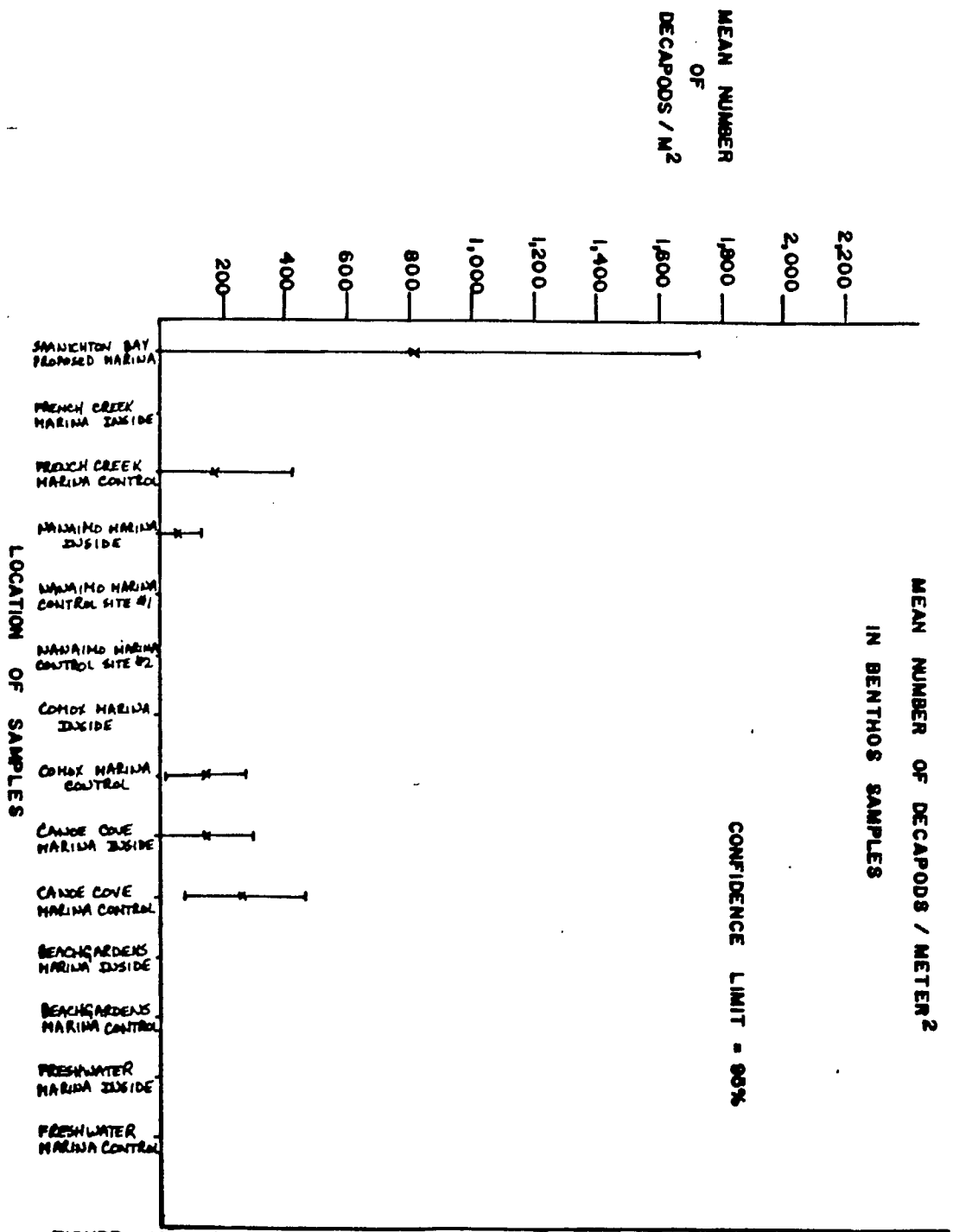


FIGURE 12. MEAN NUMBER OF DECAPODS / METER² IN BENTHOS SAMPLES.

TABLE 6: THE NUMBER OF ORDERS OF MEIOFAUNA AND MACROFAUNA ORGANISMS IN SCRAPING SAMPLES

	LOCATION OF SAMPLES		
	Comox Marina	French Creek Marina	Nanaimo Marina
Pilings	20	25	23
Wharfs	20	18	17
Inside Breakwater	17	22	13
Outside Breakwater	22	19	

TABLE 7: THE NUMBER OF ORDERS OF ZOOPLANKTON IN ZOOPLANKTON TOW SAMPLES

	LOCATION OF SAMPLES		
	French Creek Marina	Nanaimo Marina	Comox Marina
Inside Marina	19	21	21
Outside Marina	16	24	19

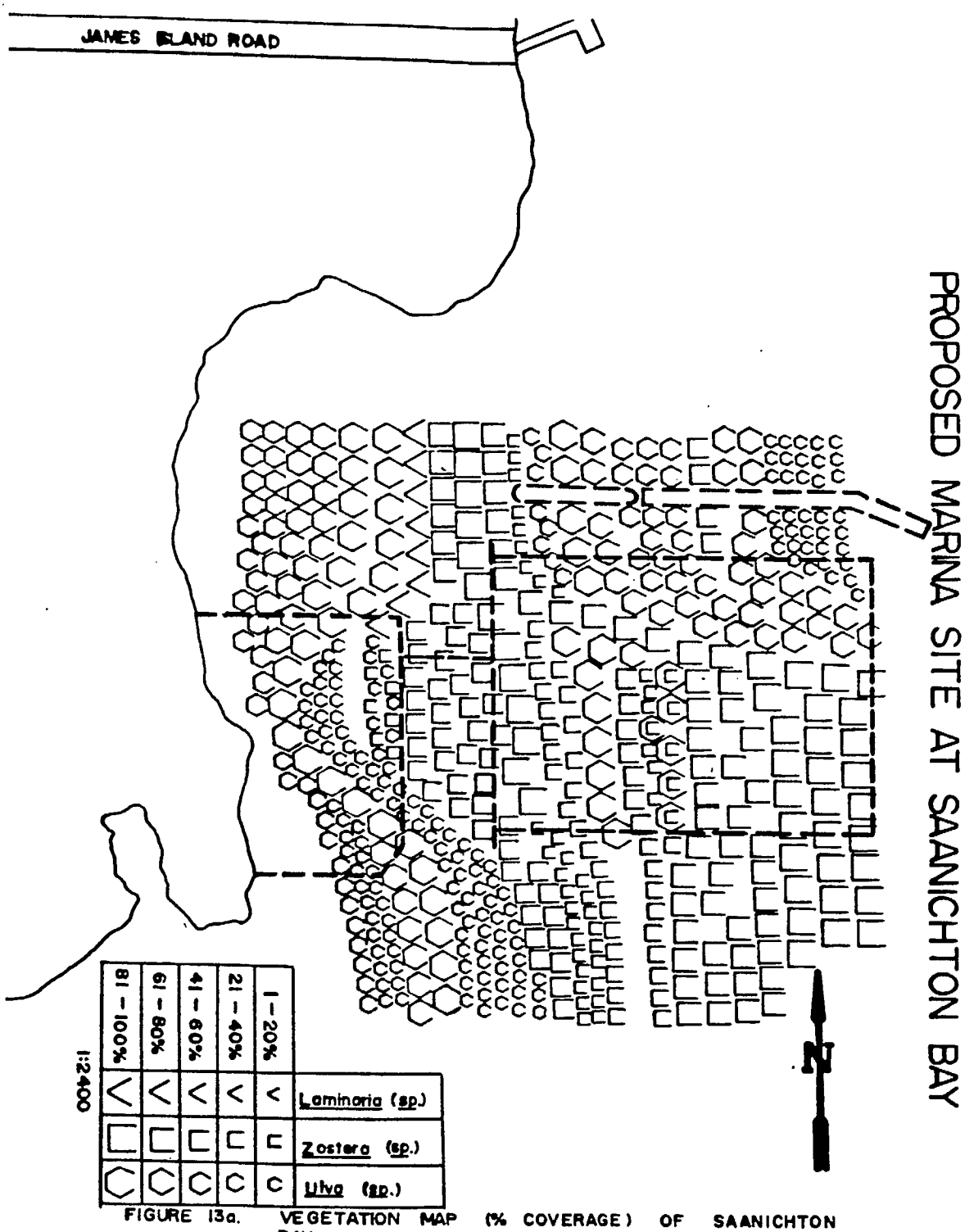


FIGURE 13a. VEGETATION MAP (% COVERAGE) OF SAANICHTON BAY.

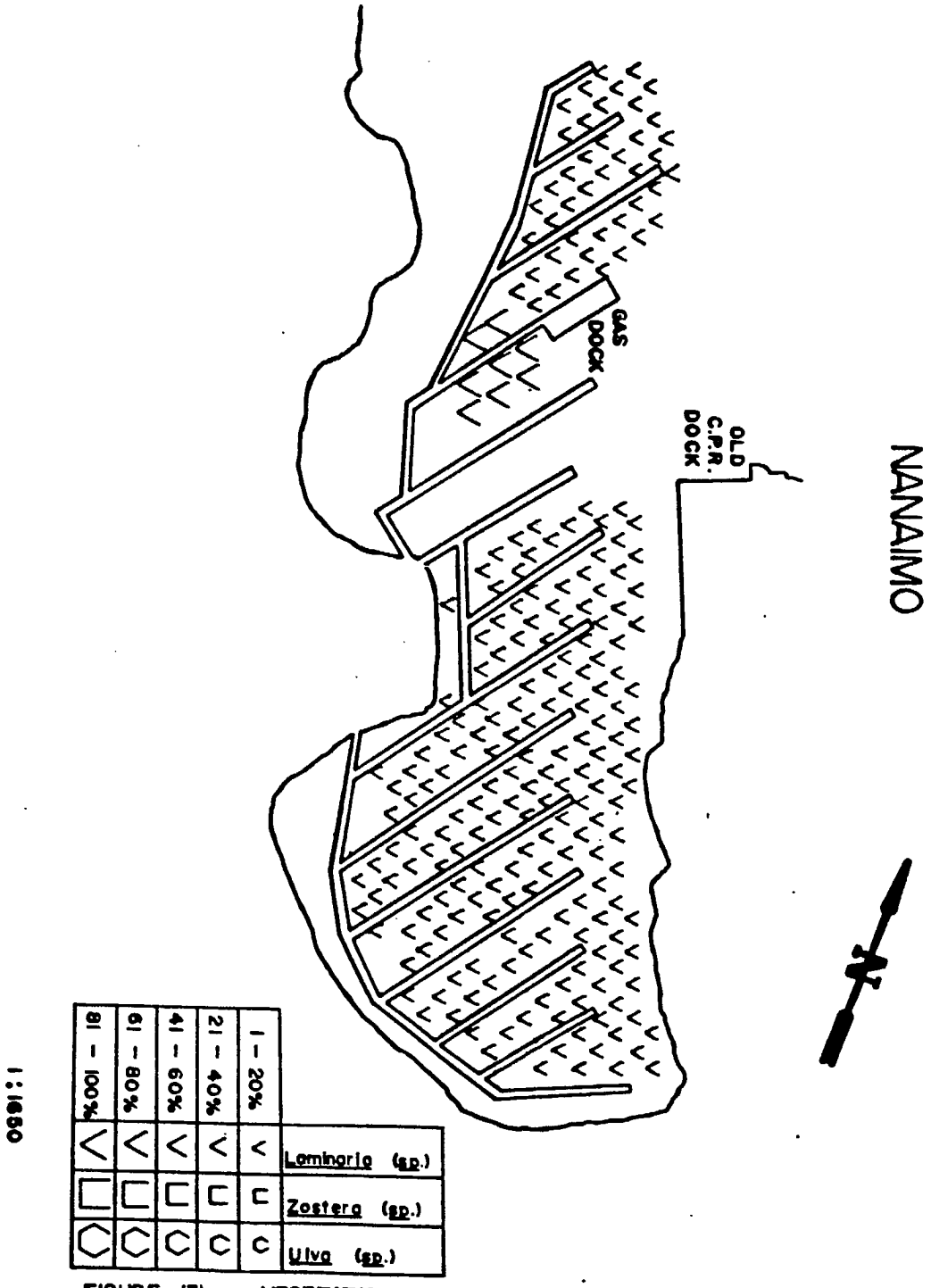


FIGURE 13b. VEGETATION MAP (% COVERAGE) OF NANAIMO MARINA BOAT BASIN.

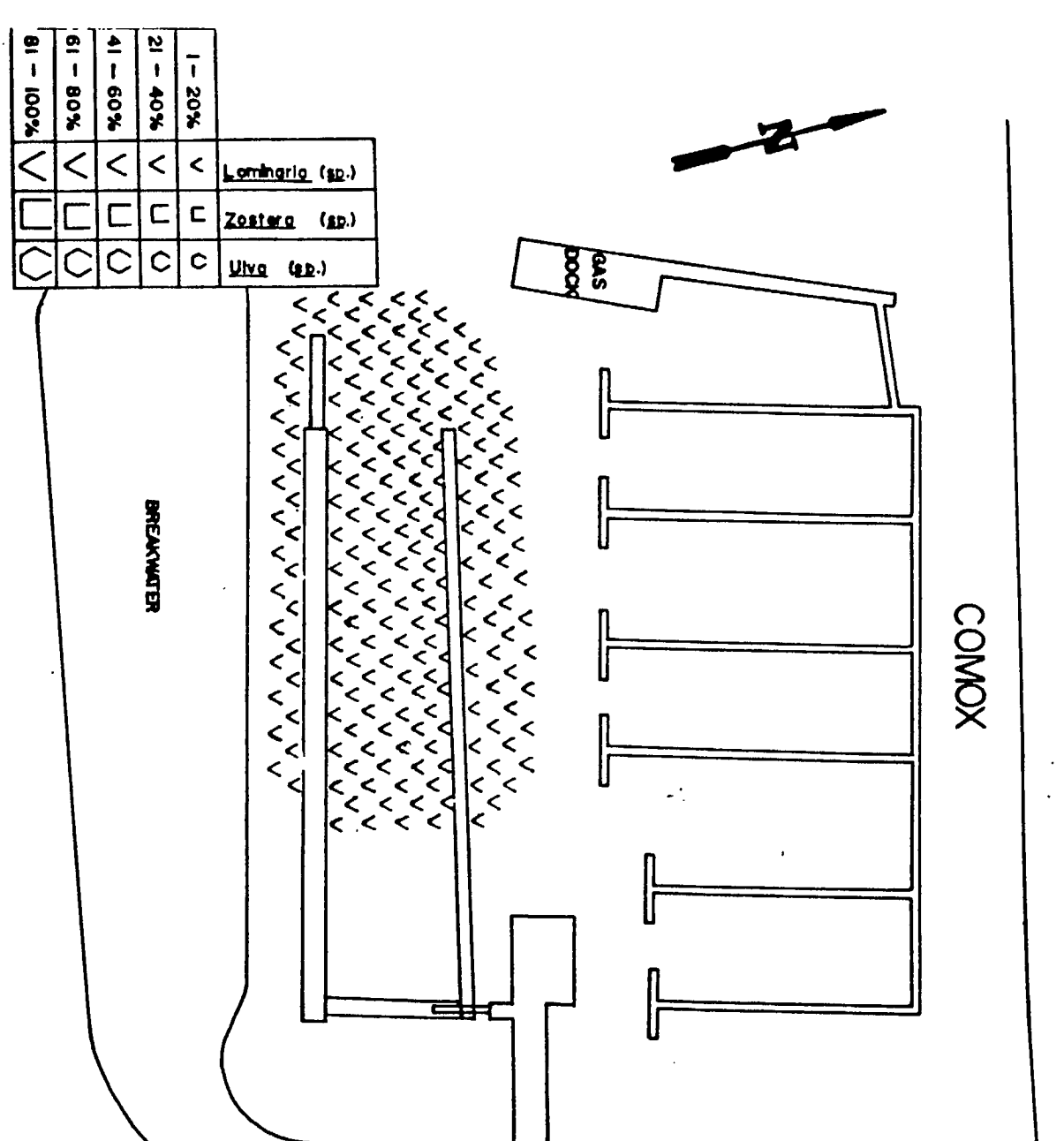


FIGURE 13c. VEGETATION MAP (% COVERAGE) OF COMOX MARINA BOAT BASIN.

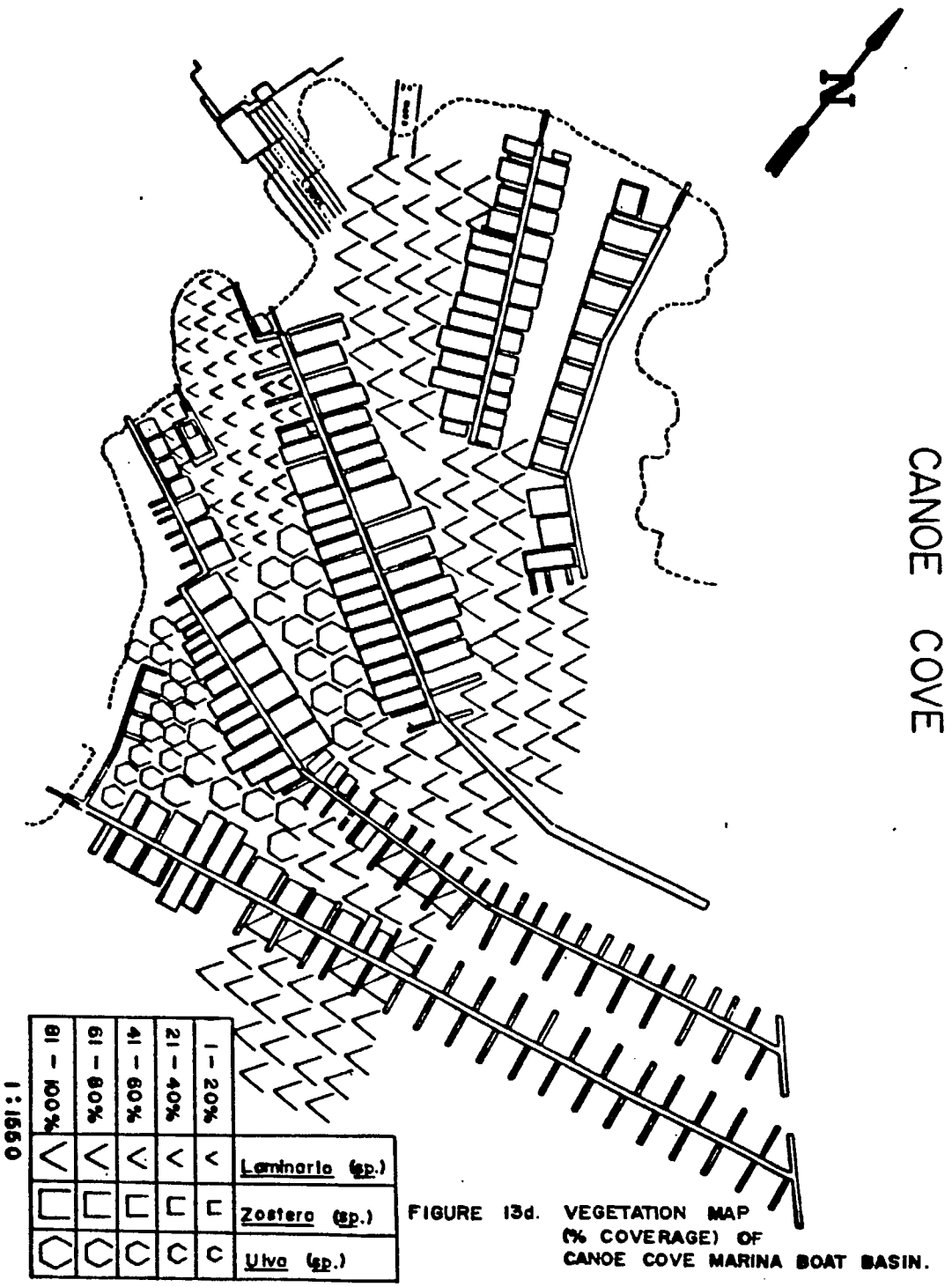
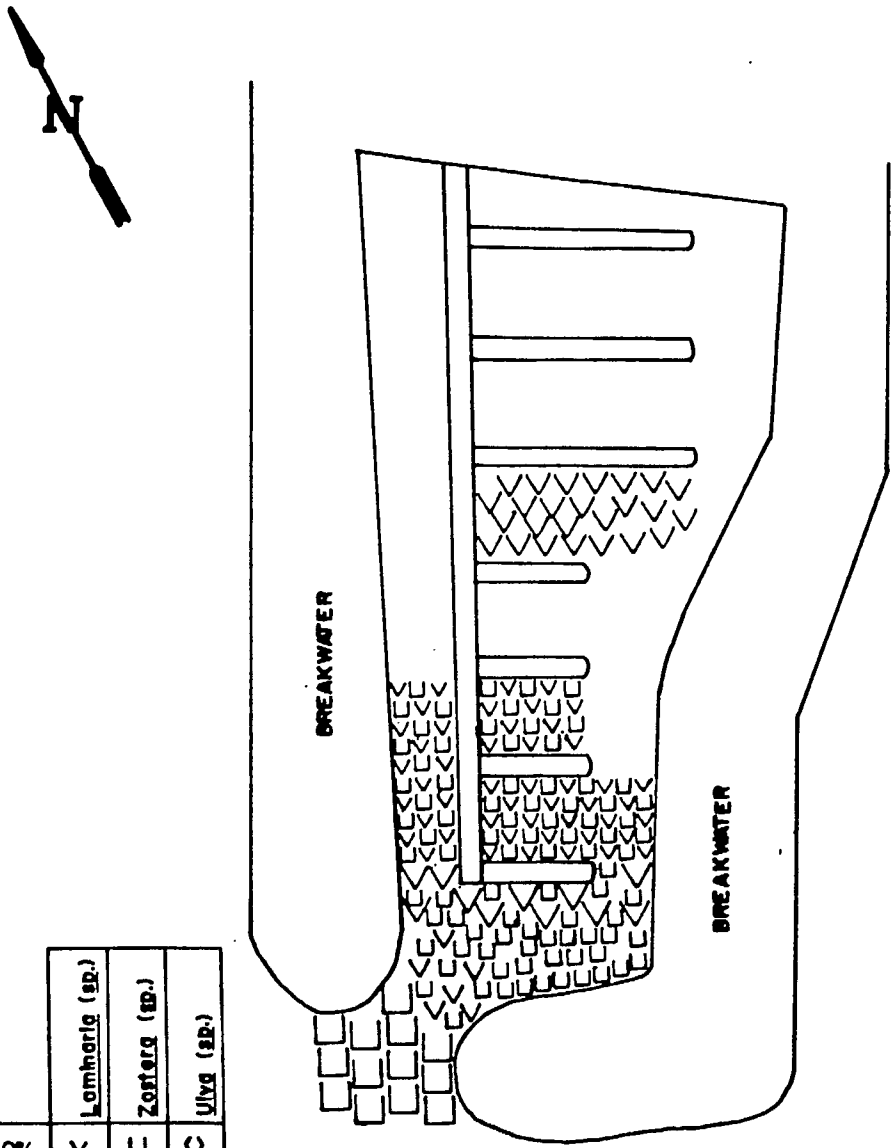


FIGURE 13d. VEGETATION MAP (% COVERAGE) OF CANOE COVE MARINA BOAT BASIN.

BEACH GARDENS



	Laminaria (sp.)	Zostera (sp.)	Ulva (sp.)
1 – 20%	V	⊔	C
21 – 40%	V	⊔	C
41 – 60%	V	⊔	C
61 – 80%	V	⊔	C
81 – 100%	V	⊔	C

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FIGURE 13e. VEGETATION MAP (% COVERAGE) OF BEACH GARDENS MARINA BOAT BASIN.

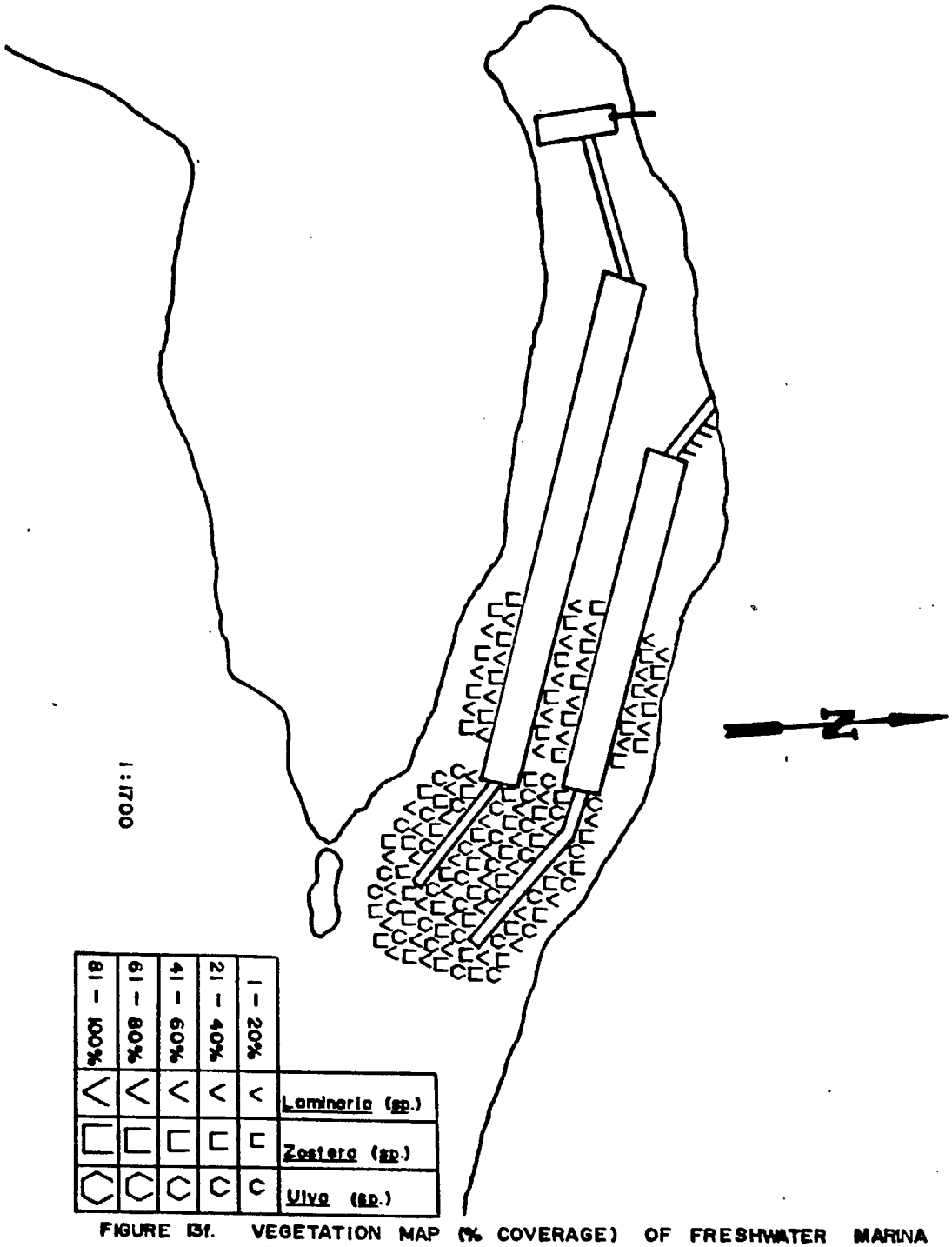


FIGURE 15f. VEGETATION MAP (% COVERAGE) OF FRESHWATER MARINA BOAT BASIN.

3.7.2 Pilings

The percent coverage of the predominant algaes observed on the pilings is presented in table 10. The pilings at Canoe Cove Marina had the most substantial algae growth. The pilings at Comox Marina and Beach Gardens Marina had sparse algae growth. No algae growth was observed on the pilings at French Creek Marina, Nanaimo Marina or Freshwater Marina.

3.7.3 Breakwaters

The percent coverage of the predominant algaes observed on the breakwaters is presented in table 8 and table 8a. All of the four breakwaters surveyed had substantial algae growth. The inside breakwater at Nanaimo Marina had the least amount of algae growth (30% Fucus (sp.) between +2.7 m and +2.2 m).

3.8 Macroinvertebrate Survey

3.8.1 Marina Basins

A list of the macroinvertebrates observed in each marina basin is shown in table 9. All of the marina basins surveyed contained numerous large macroinvertebrates. Saanichton Bay had the greatest variety of macroinvertebrates.

3.8.2 Pilings

A list of the macroinvertebrates observed on the pilings in each marina is shown in table 10. Substantial macroinvertebrate populations were observed on the pilings at French Creek Marina, Nanaimo Marina, Comox Marina and Canoe Cove Marina. A sparse coverage of Balanus (sp.) was the only macroinvertebrate observed on the pilings at Beach Gardens Marina and Freshwater Marina.

3.8.3 Wharfs

A list of the macroinvertebrates observed on the wharfs at each marina is shown in table 11. All of the wharfs in the marinas studied had substantial macroinvertebrate populations with the exception of Freshwater Marina.

TABLE 8: VEGETATION SURVEY OF INSIDE BREAKWATERS

FRENCH CREEK MARINA

Survey of Algae on the Inside Breakwater

Surveyed 12:00 14/09/84 (Depths reduced to chart datum)

(Note: % = Percent Coverage)

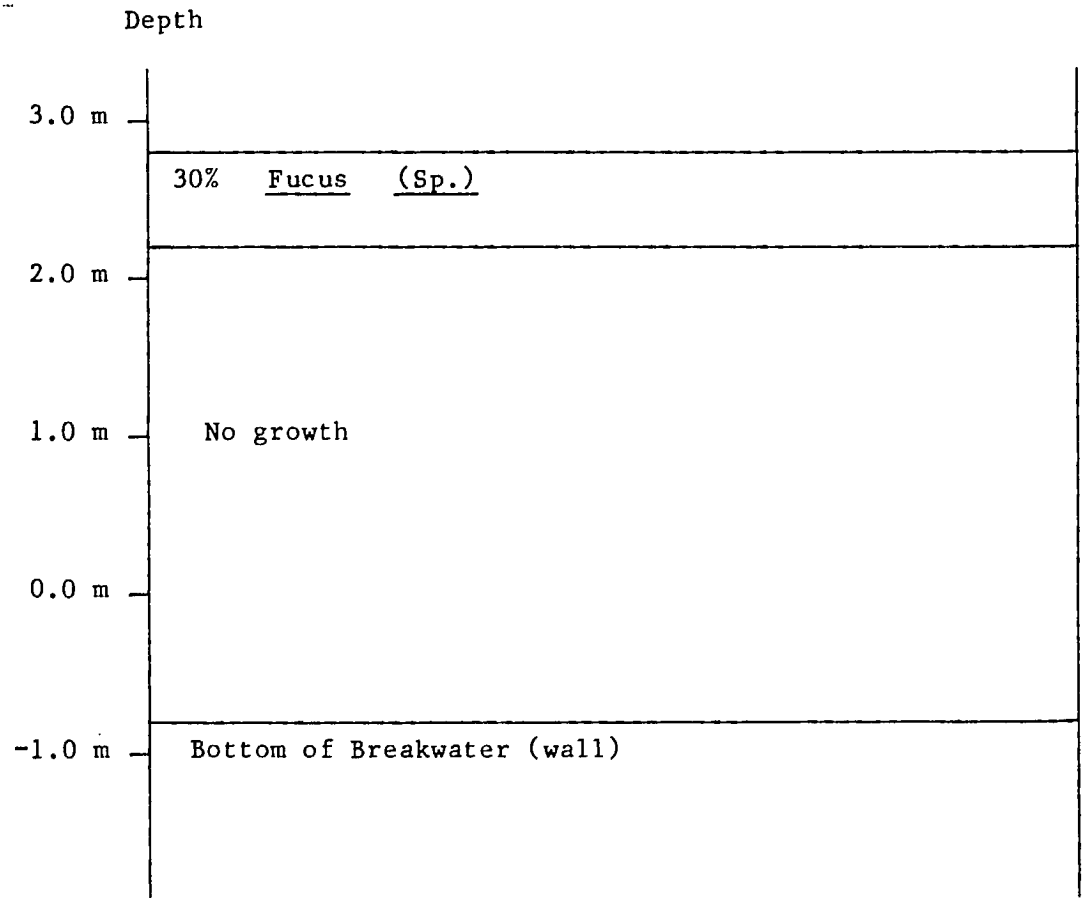
Depth	
3.0 m	
2.0 m	70% Fucus gardneri
1.0 m	
0.0 m	
-1.0 m	10% Polysiphonia pacifica 10% Gracilaria confervoides
-2.0 m	30% Laminaria (Sp.) 10% Gracilaria confervoides
-3.0 m	Bottom of Breakwater (riprap)

NANAIMO MARINA

Survey of Algae on the Inside Breakwater

Date Surveyed 16:00 11/10/84 (Depths reduced to chart datum)

(Note: % = Percent Coverage)

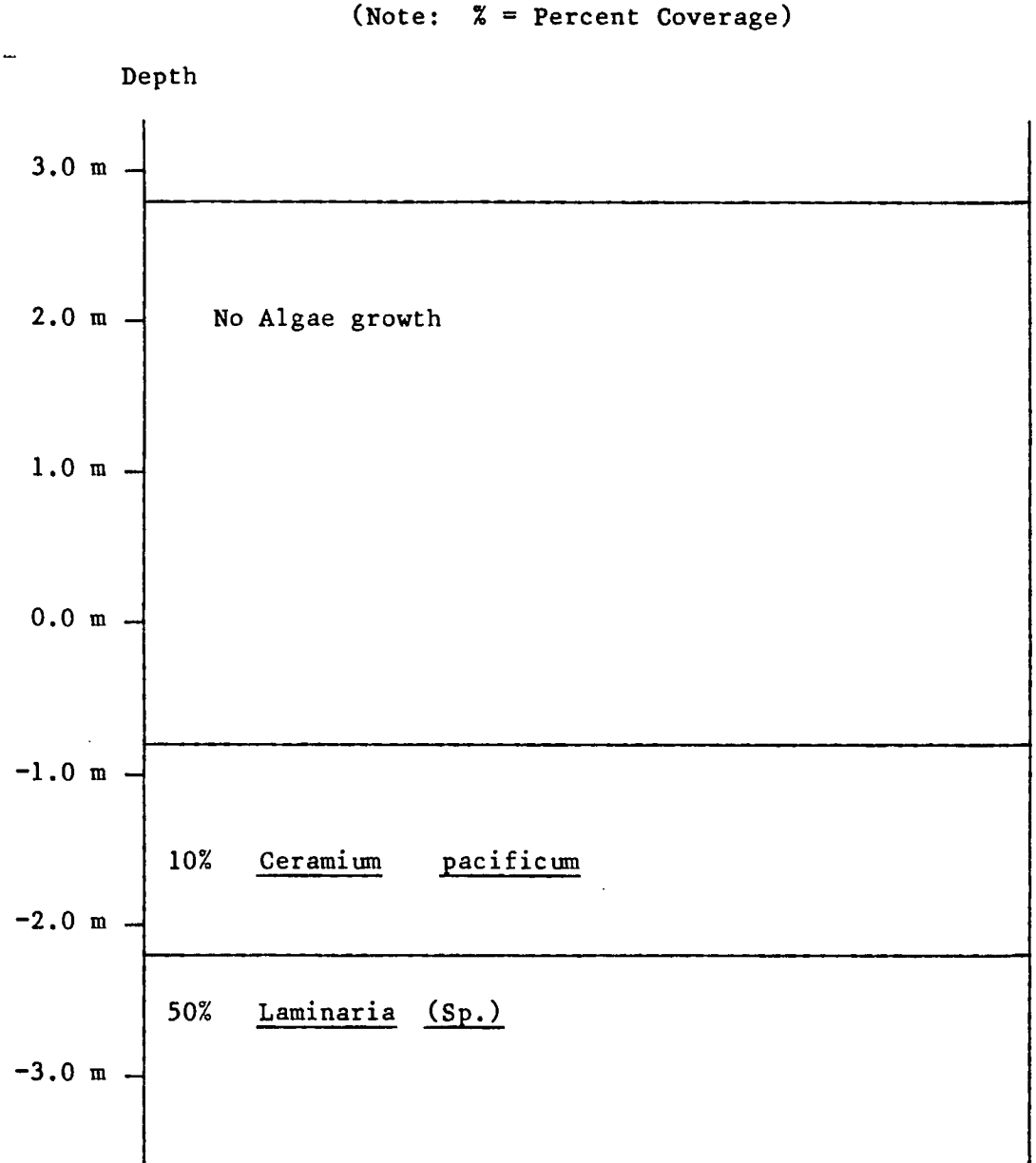


COMOX MARINA

Survey of Algae on the Inside Breakwater

Surveyed 13:00 13/09/84 (Depths reduced to chart datum)

(Note: % = Percent Coverage)



BEACH GARDENS MARINA

Survey of Algae on the Inside Breakwater

Surveyed 12:50 25/10/84 (Depths reduced to chart datum)

(Note: % = Percent Coverage)

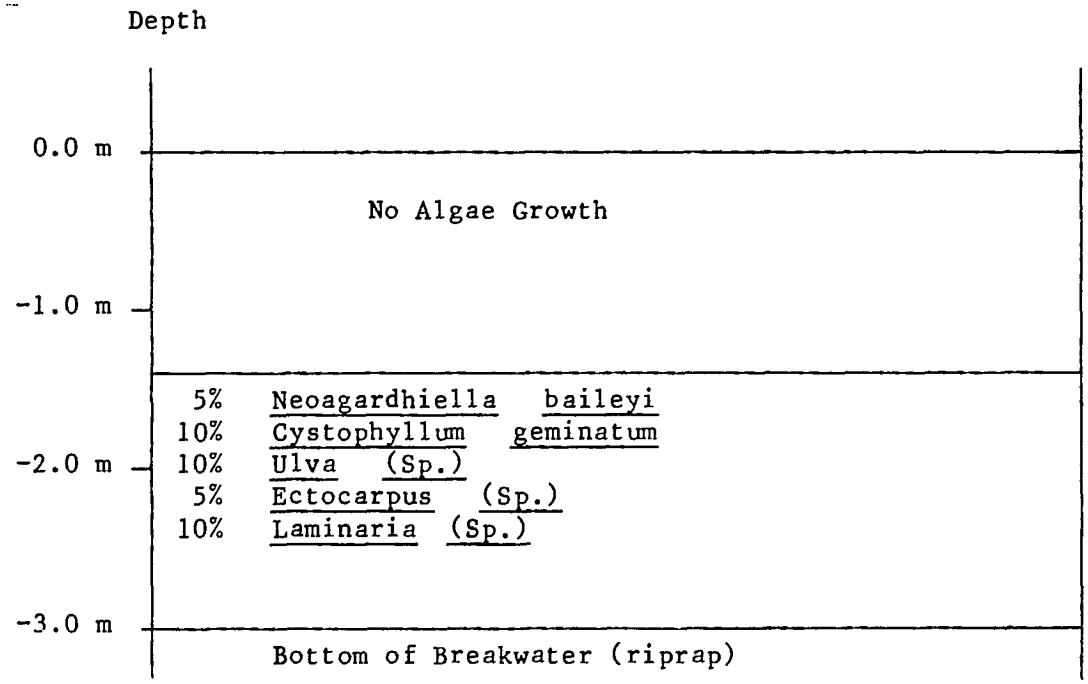


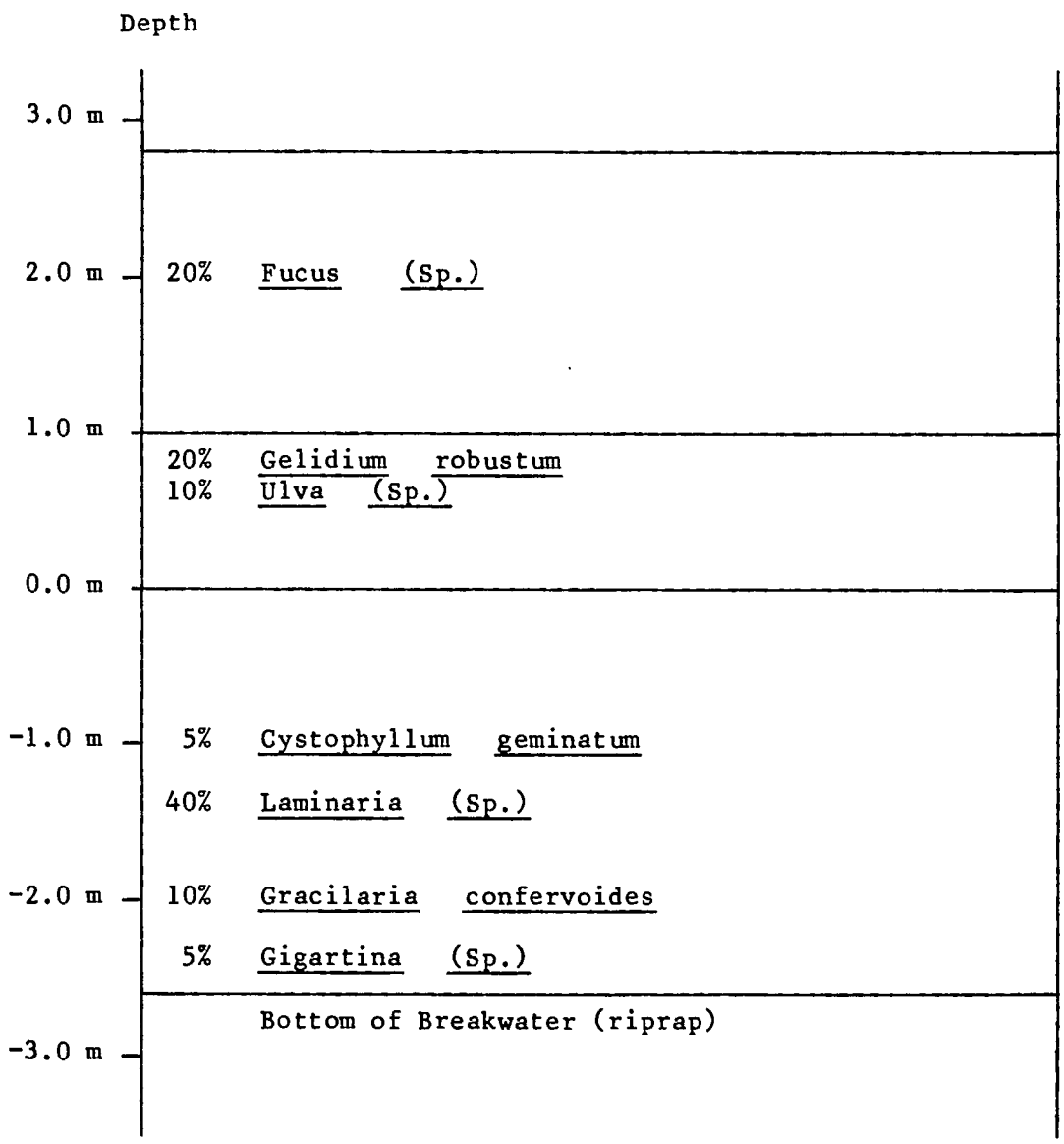
TABLE 8a: VEGETATION SURVEY OF OUTSIDE BREAKWATERS

FRENCH CREEK MARINA

Survey of Algae on the Outside Breakwater

Surveyed 14:30 12/11/84 (Depths reduced to chart datum)

(Note: % = Percent Coverage)

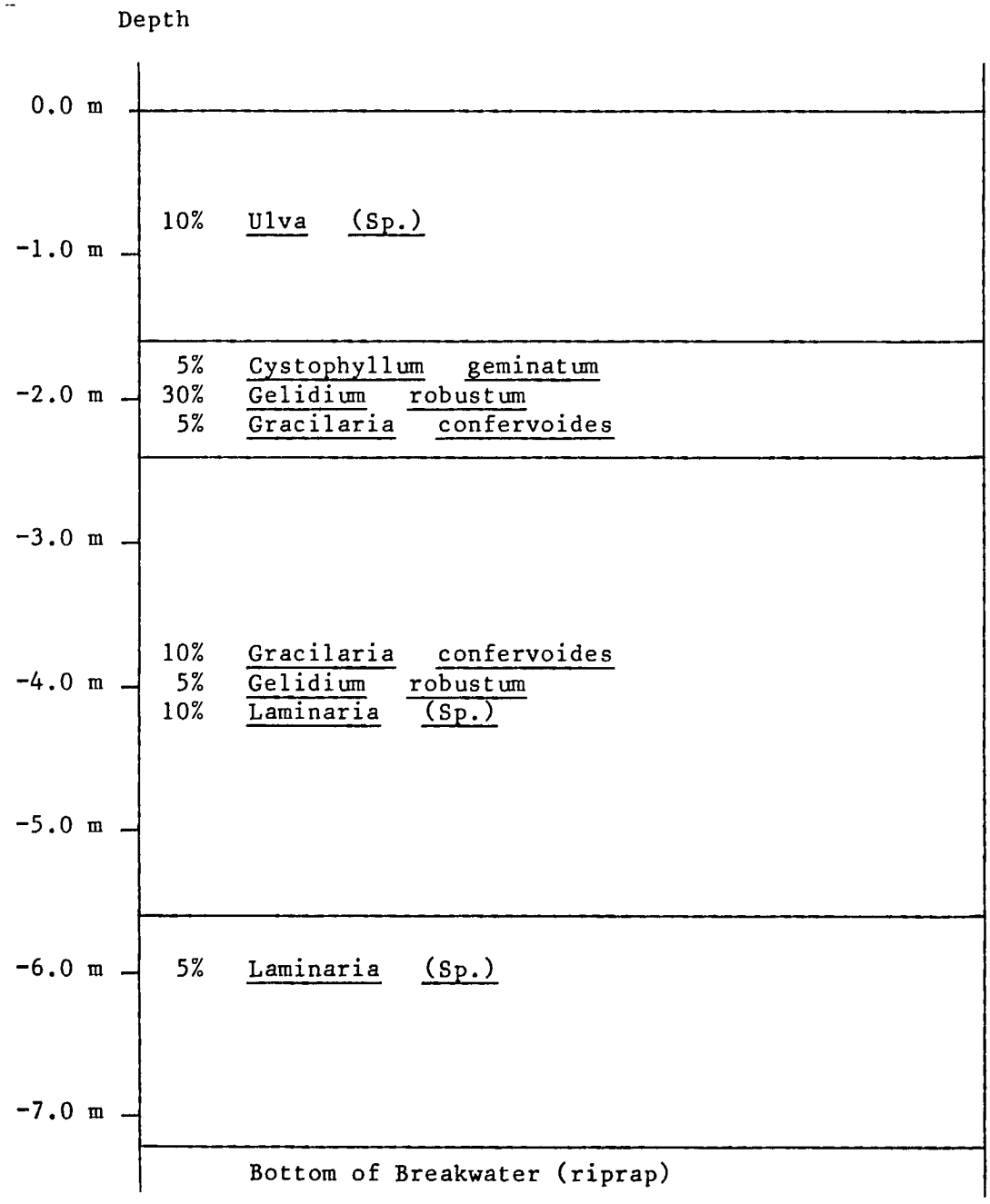


COMOX MARINA

Survey of Algae on the Outside Breakwater

Surveyed 12:00 08/11/84 (Depths reduced to chart datum)

(Note: % = Percent Coverage)



BEACH GARDENS MARINA

Survey of Algae on the Outside Breakwater

Surveyed 15:15 25/10/84 (Depths reduced to chart datum)

(Note: % = Percent Coverage)

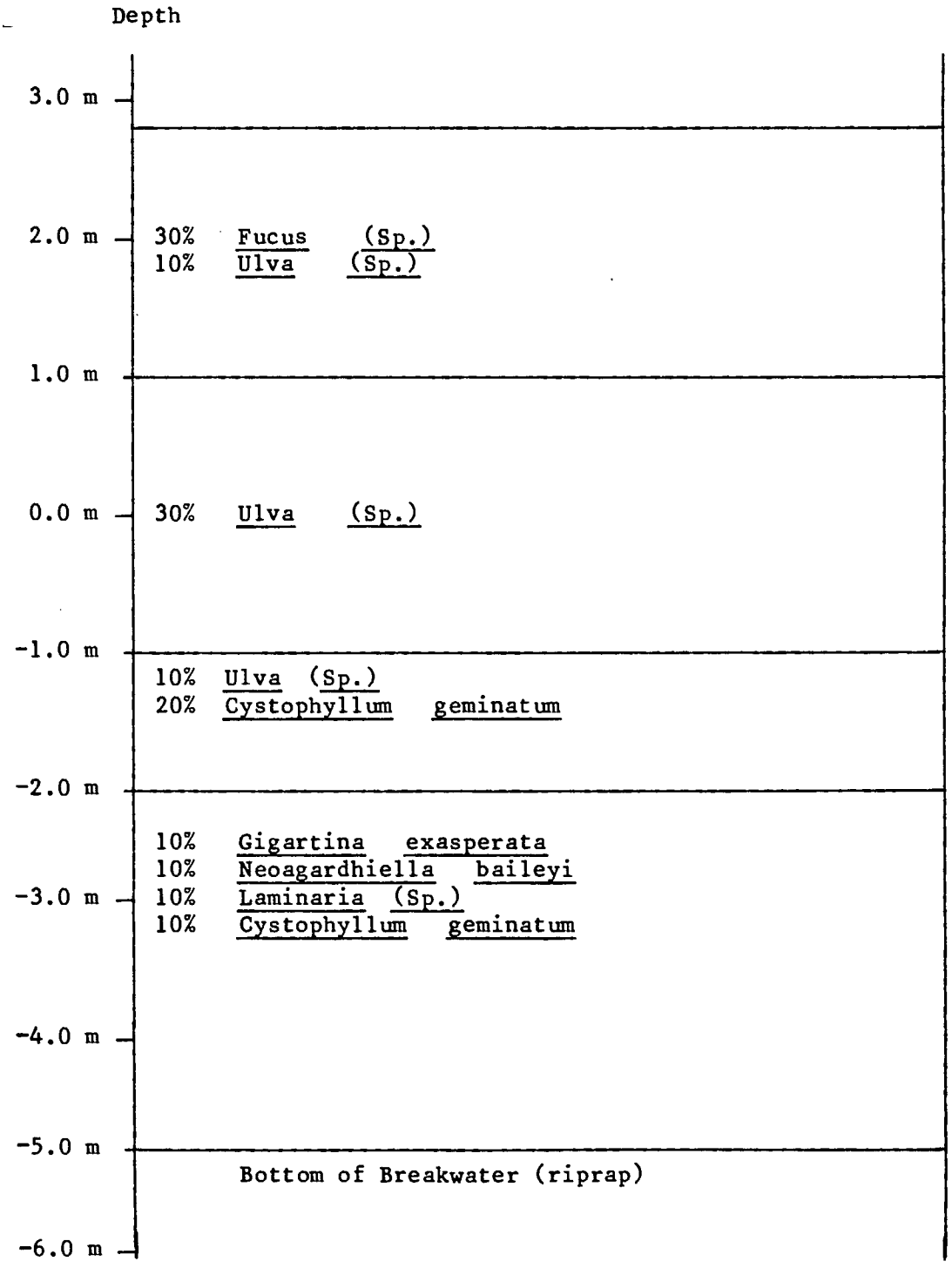


TABLE 9: MACROINVERTEBRATE SURVEY OF MARINA BASINS

SAANICHTON BAY

Macroinvertebrate Survey at the Proposed Marina Basin

Date Surveyed 23/08/84

Telmessus cheiragonus	1/1 m^2
Cancer magister	1/0.5 m^2
Cancer productus	1/2 m^2
Pandulus danae	1/0.1 m^2
Notoacmea persona	1/30 m^2
Mopalia muscosa	1/30 m^2
Macoma nasuta	1/0.1 m^2
Clinocardium nuttallii	1/0.5 m^2

FRENCH CREEK MARINA

Macroinvertebrate Survey of the Marina Basin Substrate

Date Surveyed 29/08/84

Cancer magister	1/2 m^2
Metriclium senile	1/1 m^2
Pachycerianthus fimbriatus	1/4 m^2
Dermasterias imbracata	1/4 m^2
Pisaster ochraceus	1/2 m^2

NANAIMO MARINA

Macroinvertebrate Survey of the Marina Basin Substrate

Date Surveyed 10/10/84

Cancer magister	1/3 m^2
Cancer productus	1/6 m^2
Evasterias troschelii	1/6 m^2
Dermasterias imbricata	1/30 m^2
Pycnopodia helianthoides	1/30 m^2
Metridium senile	1/6 m^2

COMOX MARINA

Macroinvertebrate Survey of the Marina Basin Substrate

Date Surveyed 12/09/84

Cancer magister	1/25 m^2
Pugettia producta	1/25 m^2
Cancer productus	1/75 m^2
Pisaster brevispinus	1/13 m^2
Parastichopus californicus	1/75 m^2

CANOE COVE MARINA

Macroinvertebrate Survey of the Marina Basin Substrate

Date Surveyed 03/10/84

Cancer productus	1/15 m^2
Pandalus danae	1/5 m^2
Evasterias troschelii	1/5 m^2
Pycnopodia helianthoides	1/20 m^2

BEACH GARDENS MARINA

Macroinvertebrate Survey of the Marina Basin Substrate

Date Surveyed 24/10/84

Cancer magister	1/30 m^2
Cancer productus	1/15 m^2
Pisaster ochraceus	1/50 m^2
Dermasterias imbricata	1/25 m^2
Pycnopodia helianthoides	1/20 m^2
Dirona albolineata	1/30 m^2

FRESHWATER MARINA

Macroinvertebrate Survey of the Marina Basin Substrate

Date Surveyed 07/11/84

Cancer magister	1/10 m^2
Cancer productus	1/100 m^2
Dirona albolineata	1/10 m^2
Pachycerianthus fimbriatus	1/5 m^2
Metridium senile	1/20 m^2

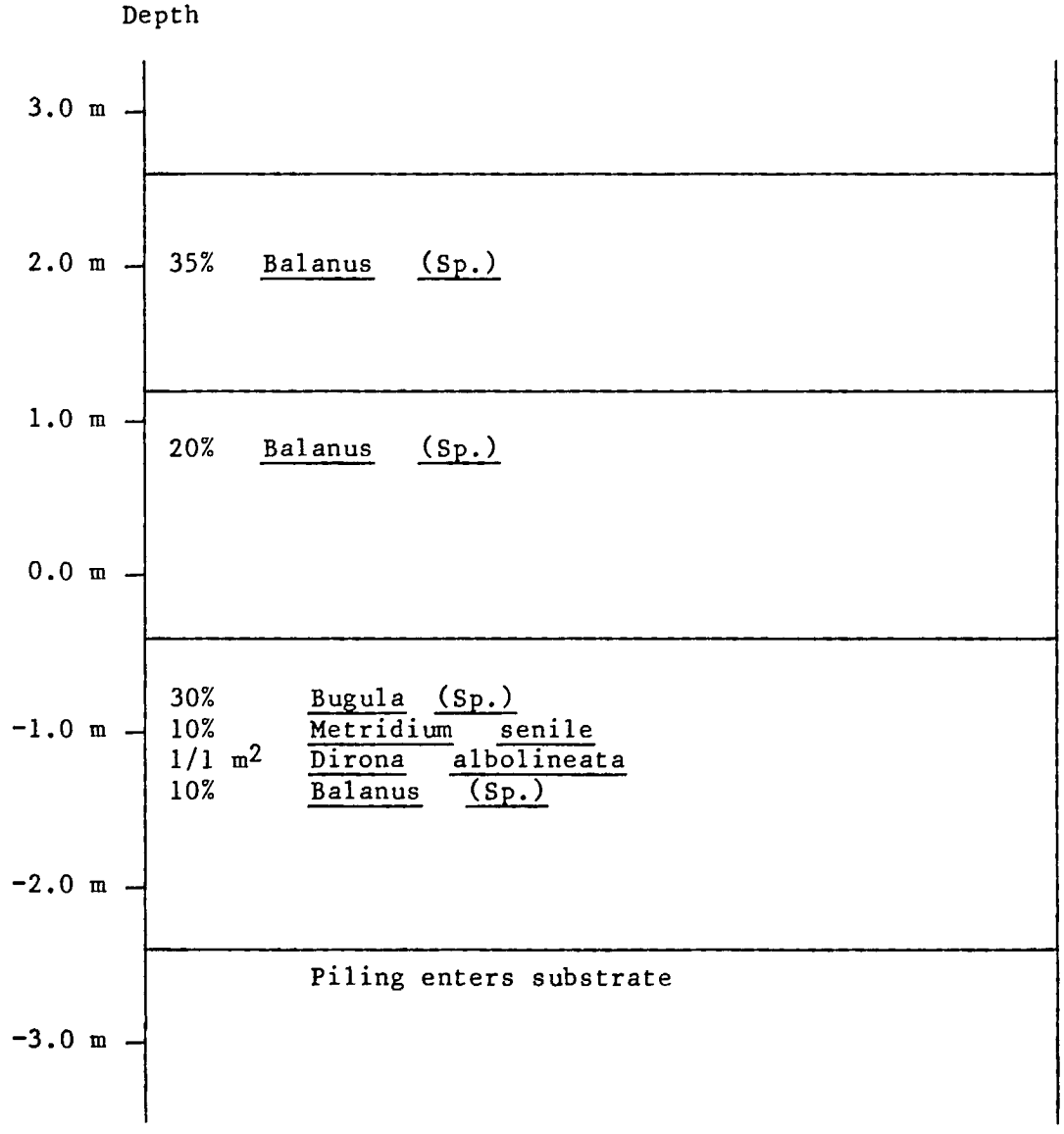
TABLE 10: MACROINVERTEBRATE AND ALGAE SURVEY OF MARINA PILINGS

FRENCH CREEK MARINA

Survey of Macroinvertebrates and Algae on the Pilings

Surveyed 13:00 29/08/84 (Depths reduced to chart datum)

(Note: % = Percent Coverage)

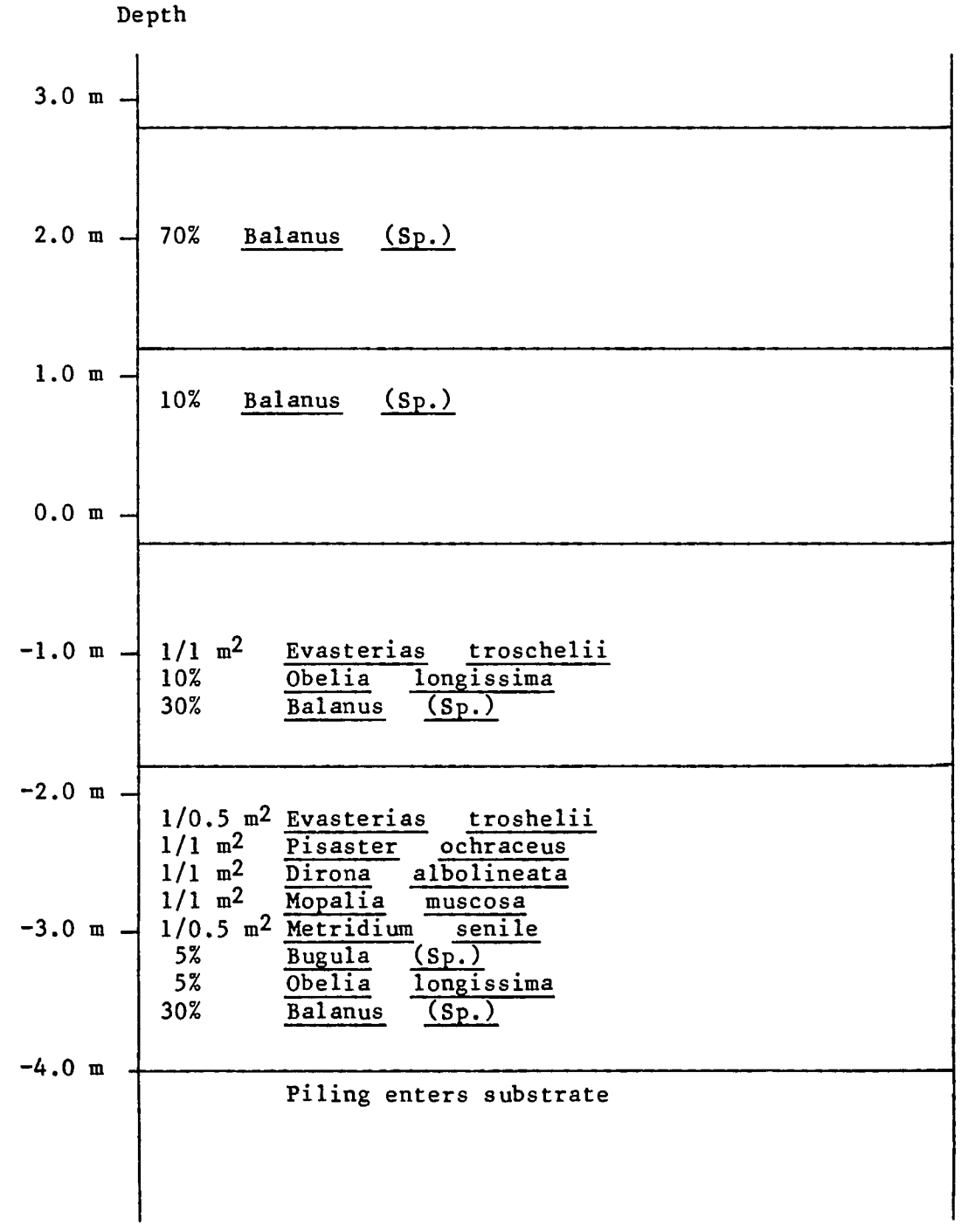


NANAIMO MARINA

Survey of Macroinvertebrates and Algae on the Pilings

Surveyed 11:00 11/10/84 (Depths reduced to chart datum)

(Note: % = Percent Coverage)

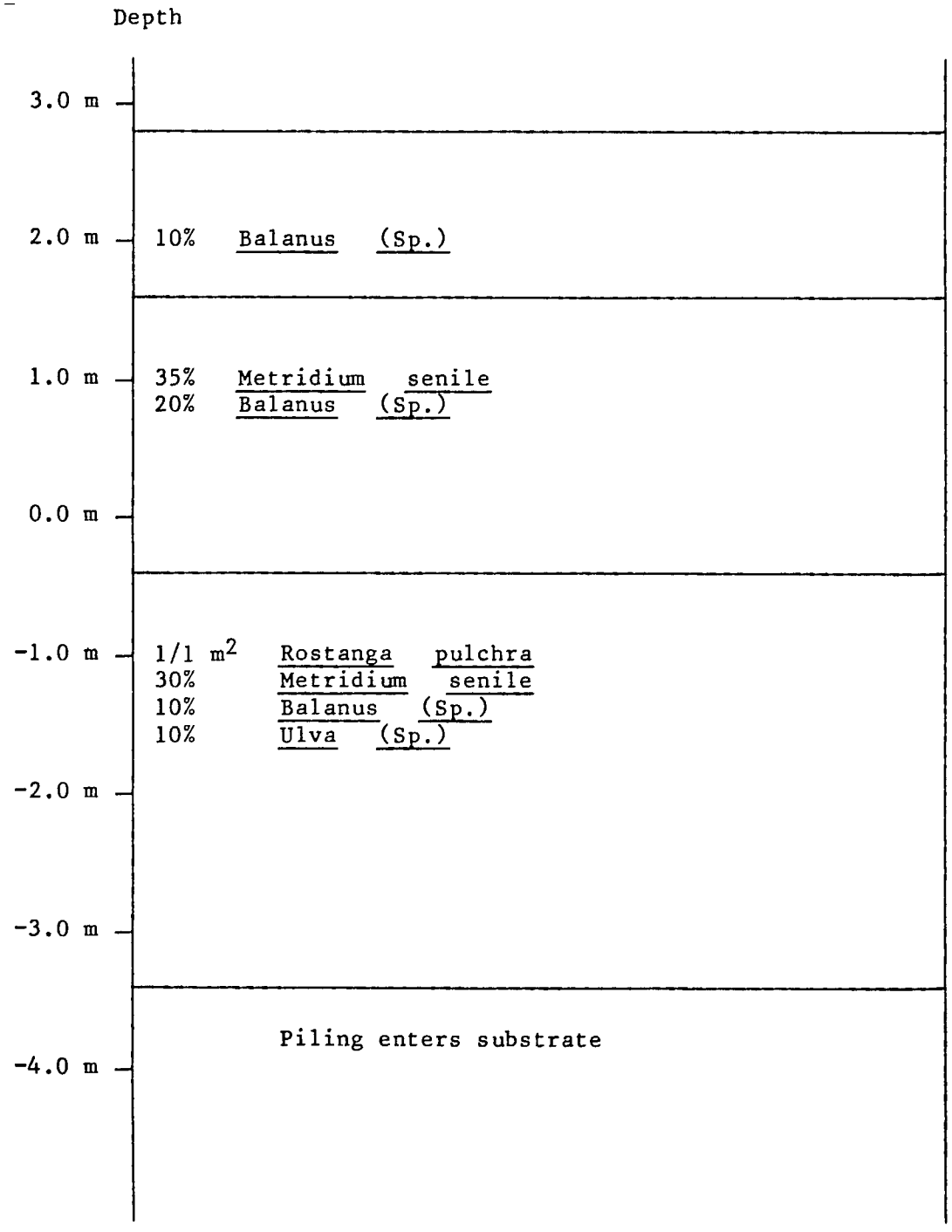


COMOX MARINA

Survey of Macroinvertebrates and Algae on the Pilings

Surveyed 14:00 12/09/84 (Depths reduced to chart datum)

(Note: % = Percent Coverage)

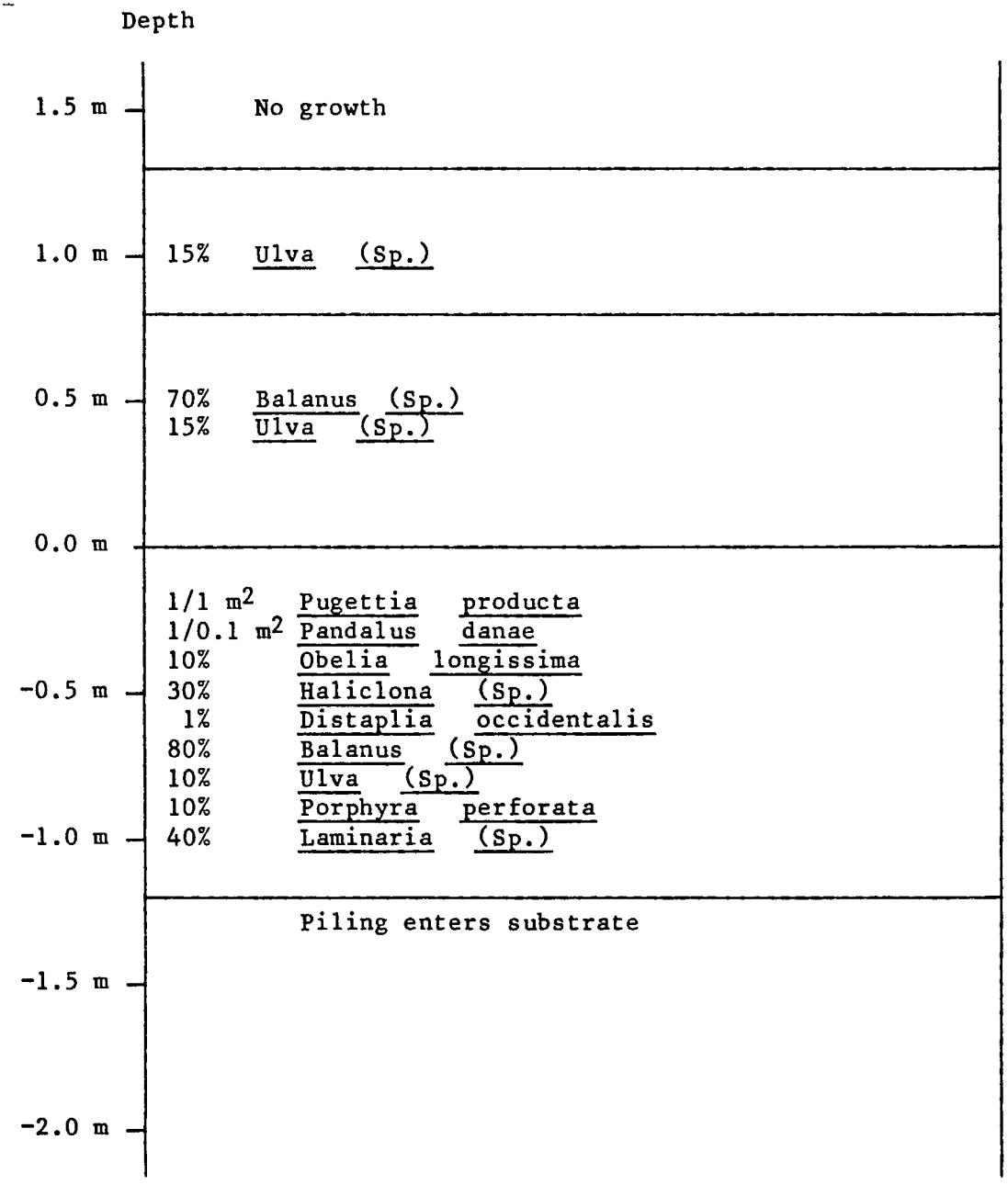


CANOE COVE MARINA

Survey of Macroinvertebrates and Algae on the Pilings

Surveyed 14:00 02/10/84 (Depths reduced to chart datum)

(Note: % = Percent Coverage)

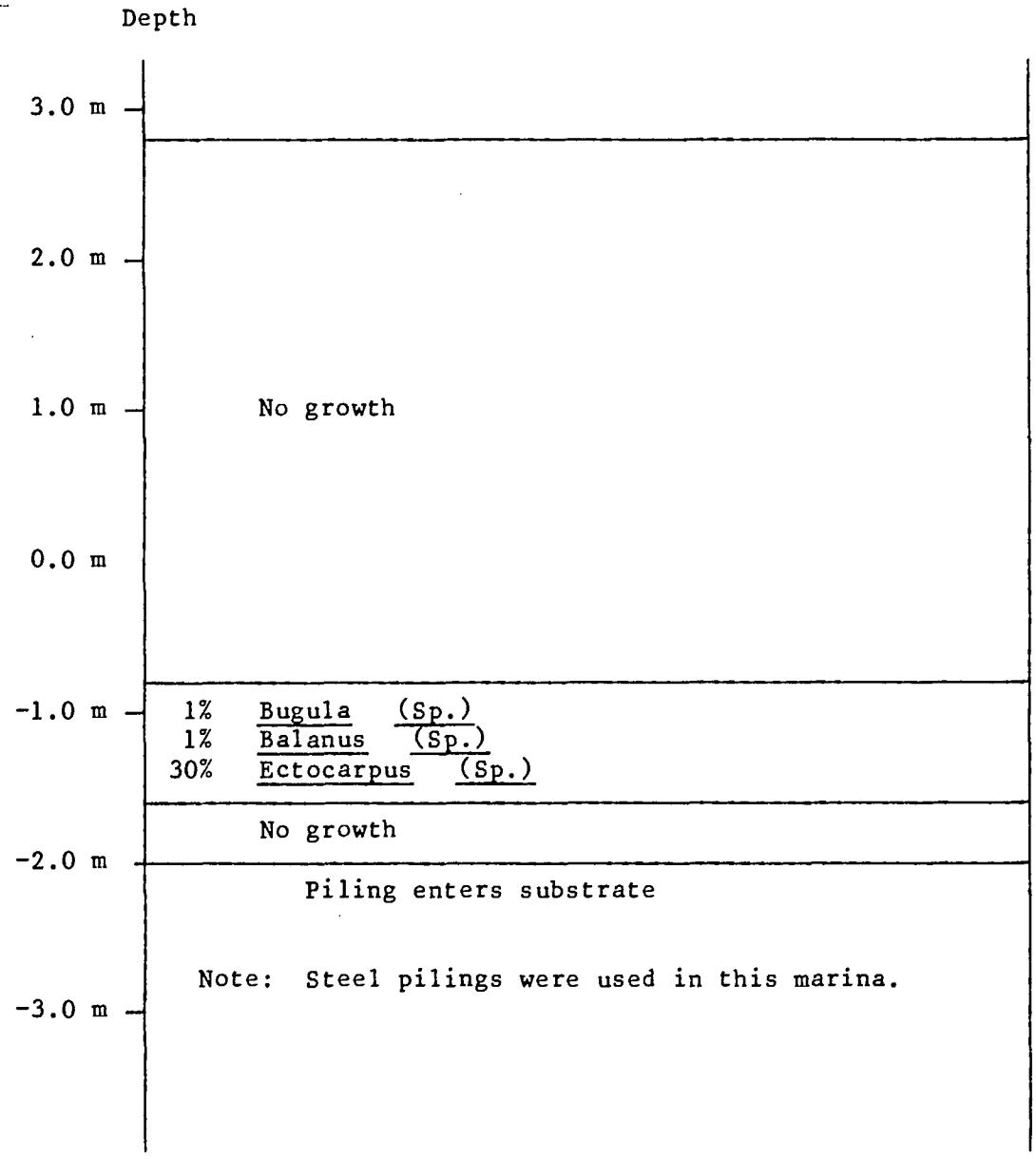


BEACH GARDENS MARINA

Survey of Macroinvertebrates and Algae on the Pilings

Surveyed 11:00 24/10/84 (Depths reduced to chart datum)

(Note: % = Percent Coverage)



FRESHWATER MARINA

Survey of Macroinvertebrates and Algae on the Pilings

Surveyed 12:00 07/11/84 (Depths reduced to chart datum)

(Note: % = Percent Coverage)

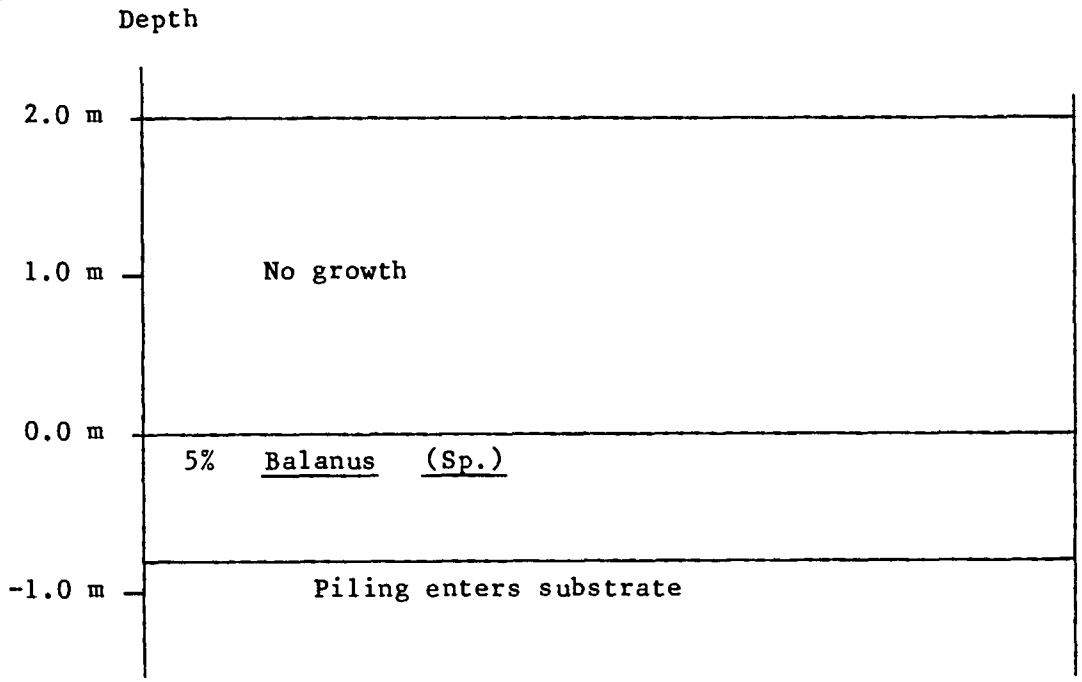


TABLE 11: MACROINVERTEBRATE SURVEY OF MARINA WHARFS

FRENCH CREEK MARINA

Macroinvertebrate Survey of the Marina Wharfs

Date Surveyed 29/08/84

Balanus glandula	20% Coverage
Mytilus edulis	1/0.02 m^2
Mopalia muscosa	1/0.1 m^2
Metridium senile	1/0.1 m^2
Corella willmeriana	10% Coverage
Obelia longissima	20% Coverage

NANAIMO MARINA

Macroinvertebrate Survey of the Marina Wharfs

Date Surveyed 11/10/84

Balanus glandula	10% Coverage
Mytilus edulis	1/0.2 m^2
Metridium senile	1/4 m^2
Obelia longissima	30% Coverage

COMOX MARINA

Macroinvertebrate Survey of the Marina Wharfs

Date Surveyed 12/09/84

Balanus glandula	90% Coverage
Mytilus edulis	1/0.02 m^2
Pisaster ochraceus	1/10 m^2
Obelia longissima	25% Coverage

CANOE COVE MARINA

Macroinvertebrate Survey of the Marina Wharfs

Date Surveyed 02/10/84

Balanus glandula	20% Coverage
Tealia crassicornis	1/0.3 m^2
Corella willmeriana	10% Coverage
Obelia longissima	10% Coverage

BEACH GARDENS MARINA

Macroinvertebrate Survey of the Marina Wharfs

Date Surveyed 24/10/84

Balanus glandula	1% Coverage
Dirona albolineata	1/10 m^2
Mytilus edulis	1/0.01 m^2
Mopalia muscosa	1/1 m^2
Metridium senile	1/0.25 m^2
Obelia longissima	20% Coverage
Bugula (Sp.)	5% Coverage
Corella willmeriana	20% Coverage
Halichondria panicea	5% Coverage

FRESH WATER MARINA

Macroinvertebrate Survey of the Marina Wharfs

Date Surveyed 07/11/84

No Invertebrates observed

3.8.4 Breakwaters

A list of the macroinvertebrates observed on the breakwaters at each marina is shown in table 12. All of the breakwaters had substantial macroinvertebrate populations with the exception of the Nanaimo Marina inside breakwater.

3.9 Fish

3.9.1 Fish Survey

The approximate number of each species of fish observed at each marina is listed in table 13. Numerous fish were observed at all the marinas with the exception of Canoe Cove Marina and Freshwater Marina. In most marinas scuba divers noted specific locations (generally a small area) where fish were repeatedly sighted.

3.9.2 Stomach Sample Analysis

During the August to December 1984 sampling period 169 fish were captured, representing 19 species and 5 orders. Two fish orders (scorpaeniformes, 65 fish; perciformes, 65 fish) accounted for 77% of the total yield. The food organism percent occurrence in the stomachs of the fish orders scorpaeniformes and perciformes is shown in table 14. The food organisms with the largest percent occurrence in perciformes stomachs were amphipods (68%), polychaetes (46%) and decapods (32%). The food organisms with the largest percent occurrence in scorpaeniformes stomachs were decapods (60%), nematodes (34%) and oligochaetes (23%). The stomach contents of each individual fish captured is listed in Appendix VI.

TABLE 12: MACROINVERTEBRATE SURVEY OF INSIDE AND OUTSIDE BREAKWATERS

FRENCH CREEK MARINA

Survey of Macroinvertebrates on the Inside Breakwater

Date Surveyed 14/09/84

Dermasterias imbricata	1/4 m^2
Pisaster ochraceus	1/35 m^2
Diaulula sandiegensis	1/50 m^2
Metridium senile	1/9 m^2
Balanus glandula	30% Coverage

Survey of Macroinvertebrates on the Outside Breakwater

Date Surveyed 12/11/84

Pugettia producta	1/5 m^2
Pisaster ochraceus	1/5 m^2
Pycnopodia helianthoides	1/15 m^2
Tonicella lineata	1/2 m^2
Balanus glandula	60% Coverage

NANAMO MARINA

Survey of Macroinvertebrates on the Inside Breakwater

Date Surveyed 11/10/84

Balanus (Sp.)	25% Coverage

COMOX MARINA

Survey of Macroinvertebrates on the Inside Breakwater

Date Surveyed 13/09/84

Cancer magister	1/40 m^2
Cancer productus	1/4 m^2
Dermasterias imbricata	1/50 m^2
Pycnopodia helianthoides	1/140 m^2
Parastichopus californicus	1/10 m^2
Tonicella lineata	1/0.5 m^2
Mopalia muscosa	1/1 m^2
Dinulula sandiegensis	1/100 m^2
Metridium senile	1/1 m^2
Notoacmea persona	1/0.25 m^2
Balanus glandula	20% Coverage

Survey of Macroinvertebrates on the Outside Breakwater

Date Surveyed 08/11/84

Pugettia producta	1/20 m^2
Dermasterias imbracata	1/10 m^2
Henricia sanguinolenta	1/10 m^2
Pycnopodia helianthoides	1/5 m^2
Parastichopus californicus	1/10 m^2
Tonicella lineata	1/0.25 m^2
Balanus glandula	40% Coverage

BEACH GARDENS MARINA

Survey of Macroinvertebrates on the Inside Breakwater

Date Surveyed 25/10/84

Cancer magister	1/40 m^2
Cancer productus	1/15 m^2
Pugettia producta	1/40 m^2
Pisaster ochraceus	1/40 m^2
Dermasterias imbricata	1/15 m^2
Pycnopodia helianthoides	1/15 m^2
Mopalia muscosa	1/10 m^2
Dirona albolineata	1/15 m^2
Balanus glandula	20% Coverage

Survey of Macroinvertebrates on the Outside Breakwater

Date Surveyed 25/10/84

Cancer productus	1/40 m^2
Pisaster ochraceus	1/40 m^2
Dermasterias imbracata	1/10 m^2
Pycnopodia helianthoides	1/10 m^2
Tonicella lineata	1/5 m^2
Mopalia muscosa	1/10 m^2
Dirona albolineata	1/5 m^2
Hermissenda crassicornis	1/5 m^2
Notoacmea persona	1/2 m^2
Notoacmea scutum	1/2 m^2
Balanus glandula	30% Coverage

TABLE 13: FISH SURVEY

Fish observed by Scuba divers during

Vegetation and Macroinvertebrate Surveys

Marina	Location	Date	Species of Fish	No. fish	Duration of Dive
Saanichton Bay	Proposed Marina Basin	23/08/84	Enophrys bison	6	2 hrs
French Creek	Marina Basin	29/08/84	Cymatogaster aggregata	100	1 hr
	Outside B.W. Artificial Reef	05/09/84	Embiotoca lateralis	500	1/2 hr
	" "	"	Cymatogaster aggregata	40	" "
	" "	"	Sebastes caurinus	12	" "
	" "	"	Ophiodon elongatus	6	" "
	" "	"	Hexagrammos decagrammus	4	" "
	" "	"	Hexagrammos stelleri	12	" "
	Inside Breakwater	14/09/84	Cymatogaster aggregata	40	2 1/2 hrs
	Outside B.W. Artificial Reef	27/11/84	Embiotoca lateralis	500	3 hrs
	" "	"	Ophiodon elongatus	12	" "
	" "	"	Hexagrammos lagocephalus	12	" "
	" "	"	Hexagrammos stelleri	12	" "
	Marina Basin	03/12/84	Cymatogaster aggregata	500	1 1/2 hrs
	" "	"	Clupea harengus	2000	" "
	" "	"	Citharichthys (Sp.)	600	" "
	Inside Breakwater	03/12/84	Ophiodon elongatus	20	1 1/2 hrs
Nanaimo	Boat Basin	22/11/84	Ophiodon elongatus	15	4 hrs
	" "	"	Cymatogaster aggregata	150	" "
	" "	"	Hexagrammos decagrammus	20	" "
	C.P.R. Dock	23/11/84	Hexagrammos superciliosus	50	" "
	" "	"	Cymatogaster aggregata	200	" "
	" "	"	Hexagrammos decagrammus	20	" "
Comox	Marina Basin	12/09/84	Cymatogaster aggregata	50	2 hrs
	Inside Breakwater	13/09/84	Sebastes caurinus	100	2 1/2 hrs
	" "	"	Ophiodon elongatus	3	
	" "	"	Cymatogaster aggregata	100	" "
	Outside Breakwater	29/11/84	Ophiodon elongatus	36	2 hrs
	" "	"	Hexagrammos lagocephalus	24	" "
	" "	"	Sebastes caurinus	12	" "
	" "	"	Embiotoca lateralis	200	" "
	Marina Basin	06/12/84	Cymatogaster aggregata	250	1 1/2 hrs
	" "	"	Clupea harengus	5,000	" "
	Inside Breakwater	06/12/84	Ophiodon elongatus	5	1 1/2 hrs
	" "	"	Sebastes (Sp.)	8	" "
	" "	"	Hexagrammos decagrammus	10	" "

TABLE 13: FISH SURVEY

Fish observed by Scuba divers during

Vegetation and Macroinvertebrate Surveys (cont'd)

Marina	Location	Date	Species of Fish	No. fish	Duration of Dive
Beach Gardens	Marina Basin	24/10/84	Cymatogaster aggregata	500	2 hrs
	" "	"	Syngnathus griseolineatus	500	" "
	Inside Breakwater	24/10/84	Sebastes (Sp.)	200	1 hr
	" "	"	Ophiodon elongatus	2	" "
	" "	"	Oxylebius pictus	1	" "
	" "	"	Hydrolagus colliei	1	" "
	Outside Breakwater	25/10/84	Embiotoca lateralis	500	$1\frac{1}{2}$ hrs
	" "	"	Sebastes (Sp.)	100	" "
	" "	"	Ophiodon elongatus	50	" "
	" "	"	Hexagrammos decagrammus	20	" "
Canoe Cove	Marina Basin		No Fish observed Sept 24 to Sept 27 1984		
Freshwater	Marina Basin		No Fish observed Nov 6 to Nov 8 1984		

TABLE 14: FOOD ORGANISMS PERCENT OCCURRENCE IN THE FISH STOMACHS OF TWO DOMINATE FISH ORDERS

Order of Fish Studied	Order of Organism Found in Fish Stomach	% Organism Occurrence in Stomachs Containing Food	$\bar{X}$ No. Organisms/ Stomachs in Which They Occurred
Perciformes (n = 65)	Amphipod	68	15.6
	Polychaete	46	14.8
	Decapod	32	7.4
	Bivalve	26	5.8
	Calanoid	23	5.4
	Gastropod	22	3.8
	Nematode	17	4.4
	Eggs	14	1.9
	Harpactecoid	12	10.6
	Cirripedia	12	4.9
	Tanaidacea	9	4.5
	Oligochaete	9	2.7
	Isopod	6	2.3
	Chitunida	5	9.3
	Egg Mass	5	1
	Turbellaria	3	8.5
	Cyclopoid	3	1
	Gasterosteiforme	2	4
	Cumacea	2	2
	Acarina	2	1
	Ostracod	2	1
	Copepod Nauplii	2	1
	Fish roe	2	1
Scorpaeniformes (n = 65)	Decapod	60	4.3
	Nematode	34	2.9
	Oligochaete	23	3.1
	Egg Mass	22	1
	Egg	15	9.2
	Polychaete	15	1.8
	Perciforme	12	1.1
	Scorpaeniforme	8	1
	Amphipod	6	1.2
	Gastropod	5	3.7
	Calanoid	5	2.3
	Fish roe	5	1.7
	Bivalve	3	5.5
	Harpactecoid	3	2
	Turbellaria	3	1
	Gasterosteiforme	2	14
	Cirripedia	2	3
	Cyclopoid	2	1
	Anguilliforme	2	1
	Actinaria	2	1

4. DISCUSSION

4.1 Dissolved Oxygen Sampling

The results of the dissolved oxygen tests suggest that generally a lower quality of water exists within marina basins (Table 2). The lowest dissolved oxygen readings were taken at Nanaimo Marina ($\bar{x}$ = 7.0 mg/L) and French Creek Marina ($\bar{x}$ = 7.0 mg/L). The low dissolved oxygen level at Nanaimo Marina may have been caused partially by the discharge from the numerous storm drains that empty into the marina basin (figure 3c). This is consistent with Soule and Oguri (1977) who found storm sewer runoff caused a significant reduction in dissolved oxygen concentrations in Marina del Rey. The maintenance (or spot) dredging conducted at French Creek Marina a few days prior to our water testing may have partially caused the low dissolved oxygen readings. This is supported by Brown and Clark (1968) who found that during dredging of a tidal waterway the dissolved oxygen content was temporarily reduced to levels of from 16% to 33% below normal.

It should be noted that the Hach kit used to determine the dissolved oxygen levels is not extremely accurate. Also, all of the dissolved oxygen readings taken inside the marina basins were above the minimum level (6.5 mg/L Davis, 1975) for the survival of a major portion of the fish population. If we were to determine the effects of the apparent lower dissolved oxygen levels in the marina basins it would require a more extensive study.

4.2 Fecal Coliform Sampling

The fecal coliform tests generally indicate that marina basins have a higher fecal coliform contamination than the adjacent foreshore (figure 5 and 6). There is insufficient evidence in our results to suggest that marinas with liveaboards have higher fecal coliform contamination than marinas without liveaboards. The large variation in fecal coliform counts within each marina basin (table 3) make determining the exact level of coliform contamination difficult. These findings are supported by Fufari (1968) who states that boat waste studies can be confusing and inconclusive because coliform counts are influenced by boat densities, the number of people per boat, and the day of the week the samples were taken. In addition, it is difficult to determine if the coliforms are from human or animal waste. To date the E.P.S or E.P.A. have not published health standards for the allowable fecal coliform counts/100g of sediment

(note: fecal coliform contamination in sediment is generally considered 10 - 100 times greater than the contamination in the adjacent water). The very high fecal coliform levels in the Comox Marina sediment and Comox Harbour sediment have resulted in follow-up sampling to determine the source of the excessive sewage contamination.

4.3 Marina Basin Benthos Sampling

When comparing the mean total abundance of benthic organism/m^2 in the marina basins to the control sites (figure 7) no clear relationship emerges. Four of the marinas had a larger total abundance of benthic organisms than their corresponding control sites; conversely, three of the control sites had a larger total abundance of benthic organisms than their corresponding marinas. Individual benthos cores from the same sample area exhibited substantial differences in total benthos abundance (Appendix I). The patchiness of benthic communities (recognized since 1913, Petersen) accounts for the large variation in benthos abundance within individual marina basins and control sites, and may explain the lack of a clear relationship between the marina basins and control sites. It is often found that the production, or standing crop, of a given species in benthic communities on seemingly similar seafloors, sometimes not very distant from each other, varies to a surprising degree (McConnaughey 1974). Finlay (1981) demonstrated that contagion is a function of the core size, season of the year and taxon studied. Also, daily or tidal differences are known to occur in meiofaunal densities (Broaden and Platt, 1971) (Palmer and Brandt, 1981). In light of the above factors, to quantitatively measure the benthos density accurately would require a much more detailed analysis. The benthos data in this study should only be used to indicate very general trends.

It appears that marina basins and their adjacent foreshores have roughly equal densities of benthic organisms. Comparing marina basins to control sites, there is no conclusive evidence to suggest a substantial difference in the number of orders of benthic organisms (table 5). The information in figure 8 and figure 9 indicates that the numerically predominant benthic organisms in the marinas and control sites are nematodes, polychaetes, oligochaetes, harpacticoids and bivalves. The data in Appendix II suggests that the benthos of marina basins and adjacent foreshores have similar organism percent compositions.

4.4 Pilings, Wharfs and Breakwaters Fauna Sampling

Our sampling implies that a large variety of orders of epiphytic organisms inhabit the pilings, wharfs and breakwaters (table 6). We observed numerous Embiotoca lateralis (striped perch) containing large numbers of Mytilus edulis (blue mussels) suggesting fouling organisms may be an important fish food. In support of this Nixon (1973) found that fouling communities with their maximum abundance in late summer, followed by their breakup into the water in fall, may serve as an important food supplement during the time when juvenile fish are abundant and larger numbers of adult fish are present.

4.5 Zooplankton Sampling

The empirical evidence suggests that there is no substantial difference between the number of orders of zooplankton organisms represented in the marina basins zooplankton and in the adjacent foreshores zooplankton (table 7). However, it should be noted that the sampling period was very limited (3 days). Cardwell and others (1980) performed an intensive study at Skyline Marina in Northern Puget Sound. After an eight month sampling period they found the overall zooplankton densities in the marina ($\bar{x}$ = 4,168/100m^3) were only slightly less than those in the adjacent bay ($\bar{x}$ = 5,623/100m^3), yet the difference was significant ($p >$ .001). The bay zooplankton populations were generally represented by more taxocences which apparently stabilized the fluctuations in population size. Cardwell and others (1980) also noted, however, brachyura, mysidacea, calanoida, and amphipoda not only accounted for 89 ± 10% and 80 ± 13% of the surface zooplankton caught at night in the marina and bay respectively, but also were among the most important prey of fish. This suggests that the zooplankton from the marina basin and adjacent bay contributed approximately equal quantities of fish food.

4.6 Vegetation Survey

The observations of the scuba divers indicate substantial algae growth on the substrate of the marina basins and breakwaters. The absence of algae growth in the marina basin at French Creek may have been caused by the recent dredging. The Zostera (eelgrass) and other algal mats observed in the marina basins (figures 13a - 13f) have the potential to support large populations of detritivores, in particular harpactecoid copepods and gammarid amphipods which are major food items for juvenile salmonids (Simenstad 1979). Vegetated areas also offer a protective habitat for juvenile fish and a spawning habitat for

herring. This implies that the majority of marinas may afford productive fish habitats.

4.7 Macroinvertebrates Survey

The observations of the scuba divers suggest that marina basins contain an abundant macroinvertebrate population (table 9). The pilings, wharfs, and breakwaters also appear to have substantial macroinvertebrate populations (tables 10, 11, 12). The lack of a substantial macroinvertebrate population on the pilings and wharfs in Freshwater Marina is possibly the result of the low salinity of the water. The substantial oxidation of the steel pilings in Beach Gardens Marina may explain the low macroinvertebrate density on these pilings. The majority of the macroinvertebrates surveyed on the breakwaters resided below 1 meter explaining the sparse density of macroinvertebrates observed on the shallower Nanaimo inside breakwater. The results of the macroinvertebrate surveys of the breakwaters suggest that the base of breakwaters must be over 2 meters deep at chart datum to support a substantial macroinvertebrate population. In general, marinas seem to provide a favorable habitat for a large variety of macroinvertebrates.

4.8 Fish

4.8.1 Fish Survey

The scuba divers' observations suggest that marina basins contain an abundant and diverse fish population (table 13). The apparent lack of fish at Freshwater Marina and Canoe Cove Marina was probably due to the the short survey period, (2 hrs) and the inability of the scuba divers to locate the feeding areas of the fish. In support, Fisheries and Marine Service (1978) captured 15 fish (using gillnets) in Freshwater Marina. Cardwell and other (1980) found Skyline Marina's fish population was numerically larger, more diverse and rich in species than those in the adjacent bay. No salmonids were observed during the scuba survey. This may be explained by the combination of the time of year (fall) the survey was conducted and the difficulty of sighting adult salmon. Penttila and Aguero, (1978) found that marinas definitely attract and support large populations of salmon and baitfish juveniles.

In the marina basin at Nanaimo and the breakwaters at French Creek and Comox, numerous large predatory fish (fork length 53 cm - 81 cm, Ophidon elongatus) were captured (Appendix VI). In light of the above, it is possible

that juvenile fish are excessively predated in and around marinas. We recommend investigating this hypothesis further.

4.8.2 Stomach Sample Analysis

The gut analysis of the fish orders scorpaeniformes and perciformes (table 14) indicate that their major food sources are amphipods, decapods, polychaetes, nemotodes, and bivalves. There appears to be no substantial difference in the abundance of these food items in the benthos of the marina basins and their adjacent foreshores (figure 8 and 9). This suggests that the benthos of marina basins are equivalent to the benthos of their adjacent foreshores in supplying food items for these two dominant fish orders. Perhaps a more extensive study with the identification of food organisms to the species level would indicate a difference in food supply between the benthos of marina basins and their adjacent foreshores.

4.9 Summary

This study was designed as a biophysical inventory and consequently sampling intensity was not sufficient to pick up subtle, yet potentially important differences between marinas and adjacent control areas or between marinas located in different areas on the Vancouver Island coast.

In general, any change in the physiographic features of the foreshore can be assumed to have an environmental impact. Marinas alter the shoreline, therefore, having a complex impact, both negative and positive, on a small section of foreshore. When they are constructed they alter the aquatic habitat and may cause local water quality degradation, especially within their confines. Conversely, they feature a potential lucrative habitat for key species of fish and invertebrates, and may be favored by some species. Therefore, marinas seem to yield an "altered" habitat, not necessarily a "degraded" habitat. We recommend that a pre and post development (construction of marina) study be performed at a proposed marina site (Saanichton Bay). A study of this nature would provide a relevant picture of the losses and gains of fish habitat by constructing small craft harbours.

Tables 15 and 15a summarize the differences in habitat quality parameters measured within and outside of the six existing marinas examined by this study.

TABLE 15: DIFFERENCES IN HABITAT QUALITY PARAMETERS (INSIDE MARINAS)

PARAMETERS	SAMPLE SITE					
	FRENCH CREEK MARINA	NANAIMO MARINA	COMOX MARINA	CANOE COVE MARINA	BEACH GARDENS MARINA	FRESHWATER MARINA
A) BENTHOS:						
i) $\bar{X}$ Total Abundance of Organisms/m^2	194,219	234,373	195,534	200,772	173,689	124,554
ii) Diversity (Number of Orders)	16	17	25	25	21	18
iii) Number of Orders Occurring in Fish Diets	11	12	16	17	15	14
iv) Percent Composition: Nematode	79%	72.1%	82.7%	89.6%	73.9%	80.8%
v) Percent Composition: Amphipod	0.2%	0.1%	0.4%	0.8%	0.6%	0.2%
vi) Percent Composition: Decapod	-	0.03%	0.03%	0.07%	0.01%	0.02%
B) ZOOPLANKTON:						
i) $\bar{X}$ Number of Organisms/m^2	407	498	52	No Sample Taken	No Sample Taken	No Sample Taken
ii) Diversity (Number of Orders)	19	21	21	No Sample Taken	No Sample Taken	No Sample Taken
iii) Number of Orders Occurring in Fish Diets	14	17	13	No Sample Taken	No Sample Taken	No Sample Taken
C) MEAN DISSOLVED OXYGEN LEVEL (mg/L)	9	7	8	8	9	7
D) MEAN FECAL COLIFORM COUNT PER 100 grams	200	715	25,813	170	2,623	83

TABLE 15a: DIFFERENCES IN HABITAT QUALITY PARAMETERS (CONTROL AREAS)

PARAMETERS	SAMPLE SITE							
A) BENTHOS:	FRENCH CREEK CONTROL	NANAIMO CONTROL #1	NANAIMO CONTROL #2	COMOX CONTROL	CANOE COVE CONTROL	BEACH GARDENS CONTROL	FRESHWATER MARINA	SAANICHTON BAY
i) $\bar{X}$ Total Abundance of Organisms/m^2	40,607	329,006	178,149	565,084	404,177	132,835	44,224	276,378
ii) Diversity (Number of Orders)	22	19	24	21	21	22	22	20
iii) Number of Orders Occurring in Fish Diets	14	13	16	16	16	15	15	16
iv) Percent Composition: Nematode	49.3%	91.7%	61.9%	90.8%	66.3%	73.5%	15.6%	67.2%
v) Percent Composition: Amphipod	2.1%	0.04%	1.3%	0.5%	2.8%	0.9%	17.0%	3.5%
vi) Percent Composition: Decapod	0.5%	0.03%	0.03%	0.03%	0.07%	0.02%	-	0.3%
B) ZOOPLANKTON:								
i) $\bar{X}$ Number of Organisms/m^2	681	376	No Sample Taken	378	No Sample Taken	No Sample Taken	No Sample Taken	No Sample Taken
ii) Diversity (Number of Orders)	16	24	No Sample Taken	19	No Sample Taken	No Sample Taken	No Sample Taken	No Sample Taken
iii) Number of Orders Occurring in Fish Diets	13	18	No Sample Taken	14	No Sample Taken	No Sample Taken	No Sample Taken	No Sample Taken
C) MEAN DISSOLVED OXYGEN LEVEL (mg/L)	9	9	10	9	8	10	9	9
D) MEAN FECAL COLIFORM COUNT PER 100 grams	100	63	28	16,913	65	20	563	125

5.0 References

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APPENDIX I - NUMBER OF BENTHIC ORGANISMS/M^2 IN BENTHOS SAMPLES
NUMBER OF BENTHIC ORGANISMS/M^2 IN BENTHOS SAMPLES FROM SAANICHTON BAY

SAMPLE	BENTHIC #1	BENTHIC #2	BENTHIC #3	BENTHIC #4	BENTHIC #5	BENTHIC #6
DATA	21/08/84	21/08/84	21/08/84	20/09/84	20/09/84	20/09/84
HARPACTECOIDS	4,932	617	18,495	45,005	21,824	8,384
CALANOIDS	4,069	247	-	17,015	1,480	1,480
CYCLOPOIDS	-	-	-	-	-	-
COPEPOD NAUPLII	-	-	-	247	370	617
NEMATODES	15,043	43,278	47,964	66,212	499,982	441,414
POLYCHAETES	8,754	617	2,219	15,166	5,179	13,563
OLIGOCHAETES	1,110	493	2,589	19,235	6,905	2,836
NEMERTEA	-	-	-	9,864	3,699	863
PARASITIC COPEPODS	123	-	-	-	-	-
BIVALVES	6,165	2,096	1,233	1,233	493	2,466
ACARINA	493	-	-	-	-	-
DECAPODS	1,233	-	2,343	863	123	247
ISOPODS	247	-	-	-	247	-
OSTRACODS	2,959	123	1,850	23,180	1,356	2,713
GASTROPODS	-	-	-	247	-	-
GASTROPOD EGGS	-	123	247	-	123	617
EGGS	-	-	-	2,096	986	123
TANAIDACEA	181,498	-	8,508	11,344	-	5,055
CUMACEA	740	123	-	3,083	123	370
CIRRIPEDIA	-	-	-	-	740	617
CIRRIPEDIA NAUPLII	-	-	-	-	-	-
AMPHIPODS	34,031	247	2,589	19,605	1,110	370
TURBELLARIA	-	-	-	-	-	-
TUNICATA (UROCHORDATA)	-	-	-	-	-	-
ECTOPROCTA COLONIES	-	-	-	-	-	-
ECHINODERMATA	-	-	-	-	-	-
CLADOCERA	-	-	-	-	-	-
INSECT LARVA	-	-	-	-	-	-
CRUSTACEA NAUPLII	-	-	-	-	-	-
CHITONIDA	-	-	-	-	-	-
STOMATOPODA	-	-	-	-	-	-
TOTAL ABUNDANCE OF ORGANISMS/m^2 IN EACH SAMPLE	261,397	47,964	88,037	234,395	544,740	481,735

NUMBER OF BENTHIC ORGANISMS/M^2 IN BENTHOS SAMPLES FROM FRENCH CREEK

	INSIDE MARINA						CONTROL AREA					
SAMPLE	BENTHIC #1	BENTHIC #2	BENTHIC #3	BENTHIC #4	BENTHIC #5	BENTHIC #6	BENTHIC #7	BENTHIC #8	BENTHIC #9	BENTHIC #10	BENTHIC #11	BENTHIC #12
DATE	28/08/84	28/08/84	28/08/84	06/09/84	06/09/84	06/09/84	18/10/84	18/10/84	18/10/84	29/10/84	29/10/84	29/10/84
HARPACTECOIDS	2,096	24,290	10,234	22,071	5,918	1,110	2,466	986	2,219	20,961	3,206	1,110
CALANOIDS	370	123	-	247	123	-	2,096	1,233	3,329	5,425	4,316	5,179
CYCLOPOIDS	-	-	247	123	123	-	-	-	-	-	-	-
COPEPOD NAUPLII	-	-	-	-	-	-	-	-	-	123	123	-
NEMATODES	55,115	99,626	208,130	84,954	358,680	114,176	11,097	3,699	6,535	50,060	31,565	17,262
POLYCHAETES	6,042	5,918	6,658	2,343	3,206	4,316	2,589	986	2,096	9,864	2,466	2,959
OLIGOCHAETES	6,782	1,233	3,699	1,110	6,905	2,096	-	-	-	6,535	123	-
NEMERTEA	123	123	5,425	1,726	986	3,699	-	-	-	3,576	863	-
PARASITIC COPEPODS	-	-	-	-	-	-	247	-	247	370	-	-
BIVALVES	863	6,658	12,700	4,439	5,672	8,261	5,795	2,096	6,782	1,973	1,110	2,219
ACARINA	123	-	-	-	1,973	-	123	-	-	-	-	-
DECAPODS	-	-	-	-	-	-	123	-	-	247	617	123
ISOPODS	-	-	-	-	-	-	-	-	-	2,589	-	-
OSTRACODS	-	370	370	-	247	123	-	-	370	1,233	617	-
GASTROPODS	-	123	863	247	123	864	123	-	617	617	-	247
GASTROPOD EGGS	247	6,658	6,412	2,959	37,113	10,481	-	-	-	123	123	-
EGGS	-	123	2,343	617	986	617	-	123	370	123	-	-
TANAIDACEA	370	123	-	-	-	-	123	123	-	863	123	-
CUMACEA	-	-	-	-	123	-	-	-	-	247	-	-
CIRRIPEDIA	-	-	-	-	-	-	-	-	-	-	-	-
CIRRIPEDIA NAUPLII	-	-	-	-	-	-	123	-	-	-	-	-
AMPHIPODS	-	-	1,603	123	247	-	617	617	1,356	1,726	617	123
TURBELLARIA	-	-	-	-	-	-	-	-	-	-	-	-
TUNICATA (UROCHORDATA)	-	-	-	-	-	-	-	-	-	-	-	-
ECTOPROCTA COLONIES	-	-	-	-	-	-	-	-	-	123	-	-
ECHINODERMATA	-	-	-	-	-	-	493	493	247	-	-	1,233
CLADOCERA	-	-	-	-	-	-	-	-	-	-	-	-
INSECT LARVA	-	-	-	-	-	-	-	-	-	-	-	-
CRUSTACEA NAUPLII	-	-	-	-	-	-	-	-	-	-	-	-
CHITONS	-	-	-	-	-	-	-	-	-	-	-	-
STOMATOPODA	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL ABUNDANCE OF ORGANISMS/m^2 IN EACH SAMPLE	72,131	145,368	258,684	120,959	422,425	145,743	26,015	10,356	24,168	106,778	45,869	30,455

NUMBER OF BENTHIC ORGANISMS/m^2 IN BENTHOS SAMPLES FROM NANAIMO

	INSIDE MARINA						CONTROL SITE #1					
SAMPLE	BENTHIC #1	BENTHIC #2	BENTHIC #3	BENTHIC #4	BENTHIC #5	BENTHIC #6	BENTHIC #7	BENTHIC #8	BENTHIC #9	BENTHIC #10	BENTHIC #11	BENTHIC #12
DATE	09/10/84	09/10/84	09/10/84	09/10/84	09/10/84	09/10/84	17/10/84	17/10/84	17/10/84	17/10/84	17/10/84	17/10/84
HARPACTECOIDS	370	2,589	4,562	2,589	7,275	3,083	7,275	2,589	16,769	3,699	6,782	12,700
CALANOIDS	370	370	-	863	2,589	1,233	1,356	1,233	4,192	986	493	1,973
CYCLOPOIDS	-	-	123	-	370	370	-	-	123	-	493	247
COPEPOD NAUPLII	-	-	-	-	-	-	-	-	-	-	-	-
NEMATODES	244,874	45,128	140,192	285,563	297,893	267,684	379,394	259,916	718,839	56,348	277,672	117,505
POLYCHAETES	6,288	4,685	7,152	5,672	17,509	5,672	12,577	12,083	21,084	5,672	2,959	4,562
OLIGOCHAETES	2,343	2,343	4,439	1,850	8,138	4,685	7,275	7,398	4,562	986	986	4,439
NEMERTEA	-	617	1,850	2,713	1,603	1,110	617	247	123	-	-	-
PARASITIC COPEPODS	-	-	-	-	-	-	-	123	-	-	123	-
BIVALVES	1,480	617	1,356	2,219	1,726	1,603	863	370	1,110	617	2,713	1,603
ACARINA	-	-	-	370	740	-	-	-	123	-	-	-
DECAPODS	123	123	-	-	-	123	-	247	247	-	-	-
ISOPODS	-	-	-	-	-	-	123	-	247	-	123	-
OSTRACODS	-	123	-	247	863	123	-	-	123	-	247	123
GASTROPODS	247	247	-	-	370	-	247	370	-	-	2,343	986
GASTROPOD EGGS	123	-	-	247	-	-	-	-	740	-	-	247
EGGS	370	123	863	-	1,233	-	247	247	247	247	493	740
TANAIDACEA	-	-	-	-	-	-	123	-	-	-	-	370
CUMACEA	-	-	-	-	-	-		-	-	-	-	-
CIRRIPEDIA	-	-	-	-	-	-	-	-	-	-	-	-
CIRRIPEDIA NAUPLII	-	123	-	123	123	-	-	247	-	-	-	-
AMPHIPODS	247	-	-	-	986	123	-	-	493	-	-	123
TURBELLARIA	-	-	-	-	-	-	-	-	-	-	-	-
TUNICATA (UROCHORDATA)	-	-	-	-	-	-	-	-	-	-	-	-
ECTOPROCTA COLONIES	-	-	740	-	1,356	-	-	-	-	-	-	-
ECHINODERMATA	-	-	-	-	-	-	-	-	-	-	-	-
CLADOCERA	-	-	-	-	-	-	-	-	-	-	-	-
INSECT LARVA	-	-	-	-	-	-	123	123	-	-	-	-
CRUSTACEA NAUPLII	-	-	-	-	-	-	-	-	-	-	-	-
CHITONIDA	-	-	-	-	-	-	-	-	-	-	-	-
STOMATOPODA	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL ABUNDANCE OF ORGANISMS/m^2 IN EACH SAMPLE	256,835	57,088	161,277	302,456	342,774	285,809	410,220	285,193	769,022	68,555	295,427	145,618

NUMBER OF BENTHIC ORGANISMS/M^2 IN BENTHOS SAMPLES FROM NANAIMO

	CONTROL SITE #2					
SAMPLE	BENTHIC #13	BENTHIC #14	BENTHIC #15	BENTHIC #16	BENTHIC #17	BENTHIC #18
DATE	17/10/84	17/10/84	17/10/84	17/10/84	17/10/84	17/10/84
HARPACTECOIDS	27,866	56,718	18,865	29,592	15,043	30,948
CALANOIDS	2,343	1,356	617	370	1,850	1,850
CYCLOPOIDS	123	-	-	-	-	123
COPEPOD NAUPLII	-	247	-	123	-	123
NEMATODES	80,515	247,586	48,087	93,338	116,149	75,830
POLYCHAETES	7,521	9,987	4,069	5,179	3,946	4,932
OLIGOCHAETES	863	9,617	-	3,206	2,713	1,233
NEMERTEA	-	-	-	-	493	-
PARASITIC COPEPODS	-	370	617	247	1,973	740
BIVALVES	21,084	27,619	16,646	20,345	11,467	20,345
ACARINA	-	-	493	-	493	247
DECAPODS	-	-	247	123	-	-
ISOPODS	-	123	123	-	-	-
OSTRACODS	247	123	123	123	1,233	1,480
GASTROPODS	370	3,083	1,603	617	370	863
GASTROPOD EGGS	123	123	123	-	-	-
EGGS	8,261	5,672	617	493	370	123
TANAIDACEA	-	-	-	-	-	-
CUMACEA	-	-	-	-	-	-
CIRRIPEDIA	-	-	370	-	-	-
CIRRIPEDIA NAUPLII	123	-	-	-	-	-
AMPHIPODS	1,850	2,836	3,083	1,110	1,480	3,206
TURBELLARIA	-	-	-	-	247	-
TUNICATA (UROCHORDATA)	123	-	-	-	-	-
ECTOPROCTA COLONIES	-	-	-	-	-	493
ECHINODERMATA	370	617	-	123	-	123
CLADOCERA	-	-	-	-	-	-
INSECT LARVA	-	-	-	-	-	-
CRUSTACEA NAUPLII	-	-	-	-	-	-
CHITONIDA	-	-	-	-	-	-
STOMATOPODA	-	-	-	-	-	-
TOTAL ABUNDANCE OF ORGANISMS/m^2 IN EACH SAMPLE	151,782	366,077	95,683	154,989	157,827	142,659

NUMBER OF BENTHIC ORGANISMS/M^2 IN BENTHOS SAMPLES FROM COMOX

	INSIDE MARINA						CONTROL AREA					
SAMPLE	BENTHIC #1	BENTHIC #2	BENTHIC #3	BENTHIC #4	BENTHIC #5	BENTHIC #6	BENTHIC #7	BENTHIC #8	BENTHIC #9	BENTHIC #10	BENTHIC #11	BENTHIC #12
DATE	11/09/84	11/09/84	11/09/84	11/09/84	11/09/84	11/09/84	11/09/84	13/09/84	13/09/84	13/09/84	13/09/84	13/09/84
HARPACTECOIDS	19,481	16,892	2,096	18,125	1,110	8,015	85,694	20,098	18,988	16,276	9,124	13,933
CALANOIDS	370	247	493	493	-	1,850	1,233	3,452	1,850	1,110	123	493
CYCLOPOIDS	-	247	-	-	-	123	-	-	-	-	-	-
COPEPOD NAUPLII	123	-	6,288	-	-	-	-	123	-	-	-	-
NEMATODES	257,574	256,711	16,152	341,171	36,004	62,143	273,603	1,075,793	643,873	368,051	178,045	539,561
POLYCHAETES	23,180	10,604	1,973	2,959	1,233	6,412	15,536	12,823	13,933	4,809	6,535	8,261
OLIGOCHAETES	5,179	7,645	493	1,233	1,110	617	3,822	3,946	4,932	1,110	2,096	3,946
NEMERTEA	-	-	-	123	-	-	123	123	-	-	-	-
PARASITIC COPEPODS	-	-	370	-	-	-	-	-	-	-	-	-
BIVALVES	6,288	12,947	9,987	11,960	1,603	2,096	6,905	3,452	3,822	2,713	2,589	3,206
ACARINA	-	-	-	123	-	-	123	617	247	-	-	123
DECAPODS	123	-	247	-	-	-	123	123	123	-	370	123
ISOPODS	-	-	-	-	-	-	-	617	123	123	123	-
OSTRACODS	123	3,083	370	123	-	-	986	123	370	370	123	617
GASTROPODS	123	1,356	370	493	123	-	123	370	1,726	247	493	863
GASTROPOD EGGS	123	247	123	-	123	-	-	-	-	-	-	-
EGGS	-	617	1,233	2,713	493	-	123	1,480	2,589	247	123	1,480
TANAIDACEA	-	-	-	123	-	247	1,726	123	247	-	123	617
CUMACEA	247	-	-	-	-	-	-	-	-	-	-	123
CIRRIPEDIA	-	-	247	-	-	-	-	-	123	-	-	-
CIRRIPEDIA NAUPLII	123	123	-	-	-	-	-	-	-	-	123	-
AMPHIPODS	1,480	123	247	247	2,219	493	5,918	3,576	2,713	986	863	1,480
TURBELLARIA	-	-	-	-	-	-	-	-	-	-	-	-
TUNICATA (UROCHORDATA)	-	-	-	-	-	-	-	-	-	-	-	-
ECTOPROCTA COLONIES	-	-	123	123	-	-	-	123	-	-	-	-
ECHINODERMATA	-	740	-	-	-	-	-	-	-	123	-	-
CLADOCERA	-	-	-	-	-	123	-	-	-	-	-	-
INSECT LARVA	-	-	-	-	-	-	-	-	-	-	-	-
CRUSTACEA NAUPLII	-	123	-	-	-	-	-	-	-	-	-	-
CHITONIDA	-	-	-	-	-	-	-	-	-	-	-	-
STOMATOPODA	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL ABUNDANCE OF ORGANISMS/m^2 IN EACH SAMPLE	314,537	311,705	40,812	380,009	44,018	82,119	396,038	1,126,962	695,659	396,165	200,853	574,826

NUMBER OF BENTHIC ORGANISMS/m^2 IN BENTHOS SAMPLES FROM CANOE COVE

	INSIDE MARINA						CONTROL AREA					
SAMPLE	BENTHIC #1	BENTHIC #2	BENTHIC #3	BENTHIC #4	BENTHIC #5	BENTHIC #6	BENTHIC #7	BENTHIC #8	BENTHIC #9	BENTHIC #10	BENTHIC #11	BENTHIC #12
DATE	25/09/84	25/09/84	25/09/84	25/09/84	25/09/84	25/09/84	27/09/84	27/09/84	27/09/84	27/09/84	27/09/84	27/09/84
HARPACTECOIDS	5,179	740	16,276	617	5,055	7,521	92,722	83,474	28,112	121,820	70,528	22,687
CALANOIDS	493	2,219	370	370	123	1,110	1,973	740	4,192	45,374	2,466	2,466
CYCLOPOIDS	123	-	-	-	123	370	4,439	370	3,452	4,069	863	863
COPEPOD NAUPLII	-	-	-	-	123	-	-	-	123	-	-	-
NEMATODES	546,342	50,430	184,580	175,949	33,784	88,406	470,883	431,057	139,822	219,474	282,234	63,623
POLYCHAETES	2,713	123	5,672	986	8,754	7,028	18,618	3,576	2,959	13,563	9,248	3,699
OLIGOCHAETES	5,179	247	1,726	1,110	6,535	3,452	11,960	2,466	4,932	5,918	2,959	9,124
NEMERTEA	-	-	123	-	123	247	-	-	-	-	-	-
PARASITIC COPEPODS	-	-	-	-	-	-	247	740	-	123	986	863
BIVALVES	740	-	2,343	617	2,589	1,480	3,699	740	247	3,699	5,549	2,219
ACARINA	-	247	247	247	-	123	-	-	123	123	123	123
DECAPODS	370	-	123	-	123	247	370	370	247	493	-	123
ISOPODS	123	-	617	-	1,726	740	1,110	370	1,603	10,604	2,219	247
OSTRACODS	370	-	2,713	-	1,603	493	16,522	493	11,467	34,524	24,783	4,192
GASTROPODS	-	-	617	247	-	617	617	493	247	1,973	740	123
GASTROPOD EGGS	1,603	2,713	-	493	370	493	1,603	4,439	123	740	123	617
EGGS	863	493	493	123	617	370	2,343	6,905	2,713	4,932	2,959	617
TANAIDACEA	-	-	740	-	-	-	123	123	-	247	4,562	-
CUMACEA	-	-	740	247	493	247	-	123	493	123	1,233	247
CIRRIPEDIA	123	-	-	-	-	247	-	-	-	-	123	123
CIRRIPEDIA NAUPLII	-	-	-	-	-	-	-	-	-	-	-	-
AMPHIPODS	2,096	-	4,316	247	1,356	1,850	18,372	8,631	3,452	17,015	16,522	4,932
TURBELLARIA	-	-	123	-	-	-	-	-	-	-	-	-
TUNICATA (UROCHORDATA)	-	-	-	-	-	-	-	-	-	-	-	-
ECTOPROCTA COLONIES	-	-	-	-	123	-	-	-	-	-	-	-
ECHINODERMATA	-	-	123	-	-	-	-	-	-	123	-	-
CLADOCERA	-	-	-	-	-	-	-	-	-	-	-	-
INSECT LARVA	123	-	-	-	-	-	-	-	-	-	-	-
CRUSTACEA NAUPLII	-	-	-	-	-	-	-	-	-	-	-	-
CHITONIDA	-	-	123	-	-	-	-	-	-	-	-	-
STOMATOPODA	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL ABUNDANCE OF ORGANISMS/m^2 IN EACH SAMPLE	566,440	57,212	222,065	181,253	63,620	115,041	645,601	545,110	204,307	484,937	428,220	116,888

NUMBER OF BENTHIC ORGANISMS/M^2 IN BENTHOS SAMPLES FROM BEACH GARDENS

	INSIDE MARINA						CONTROL AREA					
SAMPLE	BENTHIC #1	BENTHIC #2	BENTHIC #3	BENTHIC #4	BENTHIC #5	BENTHIC #6	BENTHIC #7	BENTHIC #8	BENTHIC #9	BENTHIC #10	BENTHIC #11	BENTHIC #12
DATE	23/10/84	23/10/84	23/10/84	23/10/84	23/10/84	23/10/84	23/10/84	23/10/84	23/10/84	23/10/84	23/10/84	23/10/84
HARPACTECOIDS	30,578	33,044	27,373	9,371	18,372	2,836	10,111	5,425	8,261	13,316	5,795	18,865
CALANOIDS	863	863	-	123	863	370	1,726	370	863	493	1,850	3,329
CYCLOPOIDS	247	863	493	-	247	-	247	-	1,110	247	370	740
COPEPOD NAUPLII	-	-	-	-	-	-	-	-	-	-	-	-
NEMATODES	178,045	217,625	74,720	79,282	135,260	84,830	140,932	69,418	106,408	73,117	88,776	107,148
POLYCHAETES	2,589	10,727	7,521	5,179	7,398	1,603	6,535	3,083	4,562	1,726	3,452	10,850
OLIGOCHAETES	2,959	20,221	5,795	4,192	4,069	3,946	2,836	-	617	863	3,329	4,562
NEMERTEA	-	986	863	1,110	123	-	11,590	493	370	-	123	740
PARASITIC COPEPODS	-	-	-	370	123	-	370	123	-	123	-	247
BIVALVES	5,302	6,165	4,439	2,589	5,302	1,850	3,946	5,302	8,508	13,193	11,220	13,440
ACARINA	493	-	123	123	370	123	123	123	493	123	740	1,233
DECAPODS	-	-	-	123	-	-	-	123	-	-	-	-
ISOPODS	-	-	-	-	247	-	-	-	-	-	-	-
OSTRACODS	1,603	2,096	986	493	123	247	-	123	370	-	863	370
GASTROPODS	617	370	123	247	493	617	493	-	123	247	740	370
GASTROPOD EGGS	370	247	247	-	493	123	-	-	-	-	493	-
EGGS	1,233	3,452	493	8,631	4,685	617	863	1,233	370	2,219	740	2,713
TANAIDACEA	247	1,726	-	493	493	-	370	-	123	-	-	-
CUMACEA	-	-	247	-	-	-	-	-	-	-	-	123
CIRRIPEDIA	-	-	-	-	-	-	247	-	-	123	493	-
CIRRIPEDIA NAUPLII	-	-	-	-	-	-	-	-	-	-	-	-
AMPHIPODS	986	2,466	740	740	1,603	123	986	986	247	493	1,603	3,083
TURBELLARIA	-	-	-	-	-	-	-	-	-	123	-	-
TUNICATA (UROCHORDATA)	-	-	-	-	-	-	-	-	-	-	-	-
ECTOPROCTA COLONIES	-	-	-	-	-	-	-	-	-	-	-	-
ECHINODERMATA	-	-	-	123	-	-	-	-	-	-	-	-
CLADOCERA	-	-	-	-	-	-	-	-	-	-	-	-
INSECT LARVA	-	-	-	-	-	-	-	370	-	123	493	-
CRUSTACEA NAUPLII	-	-	-	-	-	-	-	-	-	-	-	-
CHITONIDA	-	247	-	-	-	-	-	-	-	-	-	-
STOMATOPODA	-	-	-	-	-	-	-	247	-	123	370	-
TOTAL ABUNDANCE OF ORGANISMS/m^2 IN EACH SAMPLE	226,132	301,098	124,163	113,189	180,264	97,285	181,375	87,419	132,425	106,652	121,450	167,813

NUMBER OF BENTHIC ORGANISMS/M^2 IN BENTHOS SAMPLES FROM FRESHWATER MARINA

	INSIDE MARINA						CONTROL AREA					
SAMPLE	BENTHIC #1	BENTHIC #2	BENTHIC #3	BENTHIC #4	BENTHIC #5	BENTHIC #6	BENTHIC #7	BENTHIC #8	BENTHIC #9	BENTHIC #10	BENTHIC #11	BENTHIC #12
DATE	06/11/84	06/11/84	06/11/84	06/11/84	06/11/84	06/11/84	06/11/84	06/11/84	06/11/84	06/11/84	06/11/84	06/11/84
HARPACTECOIDS	9,617	13,810	9,741	5,549	14,796	8,878	6,535	24,167	9,741	4,809	17,632	6,658
CALANOIDS	123	123	-	247	493	247	123	-	-	617	123	123
CYCLOPOIDS	370	123	123	-	123	-	-	123	-	-	-	-
COPEPOD NAUPLII	-	-	-	-	-	-	-	-	-	-	-	-
NEMATODES	40,442	223,543	85,940	105,175	39,579	109,367	7,275	6,165	4,809	3,946	14,919	4,439
POLYCHAETES	370	863	370	2,713	617	617	3,576	986	2,343	247	370	493
OLIGOCHAETES	493	3,946	1,603	4,316	5,672	11,714	13,810	8,138	9,864	7,768	19,851	6,042
NEMERTEA	-	-	-	123	123	-	-	-	-	123	-	-
PARASITIC COPEPODS	-	-	-	-	-	-	123	-	-	-	-	986
BIVALVES	247	-	-	617	-	-	-	370	-	-	123	986
ACARINA	-	123	-	-	-	123	123	-	123	986	4,809	-
DECAPODS	-	123	-	-	-	-	-	-	-	-	-	7,521
ISOPODS	123	-	-	-	-	493	617	-	123	617	1,233	123
OSTRACODS	493	3,209	123	247	123	370	370	3,822	863	123	617	-
GASTROPODS	-	-	123	-	-	-	-	123	-	123	-	-
GASTROPOD EGGS	123	370	123	-	-	-	-	-	-	-	123	3,083
EGGS	123	2,466	1,480	4,562	3,329	4,069	247	740	740	123	740	-
TANAIDACEA	123	4,562	1,726	-	123	12,823	2,219	863	-	-	-	-
CUMACEA	-	-	-	-	-	-	-	-	-	-	-	123
CIRRIPEDIA	-	-	-	-	-	-	-	-	-	-	-	-
CIRRIPEDIA NAUPLII	-	-	-	-	-	-	-	-	-	-	-	15,782
AMPHIPODS	247	863	370	-	123	123	2,343	4,069	4,809	3,946	14,180	123
TURBELLARIA	-	-	-	-	-	-	-	-	-	-	-	-
TUNICATA (UROCHORDATA)	-	-	-	-	-	-	-	-	-	-	-	-
ECTOPROCTA COLONIES	-	-	-	-	-	-	-	-	-	123	-	-
ECHINODERMATA	1,110	-	-	-	-	-	-	-	-	-	-	-
CLADOCERA	-	-	-	-	-	-	-	123	-	-	-	-
INSECT LARVA	-	-	-	-	-	-	-	-	-	-	123	-
CRUSTACEA NAUPLII	-	-	-	-	-	-	-	-	-	-	-	-
CHITONIDA	-	-	-	-	-	-	-	-	-	-	-	-
STOMATOPODA	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL ABUNDANCE OF ORGANISMS/m^2 IN EACH SAMPLE	54,004	254,124	101,722	123,549	65,101	148,824	37,361	49,689	33,415	23,551	74,843	46,482

APPENDIX II - MEAN NUMBER/m^2 AND PERCENT COMPOSITION OF IMPORTANT BENTHIC ORGANISMS IN BENTHOS SAMPLES
(n = 6)

		Marina Basin		Control Area	
Organism	Sample Site	Mean number organisms/m^2	Percent Composition	Mean number organisms/m^2	Percent Composition
Nematodes	Proposed Marina at Saanichton Bay			185,649	67.2%
	F.C. Marina	153,447	79.0%	20,036	49.3%
	Nanaimo Marina	168,942	72.1%	301,612	91.7%
				110,251	61.9%
	Comox Marina	161,626	82.7%	513,154	90.8%
	C.C. Marina	179,915	89.6%	267,849	66.3%
	Beach Gardens Marina	128,294	73.9%	97,633	73.5%
	Freshwater Marina	100,674	80.8%	6,926	15.6%
Polychaetes	Proposed Marina at Saanichton Bay			7,583	2.7%
	F.C. Marina	4,747	2.4%	3,493	8.6%
	Nanaimo Marina	7,830	3.3%	9,823	3.0%
				5,939	3.3%
	Comox Marina	7,727	4.0%	10,316	1.8%
	C.C. Marina	4,213	2.1%	8,611	2.1%
	Beach Gardens Marina	5,836	3.4%	5,035	3.8%
	Freshwater Marina	925	0.7%	1,336	3.0%
Oligochaetes	Proposed Marina at Saanichton Bay			5,528	2.0%
	F.C. Marina	3,638	1.9%	1,110	2.7%
	Nanaimo Marina	3,966	1.7%	4,274	1.3%
				2,939	1.6%
	Comox Marina	2,713	1.4%	3,309	0.6%
	C.C. Marina	3,042	1.5%	6,227	1.5%
	Beach Gardens Marina	6,864	4.0%	2,035	1.5%
	Freshwater Marina	4,624	3.7%	10,912	24.7%

MEAN NUMBER/m^2 AND PERCENT COMPOSITION OF IMPORTANT BENTHIC ORGANISMS IN BENTHOS SAMPLES
(n = 6)

		Marina Basin		Control Area	
Organism	Sample Site	Mean number organisms/m^2	Percent Composition	Mean number organisms/m^2	Percent Composition
Harpactecoids	Proposed Marina at Saanichton Bay			16,543	6.0%
	F.C. Marina	10,953	5.6%	5,158	12.7%
	Nanaimo Marina	3,411	1.5%	8,302	2.5%
				29,839	16.7%
	Comox Marina	10,953	5.6%	27,352	4.8%
	C.C. Marina	5,898	2.9%	69,891	17.3%
	Beach Gardens Marina	20,262	11.7%	10,296	7.8%
	Freshwater Marina	10,399	8.3%	11,590	26.2%
Cyclopoids	Proposed Marina at Saanichton Bay			-	-
	F.C. Marina	82	0.04%	-	-
	Nanaimo Marina	144	0.06%	144	.04%
				41	0.02%
	Comox Marina	62	0.03%	-	-
	C.C. Marina	103	0.05%	2,343	0.6%
	Beach Gardens Marina	308	0.2%	452	0.3%
	Freshwater Marina	123	0.1%	21	0.05%
Amphipods	Proposed Marina at Saanichton Bay			9,659	3.5%
	F.C. Marina	329	0.2%	843	2.1%
	Nanaimo Marina	226	0.1%	144	0.04%
				2,261	1.3%
	Comox Marina	802	0.4%	2,589	0.5%
	C.C. Marina	1,644	0.8%	11,487	2.8%
	Beach Gardens Marina	1,110	0.6%	1,233	0.9%
	Freshwater Marina	288	0.2%	7,522	17.0%

MEAN NUMBER/m^2 AND PERCENT COMPOSITION OF IMPORTANT BENTHIC ORGANISMS IN BENTHOS SAMPLES
(n = 6)

		Marina Basin		Control Area	
Organism	Sample Site	Mean number organisms/m^2	Percent Composition	Mean number organisms/m^2	Percent Composition
Decapods	Proposed Marina at Saanichton Bay			802	0.3%
	F.C. Marina	-	-	185	0.5%
	Nanaimo Marina	62	0.03%	82	0.03%
				62	0.03%
	Comox Marina	62	0.03%	144	0.03%
	C.C. Marina	144	0.07%	267	0.07%
	Beach Gardens Marina	21	0.01%	21	0.02%
	Freshwater Marina	21	0.02%	-	-
Calanoids	Proposed Marina at Saanichton Bay			4,049	1.5%
	F.C. Marina	144	0.07%	3,596	8.9%
	Nanaimo Marina	904	0.4%	1,706	0.5%
				1,398	0.8%
	Comox Marina	576	0.3%	1,377	0.2%
	C.C. Marina	781	0.4%	9,535	0.02%
	Beach Gardens Marina	514	0.3%	1,439	1.1%
	Freshwater Marina	206	0.2%	164	0.4%
Ostracods	Proposed Marina at Saanichton Bay			5,364	2.0%
	F.C. Marina	185	0.01%	370	0.9%
	Nanaimo Marina	226	0.1%	82	0.02%
				555	0.3%
	Comox Marina	617	0.3%	432	0.08%
	C.C. Marina	863	0.4%	15,335	3.8%
	Beach Gardens Marina	925	0.5%	288	0.2%
	Freshwater Marina	761	0.6%	986	2.2%

MEAN NUMBER/M^2 AND PERCENT COMPOSITION OF IMPORTANT BENTHIC ORGANISMS IN BENTHOS SAMPLES
(n = 6)

		Marina Basin		Control Area	
Organism	Sample Site	Mean number organisms/m^2	Percent Composition	Mean number organisms/m^2	Percent Composition
Tanaidacea	Proposed Marina at Saanichton Bay			34,400	12.4%
	F.C. Marina	82	0.04%	205	0.5%
	Nanaimo Marina	-	-	82	0.02%
				-	-
	Comox Marina	103	0.05%	473	0.08%
	C.C. Marina	123	0.06%	843	0.21%
	Beach Gardens Marina	493	0.3%	82	0.06%
	Freshwater Marina	3,226	2.6%	514	1.16%
Bivalves	Proposed Marina at Saanichton Bay			2,281	0.8%
	F.C. Marina	6,432	3.3%	3,329	8.2%
	Nanaimo Marina	1,500	0.64%	1,213	0.4%
				19,584	11%
	Comox Marina	7,480	3.8%	3,781	0.70%
	C.C. Marina	1,295	0.64%	2,692	0.7%
	Beach Gardens Marina	4,275	2.5%	9,268	7.0%
	Freshwater Marina	144	0.1%	247	0.6%

APPENDIX III - STATISTICS APPLIED TO BENTHOS SAMPLES
SAANICHTON BAY (n = 6)
(21/08/84)

ORGANISM	(#S/m^2) $\bar{X}$	S	$\bar{X}$ ± C.L.
HARPACTECOIDS	16,543	16,105	16,809
CALANOIDS	4,049	6,514	6,837
CYCLOPOIDS	-	-	-
COPEPOD NAUPLII	206	255	
NEMATODES	185,649	222,180	233,202
POLYCHAETES	7,583	5,962	6,258
OLIGOCHAETES	5,528	7,079	7,430
NEMERTEA	2,404	3,925	
PARASITIC COPEPODS	-	-	
BIVALVES	2,281	2,027	2,134
ACARINA	-	-	
DECAPODS	802	892	936
ISOPODS	82	128	
OSTRACODS	5,364	8,788	9,224
GASTROPODS	-	-	
GASTROPOD EGGS	185	231	
EGGS	534	857	
TANAIDACEA	34,400	72,205	75,787
CUMACEA	740	1,178	
CIRRIPEDIA	226	353	
CIRRIPEDIA NAUPLII	-	-	
AMPHIPODS	9,659	14,077	14,775
TURBELLARIA	-	-	
TUNICATA (UROCHORDATA)	-	-	
ECTOPROCTA COLONIES	-	-	
ECHINODERMATA	-	-	
CLADOCERA	-	-	
INSECT LARVA	-	-	
CRUSTACEA NAUPLII	-	-	
CHITONS	-	-	
STOMATOPODA	-	-	

CONFIDENCE LIMIT
95%

$\bar{X}$ = SAMPLE MEAN
S = STANDARD DEVIATION
C.L. = CONFIDENCE LIMIT

STATISTICS APPLIED TO BENTHOS SAMPLES

FRENCH CREEK (n = 6)

28/08/84, 06/09/84, 18/10/84, 29/10/84

ORGANISM	(INSIDE) (#S/m^2) $\bar{X}$	(INSIDE) S	(INSIDE) $\bar{X} \pm$ C.L.	(OUTSIDE) (# S/m^2) $\bar{X}$	(OUTSIDE) S	(OUTSIDE) $\bar{X} \pm$ C.L.
HARPACTECOIDS	10,953	10,027	10,524	5,158	7,787	8,173
CALANOIDS	164	127	133	3,596	1,690	1,774
CYCLOPOIDS	82	101	106	-	-	-
COPEPOD NAUPLII	-	-		41	64	
NEMATODES	153,447	113,058	118,666	20,036	17,726	18,605
POLYCHAETES	4,747	1,734	1,820	3,493	3,193	3,351
OLIGOCHAETES	3,638	2,650	2,781	1,110	2,658	2,790
NEMERTEA	2,014	2,134		740	1,432	
PARASITIC COPEPODS	-	-		144	164	
BIVALVES	6,432	3,956	4,164	3,329	2,346	2,470
ACARINA	349	797		-	-	
DECAPODS	-	-	-	185	231	242
ISOPODS	-	-		-	-	
OSTRACODS	185	170	178	370	493	517
GASTROPODS	370	390		267	286	
GASTROPOD EGGS	10,645	13,428		41	64	
EGGS	781	846		103	144	
TANAIDACEA	82	149	156	205	328	344
CUMACEA	-	-		-	-	
CIRRIPEDIA	-	-		-	-	
CIRRIPEDIA NAUPLII	-	-		-	-	
AMPHIPODS	329	632	663	843	586	615
ECTOPROCTA COLONIES	-	-		-	-	
ECHINODERMATA	-	-		411	459	
INSECT LARVA	-	-		-	-	
INSECT PUPA	-	-		-	-	
TUNICATA (UROCHORDATA)	-	-		-	-	
TURBELLARIA	-	-		-	-	
MYSIDACEA	-	-		-	-	
FISH LARVA	-	-		-	-	
CIRRIPEDIA CYPRIS	-	-		-	-	
CHITON	-	-		-	-	
ADULT INSECT	-	-		-	-	
MEDUSA	-	-		-	-	

CONFIDENCE LIMIT 95%

$\bar{X}$ = SAMPLE MEAN

S = STANDARD DEVIATION

C.L. = CONFIDENCE LIMIT

STATISTICS APPLIED TO BENTHOS SAMPLES
NANAIMO (n = 6)
09/10/84 & 17/10/84

ORGANISM	NANAIMO MARINA (#S/m²) X	NANAIMO MARINA S	NANAIMO MARINA $\bar{X} \pm$ C.L.	CONTROL #1 (# S/m²) X	CONTROL #1 S	CONTROL #1 $\bar{X} \pm$ C.L.	CONTROL #2 (# S/m²) X	CONTROL #2 S	CONTROL #2 $\bar{X} \pm$ C.L.
HARPACTECOIDS	3,411	2,322	2,437	8,302	5,445	5,715	29,839	14,608	15,333
CALANOIDS	904	931	977	1,706	1,311	1,376	1,398	771	809
CYCLOPOIDS	144	182	191	144	198	208	-	-	-
COPEPOD NAUPLII	-	-		-	-		82	101	
NEMATODES	213,556	99,959	104,918	301,612	235,155	246,820	110,251	70,873	74,389
POLYCHAETES	7,830	4,811	5,050	9,823	6,805	7,143	5,939	2,364	2,481
OLIGOCHAETES	3,966	2,362	2,479	4,274	2,846	2,987	2,939	3,481	3,654
NEMERTEA	1,316	957		165	243		-	-	
PARASITIC COPEPODS	-	-		-	-		658	696	
BIVALVES	1,500	525	553	1,213	849	894	19,585	5,338	5,619
ACARINA	-	-		-	-		206	242	
DECAPODS	62	67	70	-	-	-	-	-	-
ISOPODS	-	-		82	101		-	-	
OSTRACODS	226	325	341	82	101	106	555	628	659
GASTROPODS	144	164		658	902		1,151	1,051	
GASTROPOD EGGS	-	-		-	-		62	67	
EGGS	432	510		370	206		2,589	3,492	
TANAIDACEA	-	-	-	-	-	-	-	-	-
CUMACEA	-	-		-	-		-	-	
CIRRIPEDIA	-	-		-	-		-	-	
CIRRIPEDIA NAUPLII	62	67		-	-		-	-	
AMPHIPODS	226	385	404	144	198	208	2,261	895	939
TURBELLARIA	-	-		-	-		-	-	
TUNICATA (UROCHORDATA)	-	-		-	-		-	-	
ECTOPROCTA COLONIES	-	-		-	-		-	-	
ECHINODERMATA	-	-		-	-		206	243	
CLADOCERA	-	-		-	-		-	-	
INSECT LARVA	-	-		-	-		-	-	
CRUSTACEA NAUPLII	-	-		-	-		-	-	
CHITONS	-	-		-	-		-	-	
STOMATOPODA	-	-		-	-		-	-	

CONFIDENCE LIMIT
LIMIT 95%
$\bar{X}$ = SAMPLE MEAN
S = STANDARD DEVIATION
C.L. = CONFIDENCE LIMIT

STATISTICS APPLIED TO BENTHOS SAMPLES
COMOX (n = 6)
11/09/84 & 13/11/84

ORGANISM	(INSIDE) (#S/m²) X	(INSIDE) S	(INSIDE) X ± C.L.	(OUTSIDE) (# S/m²) X	(OUTSIDE) S	(OUTSIDE) X ± C.L.
HARPACTECOIDS	10,953	8,287	8,698	27,352	28,849	30,280
CALANOIDS	576	651	683	1,377	1,181	1,240
CYCLOPOIDS	-	-	-	-	-	-
COPEPOD NAUPLII	-	-		-	-	
NEMATODES	161,626	139,516	146,437	513,154	324,063	340,139
POLYCHAETES	7,727	8,328	8,741	10,316	4,369	4,586
OLIGOCHAETES	2,713	2,983	3,131	3,309	1,415	1,485
NEMERTEA	-	-		-	-	
PARASITIC COPEPODS	-	-		-	-	
BIVALVES	7,480	4,923	5,182	3,781	1,598	1,682
ACARINA	-	-		185	231	
DECAPODS	-	-	-	144	121	127
ISOPODS	-	-		164	230	
OSTRACODS	617	1,216	1,276	432	329	345
GASTROPODS	411	497		637	591	
GASTROPOD EGGS	103	93		-	-	
EGGS	843	1,024		1,007	1,009	
TANAIDACEA	-	-	-	473	650	682
CUMACEA	-	-		-	-	
CIRRIPEDIA	-	-		-	-	
CIRRIPEDIA NAUPLII	-	-		-	-	
AMPHIPODS	802	853	895	2,589	1,942	2,038
TURBELLARIA	-	-		-	-	
TUNICATA (UROCHORDATA)	-	-		-	-	
ECTOPROCTA COLONIES	-	-		-	-	
ECHINODERMATA	-	-		-	-	
CLADOCERA	-	-		-	-	
INSECT LARVA	-	-		-	-	
CRUSTACEA NAUPLII	-	-		-	-	
CHITONS	-	-		-	-	
STOMATOPODA	-	-		-	-	

CONFIDENCE LIMIT
95%

$\bar{X}$ = SAMPLE MEAN
S = STANDARD DEVIATION
C.L. = CONFIDENCE LIMIT

STATISTICS APPLIED TO BENTHOS SAMPLES
CANOE COVE (n = 6)
25/09/84 & 27/09/84

ORGANISM	(INSIDE) (#S/m^2) $\bar{X}$	(INSIDE) S	(INSIDE) $\bar{X} \pm$ C.L.	(OUTSIDE) (# S/m^2) $\bar{X}$	(OUTSIDE) S	(OUTSIDE) $\bar{X} \pm$ C.L.
HARPACTECOIDS	5,898	5,763	6,049	79,891	30,699	32,222
CALANOIDS	781	778	817	9,535	17,592	18,645
CYCLOPOIDS	103	144	151	2,343	1,837	1,928
COPEPOD NAUPLII	-	-		-	-	
NEMATODES	179,915	190,158	199,591	267,849	160,316	168,269
POLYCHAETES	4,213	3,466	3,638	8,611	6,426	6,745
OLIGOCHAETES	3,042	2,458	2,580	6,227	3,684	3,867
NEMERTEA	82	101		-	-	
PARASITIC COPEPODS	-	-		493	420	
BIVALVES	1,295	1,025	1,079	2,692	2,010	2,116
ACARINA	144	121		82	64	
DECAPODS	144	144	151	267	182	191
ISOPODS	534	665		2,692	3,947	
OSTRACODS	863	1,081	1,134	15,330	12,793	13,428
GASTROPODS	247	302		699	665	
GASTROPOD EGGS	945	1,019		1,274	1,643	
EGGS	493	247		3,412	2,198	
TANAIDACEA	-	-	-	843	1,825	1,916
CUMACEA	288	288		370	455	
CIRRIPEDIA	-	-		-	-	
CIRRIPEDIA NAUPLII	-	-		-	-	
AMPHIPODS	1,644	1,557	1,634	11,487	6,618	6,946
TURBELLARIA	-	-		-	-	
TUNICATA (UROCHORDATA)	-	-		-	-	
ECTOPROCTA COLONIES	-	-		-	-	
ECHINODERMATA	-	-		-	-	
CLADOCERA	-	-		-	-	
INSECT LARVA	-	-		-	-	
CRUSTACEA NAUPLII	-	-		-	-	
CHITONS	-	-		-	-	
STOMATOPODA	-	-		-	-	

CONFIDENCE LIMIT
95%

$\bar{X}$ = SAMPLE MEAN
S = STANDARD DEVIATION
C.L. = CONFIDENCE LIMIT

STATISTICS APPLIED TO BENTHOS SAMPLES
BEACH GARDENS (n = 6)
23/10/84

ORGANISM	(INSIDE) (#S/m²) X	(INSIDE) S	(INSIDE) X ± C.L.	(OUTSIDE) (# S/m²) X	(OUTSIDE) S	(OUTSIDE) X ± C.L.
HARPACTECOIDS	20,262	12,217	12,823	10,296	5,113	5,367
CALANOIDS	514	401	421	1,439	1,113	1,168
CYCLOPOIDS	308	328	344	452	403	423
COPEPOD NAUPLII	-	-		-	-	
NEMATODES	128,294	59,439	62,388	97,632	26,526	27,842
POLYCHAETES	5,836	3,409	3,578	5,035	3,273	3,435
OLIGOCHAETES	6,864	6,607	6,935	2,035	1,802	1,891
NEMERTEA	514	526		2,219	4,598	
PARASITIC COPEPODS	-	-		144	144	
BIVALVES	4,275	1,699	1,788	9,268	4,031	4,243
ACARINA	205	186		473	451	
DECAPODS	-	-	-	-	-	-
ISOPODS	-	-		-	-	
OSTRACODS	925	790	829	288	328	344
GASTROPODS	411	202		329	266	
GASTROPOD EGGS	247	174		-	-	
EGGS	3,185	3,151		1,356	916	
TANAIDACEA	493	643	675	-	-	-
CUMACEA	-	-		-	-	
CIRRIPEDIA	-	-		144	198	
CIRRIPEDIA NAUPLII	-	-		-	-	
AMPHIPODS	1,110	818	859	1,233	1,020	1,071
TURBELLARIA	-	-		-	-	
TUNICATA (UROCHORDATA)	-	-		-	-	
ECTOPROCTA COLONIES	-	-		-	-	
ECHINODERMATA	-	-		-	-	
CLADOCERA	-	-		-	-	
INSECT LARVA	-	-		164	216	
CRUSTACEA NAUPLII	-	-		-	-	
CHITONS	-	-		-	-	
STOMATOPODA	-	-		123	156	

CONFIDENCE LIMIT
95%

$\bar{X}$ = SAMPLE MEAN
S = STANDARD DEVIATION
C.L. = CONFIDENCE LIMIT

STATISTICS APPLIED TO BENTHOS SAMPLES

FRESHWATER MARINA (n = 6)

06/11/84

ORGANISM	(INSIDE) (#S/m^2) $\bar{X}$	(INSIDE) S	(INSIDE) $\bar{X} \pm$ C.L.	(OUTSIDE) (# S/m^2) $\bar{X}$	(OUTSIDE) S	(OUTSIDE) $\bar{X} \pm$ C.L.
HARPACTECOIDS	10,399	3,401	3,580	11,590	7,668	8,048
CALANOIDS	206	168	176	164	230	241
CYCLOPOIDS	123	135	142	-	-	-
COPEPOD NAUPLII	-	-		-	-	
NEMATODES	100,674	67,484	70,832	6,926	4,102	4,305
POLYCHAETES	925	895	939	1,336	1,340	1,406
OLIGOCHAETES	4,624	3,953	4,149	10,912	5,113	5,367
NEMERTEA	-	-		-	-	
PARASITIC COPEPODS	-	-		-	-	
BIVALVES	-	-	-	247	390	411
ACARINA	-	-		1,171	1,837	
DECAPODS	-	-	-	-	-	-
ISOPODS	-	-		1,685	2,892	
OSTRACODS	761	1,208	1,268	986	1,419	1,489
GASTROPODS	-	-		-	-	
GASTROPOD EGGS	103	144		-	-	
EGGS	2,672	1,668		946	1,083	
TANAIDACEA	3,226	5,016	5,265	-	-	-
CUMACEA	-	-		-	-	
CIRRIPEDIA	-	-		-	-	
CIRRIPEDIA NAUPLII	-	-		-	-	
AMPHIPODS	288	309	324	7,522	5,856	6,146
TURBELLARIA	-	-		-	-	
TUNICATA (UROCHORDATA)	-	-		-	-	
ECTOPROCTA COLONIES	-	-		-	-	
ECHINODERMATA	-	-		-	-	
CLADOCERA	-	-		-	-	
INSECT LARVA	-	-		-	-	
CRUSTACEA NAUPLII	-	-		-	-	
CHITONS	-	-		-	-	
STOMATOPODA	-	-		-	-	

CONFIDENCE LIMIT
95%

$\bar{X}$ = SAMPLE MEAN
S = STANDARD DEVIATION
C.L. = CONFIDENCE LIMIT

APPENDIX IV - NUMBER OF MEIOFAUNA AND MACROFAUNA ORGANISMS/m^2 IN SCRAPING SAMPLES (FROM FRENCH CREEK MARINA)

SCRAPINGS-DEPTHS REDUCED TO CHART DATA SAMPLE	PILING #1 DEPTH 1.5m	PILING #2 DEPTH +0.5m	PILING #3 DEPTH +1.5m	WHARF #1	WHARF #2	WHARF #3	INSIDE BREAKWATER #1 DEPTH 2.6m	INSIDE BREAKWATER #2 DEPTH 1.4m	INSIDE BREAKWATER #3 DEPTH 0.1m	OUTSIDE BREAKWATER #1 DEPTH 1.6m	OUTSIDE BREAKWATER #2 DEPTH 0.1m	OUTSIDE BREAKWATER #3 DEPTH +1.8m
DATE	29/08/84	29/08/84	29/08/84	29/08/84	29/08/84	29/08/84	14/09/84	14/09/84	14/09/84	12/11/84	12/11/84	12/11/84
HARPACTECOIDS	44	78	56	322	400	100	322	1,687	566	3,108	2,631	1,310
CALANOIDS	-	22	56	178	111	44	300	788	488	777	189	89
CYCLOPOIDS	-	56	-	11	-	-	-	44	-	-	-	-
COPEPOD NAUPLII	-	22	-	-	122	-	-	11	-	-	-	-
NEMATODES	289	555	1,543	1,743	4,151	5,872	810	1,354	-	300	100	89
POLYCHAETES	266	466	577	333	400	311	966	599	22	3,374	89	144
OLIGOCHAETES	67	289	167	89	167	22	355	67	22	122	-	-
NEMERTEA	-	78	33	-	22	-	22	33	-	-	-	-
PARASITIC COPEPODS	-	11	-	-	-	-	11	-	11	167	100	133
BIVALVES	133	6,649	9,579	533	178	322	333	300	78	4,163	1,110	5,572
ACARINA	-	11	-	-	78	167	33	11	-	144	-	11
DECAPODS	44	22	11	44	67	22	-	167	22	44	-	-
ISOPODS	-	22	-	-	-	-	-	11	-	266	33	44
OSTRACODS	22	89	-	-	11	-	-	-	-	11	-	-
GASTROPODS	333	22	222	11	11	-	511	1,088	144	344	244	3,519
GASTROPOD EGGS	22	-	11	-	-	-	89	-	-	-	-	-
EGGS	-	322	222	144	89	33	33	111	211	844	133	11
TANAIDACEA	33	11	11	-	-	-	155	1,010	-	-	-	-
CUMACEA	11	-	11	-	-	-	11	-	-	-	-	-
CIRRIPEDIA	-	389	122	22	-	-	-	-	78	3,630	1,521	6,338
CIRRIPEDIA NAUPLII	-	-	-	11	11	-	33	-	11	-	-	-
AMPHIPODS	633	4,118	2,398	233	244	333	278	677	400	3,430	2,686	511
ECTOPROCTA COLONIES	-	-	222	11	-	-	-	-	-	3,541	-	-
ECHINODERMATA	-	22	-	-	-	-	-	-	-	-	-	-
INSECT LARVA	-	-	11	-	-	-	-	-	-	-	-	-
INSECT PUPA	-	-	11	-	-	-	-	-	-	-	-	-
TUNICATA (UROCHORDATA)	-	-	-	-	44	11	-	-	-	-	-	-
TURBELLARIA	-	-	-	-	-	-	11	-	-	22	11	-
CIRRIPEDIA CYPRIS	-	-	-	-	-	-	-	-	-	22	-	-
CHITONIDA	-	-	-	-	-	-	-	-	-	22	-	-
TOTAL ABUNDANCE/m^2 OF EACH SAMPLE	1,897	13,254	15,263	3,685	6,106	7,237	4,273	7,958	2,053	24,331	8,847	17,771
$\bar{X}$ TOTAL ABUNDANCE/m^2 FOR EACH AREA		10,138			5,676			4,761			16,983	

APPENDIX IV - NUMBER OF MEIOFAUNA AND MACROFAUNA ORGANISMS/M^2 IN SCRAPING SAMPLES (FROM NANAIMO MARINA)

SCRAPINGS-DEPTHS REDUCED TO CHART DATA SAMPLE	PILING #1 DEPTH 4.9m	PILING #2 DEPTH 1.9m	PILING #3 DEPTH 0.3m	WHARF #1	WHARF #2	WHARF #3	INSIDE BREAKWATER #1 DEPTH 1.2m	INSIDE BREAKWATER #2 DEPTH 0.3m	INSIDE BREAKWATER #3 DEPTH 2.3m
DATE	11/10/84	11/10/84	11/10/84	11/10/84	11/10/84	11/10/84	11/10/84	11/10/84	11/10/84
HARPACTECOIDS	710	833	555	155	56	56	444	377	100
CALANOIDS	311	56	-	266	155	100	167	78	111
CYCLOPOIDS	11	-	11	11	11	-	-	-	-
COPEPOD NAUPLII	11	-	-	-	-	-	-	-	-
NEMATODES	488	389	189	3,275	4,629	1,665	167	22	-
POLYCHAETES	533	2,131	233	255	111	167	411	56	11
OLIGOCHAETES	22	11	11	1,765	133	144	22	-	11
NEMERTEA	-	-	-	78	-	-	-	-	-
PARASITIC COPEPODS	78	56	22	-	-	-	-	-	-
BIVALVES	4,040	7,426	1,154	1,621	2,731	1,654	322	11	-
ACARINA	11	22	-	11	-	-	-	-	-
DECAPODS	-	11	-	-	-	-	11	11	-
ISOPODS	-	-	11	11	-	-	-	-	-
OSTRACODS	-	11	-	22	11	-	-	-	-
GASTROPODS	633	588	289	-	11	-	222	688	178
GASTROPOD EGGS	11	-	-	-	-	-	-	-	-
EGGS	33	566	33	-	11	44	-	11	-
TANAIDACEA	-	89	-	11	-	-	-	-	-
CUMACEA	-	-	-	33	-	-	-	-	-
CIRRIPEDIA	200	255	744	33	-	11	22	44	222
CIRRIPEDIA NAUPLII	-	11	-	-	-	-	11	-	-
AMPHIPODS	1,565	4,107	688	1,765	2,031	1,154	178	44	89
ECTOPROCTA COLONIES	200	2,886	200	33	-	-	-	-	-
ECHINODERMATA	22	22	-	-	-	-	-	-	-
INSECT LARVA	-	-	1,154	-	-	-	-	-	44
INSECT PUPA	-	-	-	33	-	-	-	-	-
TUNICATA (UROCHORDATA)	-	-	-	-	-	22	-	-	-
TURBELLARIA	-	-	-	-	-	-	-	-	-
CIRRIPEDIA CYPRIS	-	-	-	-	-	-	-	-	-
CHITONIDA	-	-	-	-	-	-	-	-	-
TOTAL ABUNDANCE/m^2 OF EACH SAMPLE	8,879	19,470	5,294	9,378	9,890	5,017	1,977	1,342	766
$\bar{X}$ TOTAL ABUNDANCE/m^2 FOR EACH AREA		11,214			8,095			1,362	

APPENDIX IV - NUMBER OF MEIOFAUNA AND MACROFAUNA ORGANISMS/m^2 IN SCRAPING SAMPLES (FROM COMOX MARINA)

SCRAPINGS-DEPTHS REDUCED TO CHART DATA SAMPLE	PILING #1 DEPTH 3.8m	PILING #2 DEPTH 1.7m	PILING #3 DEPTH 0.2m	WHARF #1	WHARF #2	WHARF #3	INSIDE BREAKWATER #1 DEPTH 3.8m	INSIDE BREAKWATER #2 DEPTH 2.3m	INSIDE BREAKWATER #3 DEPTH 0.8m	OUTSIDE BREAKWATER #1 DEPTH 3.4m	OUTSIDE BREAKWATER #2 DEPTH 0.6m	OUTSIDE BREAKWATER #3 DEPTH +1.5m
DATE	12/09/84	12/09/84	12/09/84	12/09/84	12/09/84	12/09/84	13/09/84	13/09/84	13/09/84	08/11/84	08/11/84	08/11/84
HARPACTECOIDS	78	67	777	189	255	1,654	222	200	144	1,077	844	189
CALANOIDS	111	44	22	11	100	222	11	33	167	56	255	44
CYCLOPOIDS	22	-	-	-	-	11	-	-	-	11	11	-
COPEPOD NAUPLII	-	22	-	33	22	-	-	11	-	-	56	-
NEMATODES	56	577	821	966	4,640	5,961	244	400	366	3,730	1,809	-
POLYCHAETES	833	1,676	422	155	56	89	766	944	977	4,784	633	78
OLIGOCHAETES	11	67	11	-	11	-	-	22	167	56	56	33
NEMERTEA	22	67	33	-	-	-	-	-	-	-	-	-
PARASITIC COPEPODS	11	22	-	11	-	-	-	-	11	33	11	-
BIVALVES	966	999	189	4,529	10,157	7,382	311	122	699	566	1,143	688
ACARINA	-	-	11	11	44	-	-	-	11	11	44	-
DECAPODS	11	11	11	-	-	-	-	-	-	-	11	-
ISOPODS	-	-	11	78	22	33	-	-	-	-	-	-
OSTRACODS	-	-	-	-	22	-	-	33	-	477	155	-
GASTROPODS	133	311	11	33	-	44	278	278	1,143	377	289	1,798
GASTROPOD EGGS	-	-	-	22	-	-	-	-	-	-	11	22
EGGS	122	100	211	433	1,543	3,741	22	11	144	33	78	-
TANAIDACEA	-	-	-	-	-	11	111	-	-	67	899	11
CUMACEA	-	-	-	-	-	-	-	-	-	-	-	-
CIRRIPEDIA	433	78	33	33	11	78	-	-	11	200	1,099	1,299
CIRRIPEDIA NAUPLII	78	56	-	-	22	-	22	22	22	-	-	-
AMPHIPODS	189	4,318	2,309	3,596	14,208	24,331	888	344	2,997	3,263	4,906	255
ECTOPROCTA COLONIES	200	821	-	-	-	-	-	-	-	11	-	-
ECHINODERMATA	278	200	11	-	22	-	11	-	56	11	-	-
INSECT LARVA	-	-	-	-	-	-	-	-	-	-	-	-
INSECT PUPA	-	-	-	-	-	-	-	-	-	-	-	11
TUNICATA (UROCHORDATA)	-	-	-	-	-	-	-	-	-	-	22	-
TURBELLARIA	-	-	-	-	-	-	-	-	-	-	-	-
CIRRIPEDIA CYPRIS	-	-	-	-	-	-	-	-	-	-	-	-
CHITONIDA	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL ABUNDANCE/m^2 OF EACH SAMPLE	3,554	9,436	4,883	10,100	31,135	43,557	2,886	2,420	6,915	14,763	12,332	4,428
$\bar{X}$ TOTAL ABUNDANCE/m^2 FOR EACH AREA		5,958			28,264			4,074			10,508	

APPENDIX V - NUMBER OF ZOOPLANKTON ORGANISMS/M^3 IN ZOOPLANKTON TOW SAMPLES FROM FRENCH CREEK MARINA (INSIDE)

SAMPLE	TOW #1 TIME: 10:30 DEPTH: 6m	TOW #2 TIME: 10:40 DEPTH: 3m	TOW #3 TIME: 10:51 DEPTH: 1m	TOW #4 TIME: 11:37 DEPTH: 6m	TOW #5 TIME: 11:44 DEPTH: 3m	TOW #6 TIME: 11:51 DEPTH: 1m	TOW #7 TIME: 12:43 DEPTH: 7m	TOW #8 TIME: 12:50 DEPTH: 4m	TOW #9 TIME: 12:56 DEPTH: 1m	TOW #10 TIME: 1:27 DEPTH: 7m	TOW #11 TIME: 1:33 DEPTH: 4m	TOW #12 TIME: 1:40 DEPTH: 1m
DATE	20/11/84	20/11/84	20/11/84	20/11/84	20/11/84	20/11/84	20/11/84	20/11/84	20/11/84	20/11/84	20/11/84	20/11/84
HARPACTECOIDS	53	-	-	5	-	-	7	-	2	-	4	-
CALANOIDS	178	473	242	289	291	591	209	316	391	258	258	260
CYCLOPOIDS	-	-	-	-	-	-	-	-	-	-	-	-
COPEPOD NAUPLII	-	-	-	-	-	-	-	-	2	4	-	-
NEMATODES	196	-	-	-	-	-	-	-	-	-	-	-
POLYCHAETES	44	-	2	-	2	-	-	-	-	-	-	-
OLIGOCHAETES	7	-	2	-	-	-	-	-	-	-	-	-
NEMERTEA	-	-	-	-	-	-	-	-	-	-	-	-
PARASITIC COPEPODS	-	-	2	-	-	2	4	-	-	-	-	-
BIVALVES	44	-	-	-	-	-	-	-	-	-	-	-
ACARINA	-	-	-	-	-	-	-	-	-	-	-	-
DECAPODS	2	-	-	-	-	-	4	-	-	2	2	-
ISOPODS	-	-	-	-	-	4	-	-	-	-	-	-
OSTRACODS	95	-	5	18	2	2	4	-	4	18	5	-
GASTROPODS	13	29	22	29	15	42	16	55	95	20	15	62
GASTROPOD EGGS	5	-	-	-	-	-	-	-	-	-	-	-
EGGS	-	-	-	-	-	-	-	2	2	-	-	-
TANAIDACEA	-	-	-	-	-	-	-	-	-	-	-	-
CUMACEA	-	-	-	-	-	-	-	-	-	-	-	-
CIRRIPEDIA	-	-	-	-	-	-	-	-	-	-	-	-
CIRRIPEDIA NAUPLII	-	-	-	-	-	-	-	-	-	-	-	-
AMPHIPODS	2	-	-	2	2	-	7	4	-	7	-	2
ECHINODERMATA	-	-	-	-	-	-	-	-	-	-	-	-
INSECT LARVA	-	-	-	-	-	-	-	-	-	-	-	-
TUNICATA (UROCHORDATA)	-	7	2	15	9	18	4	24	24	5	5	15
TURBELLARIA	2	-	-	-	-	-	-	-	-	-	-	-
CLADOCERA	-	-	-	-	-	-	-	-	-	-	-	-
MYSIDACEA	-	-	-	-	-	-	-	-	-	2	-	-
FISH LARVA	-	-	-	-	-	-	-	-	-	2	-	-
CIRRIPEDIA CYPRIS	-	-	-	-	-	-	-	-	-	-	-	-
ADULT INSECT	-	-	-	-	-	-	-	-	-	-	-	-
MEDUSA	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL ABUNDANCE/m^3 OF EACH TOW	641	509	277	358	321	659	255	401	520	318	289	339
$\bar{X}$ TOTAL ABUNDANCE/m^3 FOR AREA		407										

NUMBER OF ZOOPLANKTON ORGANISMS/m^3 IN ZOOPLANKTON TOW SAMPLES FROM FRENCH CREEK MARINA (OUTSIDE)

SAMPLE	TOW #1 TIME: 11:02 DEPTH: 1m	TOW #2 TIME: 11:10 DEPTH: 3m	TOW #3 TIME: 11:20 DEPTH: 6m	TOW #4 TIME: 11:59 DEPTH: 1m	TOW #5 TIME: 12:04 DEPTH: 3m	TOW #6 TIME: 12:16 DEPTH: 6m	TOW #7 TIME: 1:04 DEPTH: 1m	TOW #8 TIME: 1:11 DEPTH: 4m	TOW #9 TIME: 1:19 DEPTH: 7m	TOW #10 TIME: 1:49 DEPTH: 1m	TOW #11 TIME: 1:56 DEPTH: 4m	TOW #12 TIME: 2:03 DEPTH: 7m
DATE	20/11/84	20/11/84	20/11/84	20/11/84	20/11/84	20/11/84	20/11/84	20/11/84	20/11/84	20/11/84	20/11/84	20/11/84
HARPACTECOIDS	4	-	4	-	-	2	4	-	15	-	-	-
CALANOIDS	300	286	571	444	517	557	149	49	900	608	1,210	1,572
CYCLOPOIDS	-	-	-	-	-	-	-	-	-	-	-	-
COPEPOD NAUPLII	-	-	-	-	-	-	-	-	-	-	-	-
NEMATODES	-	-	-	-	-	-	-	-	-	-	-	-
POLYCHAETES	-	-	2	4	2	-	-	-	2	-	4	-
OLIGOCHAETES	-	-	-	-	-	-	-	-	-	-	-	-
NEMERTEA	-	-	-	-	-	-	-	-	-	-	-	-
PARASITIC COPEPODS	-	-	-	-	-	-	4	-	4	-	-	2
BIVALVES	-	-	-	-	-	-	-	-	-	-	-	-
ACARINA	2	-	-	-	-	-	-	-	-	-	-	-
DECAPODS	-	-	5	4	9	15	7	4	20	-	2	16
ISOPODS	-	-	2	-	-	2	-	-	4	-	-	-
OSTRACODS	2	38	67	7	13	7	2	4	18	13	4	-
GASTROPODS	56	2	45	36	-	31	56	4	29	18	71	44
GASTROPOD EGGS	-	-	-	-	-	-	-	-	-	-	-	-
EGGS	-	4	2	-	-	-	2	-	-	-	-	-
TANAIDACEA	-	-	-	-	-	-	-	-	-	-	-	-
CUMACEA	-	-	-	-	-	-	-	-	-	-	-	-
CIRRIPEDIA	-	-	-	-	-	-	-	-	-	-	-	-
CIRRIPEDIA NAUPLII	-	-	-	-	-	-	2	-	-	-	-	-
AMPHIPODS	2	-	4	-	-	35	-	-	7	-	4	5
ECHINODERMATA	-	-	-	-	-	-	-	-	-	-	-	-
INSECT LARVA	-	-	-	-	-	-	-	-	-	-	-	-
TUNICATA (UROCHORDATA)	9	18	49	33	11	18	5	7	11	13	20	15
TURBELLARIA	-	-	-	-	-	-	-	-	-	-	-	-
CLADOCERA	-	-	-	-	2	-	-	-	-	-	-	-
MYSIDACEA	-	-	-	-	-	-	-	-	9	-	2	-
FISH LARVA	-	-	-	-	-	-	-	-	-	-	2	2
CIRRIPEDIA CYPRIS	-	-	-	-	-	-	-	-	-	-	-	-
ADULT INSECT	-	-	-	-	-	-	-	-	-	-	-	-
MEDUSA	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL ABUNDANCE/m^3 OF EACH TOW	375	348	751	528	554	667	231	68	1,019	652	1,319	1,656
$\bar{X}$ TOTAL ABUNDANCE/m^3 FOR AREA			681									

NUMBER OF ZOOPLANKTON ORGANISMS/M^3 IN ZOOPLANKTON TOW SAMPLES
($\bar{X}$ NUMBER OF ORGANISMS FROM 12 INDIVIDUAL TOWS AT EACH AREA)

SAMPLE	NANAIMO INSIDE COMB. NOV 19/84 TIME: 10:54-14:13 DEPTH: 1-7m	NANAIMO OUTSIDE COMB. NOV 19/84 TIME: 11:24-14:43 DEPTH: 1-7m		COMOX INSIDE COMB. NOV 21/84 TIME: 11:08-14:01 DEPTH: 1-7m	COMOX OUTSIDE COMB. NOV 21/84 TIME: 11:26-14:23 DEPTH: 1-7m
DATE	19/11/84	19/11/84		21/11/84	21/11/84
HARPACTECOIDS	29	8		2	13
CALANOIDS	201	204		23	306
CYCLOPOIDS	1	1		-	-
COPEPOD NAUPLII	1	1		1	1
NEMATODES	96	15		3	17
POLYCHAETES	11	2		1	10
OLIGOCHAETES	10	1		1	1
NEMERTEA	-	1		-	-
PARASITIC COPEPODS	-	2		1	1
BIVALVES	4	1		1	6
ACARINA	1	-		1	-
DECAPODS	2	1		1	2
ISOPODS	2	1		1	1
OSTRACODS	-	1		-	1
GASTROPODS	4	2		1	2
GASTROPOD EGGS	-	-		1	1
EGGS	3	1		1	-
TANAIDACEA	6	-		-	1
CUMACEA	1	1		1	1
CIRRIPEDIA	-	1		-	3
CIRRIPEDIA NAUPLII	1	-		1	-
AMPHIPODS	2	1		1	-
ECHINODERMATA	-	1		1	
INSECT LARVA	-	-		-	-
TUNICATA (UROCHORDATA)	120	126		1	3
TURBELLARIA	-	-		-	-
CLADOCERA	1	1		1	-
MYSIDACEA	1	1		-	-
FISH LARVA	-	-		-	-
CIRRIPEDIA CYPRIS	1	1		-	-
ADULT INSECT	-	-		-	1
MEDUSA	-	1		7	7
TOTAL ABUNDANCE/m^3 OF EACH AREA	498	376		52	378

APPENDIX VI - STOMACH CONTENTS OF FISH STUDIED

DATE	SITE	LENGTH (cm)	ORDER OF FISH ANALYZED	SPECIES OF FISH ANALYZED	GUT ANALYSIS
30/08/84	French Creek Outside Breakwater	11.7	Scorpaeniformes	Oligocottus maculosus	2 decapods
		6.1	"	Oligocottus maculosus	nothing identifiable
		17.8	"	Oligocottus maculosus	3 decapods
		19.0	"	Oligocottus maculosus	nothing identifiable
		13.8	"	Oligocottus maculosus	nothing identifiable
		6.5	"	Sebastes caurinus	2 decapods
		19.5	"	Sebastes maliger	5 nematodes
		7.3	Perciformes	Cymatogaster aggregata	48 calanoids, 1 harpactecoid
		11.8	"	Cymatogaster aggregata	nothing identifiable
		9.8	"	Cymatogaster aggregata	4 eggs
		11.6	"	Cymatogaster aggregata	nothing identifiable
		6.0	"	Cymatogaster aggregata	34 nematodes, 2 eggs, 1 cyclopoid
27/11/84	French Creek Outside Breakwater	24.9	Perciformes	Rhacochilus vacca	2 amphipods, 1 tanaidacea
		24.6	"	Rhacochilus vacca	2 oligochaetes, 10 amphipods 3 decapods
		28.6	"	Embiotoca lateralis	8 decapod, 1 nematode, 23 amphipods
		25.8	"	Embiotoca lateralis	7 amphipods, 2 polychaetes, 9 decapods, 2 turbellaria
		24.7	"	Embiotoca lateralis	192 polychaetes, 79 amphipods, 4 nematodes, 21 gastropods, 5 decapods
		20.6	"	Embiotoca lateralis	2 harpactecoids, 32 amphipods, 14 polychaetes, 2 decapods, 4 gastropods, 1 oligochaete
		24.9	"	Embiotoca lateralis	1 harpactecoid, 2 gastropods, 3 polychaetes, 52 amphipods, 3 decapods
		19.7	"	Embiotoca lateralis	103 amphipods, 61 polychaetes, 18 tanaidacea, 2 isopods, 1 gastropod, 1 bivalve, 2 cumacea, 6 harpactecoids, 2 nematodes
		25.6	"	Embiotoca lateralis	1 gastropod, 9 amphipods, 10 polychaetes, 1 decapod
		16.8	"	Embiotoca lateralis	6 amphipods
		18.6	"	Embiotoca lateralis	1 decapod, 17 polychaetes, 15 amphipods
		21.9	"	Embiotoca lateralis	3 amphipods, 2 decapods, 1 calanoid, 1 polychaete
		22.5	"	Embiotoca lateralis	nothing identifiable
		24.2	"	Embiotoca lateralis	2 gastropods, 1 tanaidacea, 25 amphipods, 2 polychaetes, 2 decapods

STOMACH CONTENTS OF FISH STUDIED

DATE	SITE	LENGTH (cm)	ORDER OF FISH ANALYZED	SPECIES OF FISH ANALYZED	GUT ANALYSIS
27/11/84	French Creek Outside Breakwater	27.8	Perciformes	Embiotoca lateralis	15 turbellaria, 1 polychaete
		28.7	"	Embiotoca lateralis	30 amphipods, 35 decapods
		28.5	"	Embiotoca lateralis	8 gastropods, 5 decapods
		25.3	"	Embiotoca lateralis	1 tanaidacea, 1 cirripedia
		26.1	"	Embiotoca lateralis	41 decapods, 5 gastropods, 1 nematode, 10 polychaetes, 39 amphipods
		25.4	Scorpaeniformes	Sebastes maliger	nothing identifiable
		25.6	"	Hexagrammos lagacephalus	1 polychaete, 2 amphipods, 1 calanoid, 7 decapods
		25.4	"	Hexagrammos lagacephalus	4 decapods, 3 nematodes, 1 amphipod, 1 oligochaete
		35.1	"	Hexagrammos lagacephalus	fish roe, 1 nematode
		32.6	"	Hexagrammos lagacephalus	7 eggs, 1 gastropod, 4 decapods
		41.0	"	Hexagrammos lagacephalus	4 oligochaetes, 9 eggs, 1 perciforme
		53.0	"	Ophiodon elongatus	16 decapods, 2 nematodes, 3 oligochaetes, 2 polychaetes, 1 perciforme
		42.0	"	Ophiodon elongatus	1 perciforme
		43.0	"	Ophiodon elongatus	1 scorpaeniforme
		46.0	"	Ophiodon elongatus	1 scorpaeniforme
04/09/84	French Creek Inside Marina Basin	35.0	Perciformes	Embiotoca lateralis	1 cirripedia, 15 bivalves
		38.0	"	Embiotoca lateralis	7 bivalves
		34.0	"	Embiotoca lateralis	nothing identifiable
		15.6	"	Embiotoca lateralis	40 amphipods, 1 cyclopoid
03/12/84	French Creek Inside Marina Basin	29.4	Scorpaeniformes	Hexagrammos decagrammus	22 eggs, 5 decapods, 1 harpactecoid, 2 nematodes
		22.2	"	Hexagrammos decagrammus	nothing identifiable
		17.6	"	Hexagrammos decagrammus	4 decapods
		23.5	"	Hexagrammos decagrammus	2 oligochaetes, 1 egg, 2 decapods
		21.5	"	Hexagrammos decagrammus	1 turbellaria
		20.1	"	Hexagrammos decagrammus	3 decapods
		16.2	"	Hexagrammos decagrammus	nothing identifiable
		22.4	"	Icelinus borealis	1 perciforme, 1 nematode, 1 scorpaeniforme
		12.6	Gasterosteiformes	Pholis laeta	nothing identifiable
		32.3	"	Pholis laeta	nothing identifiable
		26.2	"	Pholis laeta	nothing identifiable
		20.8	"	Pholis laeta	81 nematodes
		10.3	Clupeiformes	Clupea harengus pallasi	868 calanoids, 3 harpactecoids
		12.0	Pleuronectiformes	Citharichthys stigmaeus	1 polychaete

STOMACH CONTENTS OF FISH STUDIED

DATE	SITE	LENGTH (cm)	ORDER OF FISH ANALYZED	SPECIES OF FISH ANALYZED	GUT ANALYSIS
14/09/84	French Creek Inside Breakwater	20.8	Perciformes	Embiotoca lateralis	nothing identifiable
		22.3	"	Embiotoca lateralis	nothing identifiable
		6.6	"	Embiotoca lateralis	2 calanoids
		6.8	"	Embiotoca lateralis	1 polychaete, 1 calanoid
		6.8	"	Embiotoca lateralis	nothing identifiable
		6.8	"	Embiotoca lateralis	nothing identifiable
		6.6	"	Embiotoca lateralis	1 egg
		6.7	"	Embiotoca lateralis	1 ostracod
		28.6	Scorpaeniformes	Sebastes maliger	1 decapod
		23.5	"	Ophiodon elongatus	1 oligochaete, 1 decapod
08/11/84	Comox Marina Outside Breakwater	24.0	Perciformes	Rhacochilus vacca	14 polychaetes, 1 oligochaete, 10 amphipods, 3 calanoids, 1 harpactecoid, 1 nematode, 2 decapods, 7 bivalves
		28.0	"	Rhacochilus vacca	9 oligochaetes, 1 amphipod 1 decapods
		49.9	Scorpaeniformes	Sebastes maliger	1 nematode
		27.3	"	Sebastes maliger	2 decapods
		28.8	"	Sebastes maliger	1 oligochaete, 1 decapod
		23.2	"	Sebastes maliger	1 oligochaete
		23.2	"	Sebastes maliger	9 oligochaetes, 2 decapods
29/11/84	Comox Marina Outside Breakwater	29.8	Perciformes	Embiotoca lateralis	1 cirripedia, 1 egg mass, 2 bivalves
		29.4	"	Embiotoca lateralis	1 egg mass, 1 isopod, 2 polychaetes, 9 amphipods, 2 oligochaetes
		22.5	"	Embiotoca lateralis	49 amphipods, 1 oligochaete
				Embiotoca lateralis	13 chitonida, 21 polychaetes, 1 nematode, 9 bivalves, 12 amphipods
		24.0	"	Embiotoca lateralis	21 amphipods
		32.2	"	Embiotoca lateralis	10 chitonida, 1 cirripedia
		28.0	"	Embiotoca lateralis	3 amphipods, 1 egg
		34.6	Scorpaeniformes	Hexagrammos lagocephalus	4 decapods, 8 nematodes, 1 actiniaria
		29.6	"	Hexagrammos lagocephalus	7 decapods
		39.2	"	Hexagrammos lagocephalus	1 egg mass, 5 decapods
		41.1	"	Hexagrammos lagocephalus	1 egg mass, 2 polychaetes, 1 scorpaeniforme
		40.2	"	Hexagrammos lagocephalus	1 egg mass, 2 gastropods, 3 polychaetes, 2 decapods
		29.5	"	Hexagrammos lagocephalus	1 nematode, 1 polychaete, 9 decapods

STOMACH CONTENTS OF FISH STUDIED

DATE	SITE	LENGTH (cm)	ORDER OF FISH ANALYZED	SPECIES OF FISH ANALYZED	GUT ANALYSIS
29/11/84	Comox Marina Outside Breakwater	39.2	Scorpaeniformes	Hexagrammos lagocephalus	3 polychaetes, 10 decapods, 1 egg mass
		34.0	"	Hexagrammos lagocephalus	2 eggs, 1 polychaete, 3 decapods
		36.0	"	Hexagrammos lagocephalus	4 nematodes, 1 egg, 2 decapods
		25.1	"	Sebastes caurinus	9 bivalves
		30.2	"	Sebastes caurinus	nothing identifiable
		27.5	"	Sebastes caurinus	2 oligochaetes, 1 nematode
		27.8	"	Sebastes caurinus	1 perciforme, 7 nematodes, 1 oligochaete, 2 decapods
		61.0	"	Ophiodon elongatus	4 oligochaete, 1 egg mass
		70.0	"	Ophiodon elongatus	1 scorpaeniformes, 3 fish roe, 46 eggs
		54.0	"	Ophiodon elongatus	1 turbellaria, 1 perciforme
		81.0	"	Ophiodon elongatus	4 oligochaetes, 1 egg mass
		64.0	"	Ophiodon elongatus	1 nematode, 1 amphipod
		76.0	"	Ophiodon elongatus	4 nematodes, 1 egg
13/09/84	Comox Marina Inside Breakwater	20.7	Perciformes	Embiotoca lateralis	nothing identifiable
		16.0	"	Cymatogaster aggregata	25 decapods, 14 polychaetes 3 calanoids
		31.5	Scorpaeniformes	Sebastes maliger	nothing identifiable
		26.0	"	Sebastes maliger	5 decapods, 1 anguilliforme
		24.3	"	Sebastes maliger	nothing identifiable
		18.6	"	Sebastes maliger	1 decapod, 4 nematodes
		22.2	"	Sebastes maliger	1 decapod
06/12/84	Comox Marina Inside Breakwater	30.4	Perciformes	Embiotoca lateralis	fish roe
		24.7	"	Embiotoca lateralis	Schitonida
		19.8	"	Embiotoca lateralis	1 polychaete
		27.6	"	Embiotoca lateralis	1 egg
		25.3	"	Embiotoca lateralis	nothing identifiable
		27.5	"	Embiotoca lateralis	1 gastropod, 1 amphipod, 2 polychaetes
		18.3	"	Embiotoca lateralis	5 eggs
		19.8	"	Embiotoca lateralis	12 calanoids, 1 amphipod 72 harpactecoids, 3 decapods
		20.4	"	Embiotoca lateralis	4 isopods, 1 polychaete 12 amphipods, 3 tanaidacea
		57.0	Scorpaeniformes	Ophiodon elongatus	2 perciformes, 1 egg mass 1 nematode

STOMACH CONTENTS OF FISH STUDIED

DATE	SITE	LENGTH (cm)	ORDER OF FISH ANALYZED	SPECIES OF FISH ANALYZED	GUT ANALYSIS
06/12/84	Comox Marina Inside Breakwater	58.0	Scorpaeniformes	Ophiodon elongatus	6 nematodes, 8 oligochaetes, 3 harpactecoids, 2 calanoids
		39.6	"	Hexagrammos lagocephalus	7 decapods, 8 gastropods 3 polychaetes, 1 egg
		34.8	"	Hexagrammos lagocephalus	3 decapods
		9.8	"	Clupea harengus pallasi	nothing identifiable
		9.9	"	Clupea harengus pallasi	1 amphipod
		10.5	"	Clupea harengus pallasi	1 calanoid
22/11/84	Nanaimo Inside Marina Basin	11.1	Perciformes	Embiotoca lateralis	nothing identifiable
		24.5	"	Embiotoca lateralis	1 calanoid, 5 amphipods, 3 decapod, 2 gastropods
		17.2	"	Embiotoca lateralis	1 calanoid, 3 polychaetes, 1 bivalve, 12 amphipods
		18.9	"	Embiotoca lateralis	nothing identifiable
		19.6	"	Embiotoca lateralis	nothing identifiable
		30.2	"	Embiotoca lateralis	7 bivalves, 2 amphipods, 1 gastropod, 1 decapod, 4 gasterosteiformes
		16.2	"	Embiotoca lateralis	1 calanoid, 1 nematode, 1 amphipod
		26.1	"	Embiotoca lateralis	3 calanoids, 3 gastropods, 3 polychaetes, 5 amphipods, 1 egg, 1 cirripedia, 1 harpactecoid, 3 bivalves
		28.4	"	Embiotoca lateralis	1 nematode, 1 amphipod
		28.2	"	Embiotoca lateralis	1 nematode, 4 polychaetes, 4 amphipods, 1 decapod
		25.1	"	Embiotoca lateralis	2 amphipods, 1 harpactecoid 1 polychaete
		22.0	"	Embiotoca lateralis	1 calanoid, 2 polychaetes, 2 bivalves, 1 amphipod
		19.1	"	Embiotoca lateralis	1 calanoid, 1 egg, 1 polychaete, 26 bivalves, 2 amphipods
		22.3	"	Embiotoca lateralis	1 egg mass, 1 polychaete
		25.4	"	Embiotoca lateralis	7 bivalves, 7 amphipods 1 egg
		20.2	"	Embiotoca lateralis	1 amphipod
		27.8	Scorpaeniformes	Hexagrammos lagocephalus	1 egg mass, 4 calanoids, 2 nematodes, 1 amphipod, 3 oligochaetes
		35.6	"	Hexagrammos lagocephalus	2 nematodes

STOMACH CONTENTS OF FISH STUDIED

DATE	SITE	LENGTH (cm)	ORDER OF FISH ANALYZED	SPECIES OF FISH ANALYZED	GUT ANALYSIS
22/11/84	Nanaimo Inside Marina Basin	49.1	Perciformes	Hexagrammos lagocephalus	nothing identifiable
		37.3	"	Hexagrammos lagocephalus	3 decapods, 2 bivalves, 2 eggs
		27.8	"	Hexagrammos lagocephalus	nothing identifiable
		16.3	"	Hexagrammos lagocephalus	3 decapods, 1 polychaete, 1 cyclopoid
		34.9	"	Artedius harringtoni	fish roe, 4 nematodes, 1 decapod
			"		
		53.0	"	Ophiodon elongatus	1 perciforme 14 gasterosteiformes
		5.0	Gasterosteiformes	Gasterosteus aculeatus	1 turbellaria, 4 amphipod, 10 polychaetes, 1 harpactecoid
		4.5		Gasterosteus aculeatus	4 calanoids, 1 polychaete, 1 amphipod
		11.3		Aulorhynchus flavidus	nothing identifiable
		10.2	Pleuronectiformes	Citharichthys stigmaeus	nothing identifiable
23/11/84	Nanaimo CPR Dock	22.8	Perciformes	Embiotoca lateralis	1 copepod, nauplii, 1 gastropod 9 polychaetes, 3 bivalves, 1 amphipod
		25.2	"	Embiotoca lateralis	3 amphipods, 4 polychaetes, 30 cirripedia, 1 gastropod, 2 decapods
		21.3	"	Embiotoca lateralis	1 bivalve, 3 tanaidacea, 1 nematode, 3 amphipods, 2 decapods
		22.3	"	Embiotoca lateralis	nothing identifiable
		18.5	"	Embiotoca lateralis	1 bivalve, 21 amphipods, 2 cirripedia, 1 calanoid, 19 polychaetes
		18.6	"	Embiotoca lateralis	14 amphipods, 2 isopods, 2 cirripedia, 4 bivalves
		19.9	"	Embiotoca lateralis	2 bivalves, 2 calanoids, 27 polychaetes, 9 amphipods
		36.8	Scorpaeniformes	Hexagrammos lagocephalus	2 decapods
		40.7	"	Hexagrammos lagocephalus	1 egg mass, 1 polychaete, 2 decapods
		39.6	"	Hexagrammos lagocephalus	1 egg mass
		33.7	"	Hexagrammos lagocephalus	29 decapods, 1 nematode
		28.1	"	Hexagrammos lagocephalus	1 egg mass, 3 decapods
		36.7	"	Hexagrammos lagocephalus	2 nematodes, 1 egg mass, 4 decapods
		24.8	"	Hexagrammos lagocephalus	1 egg mass, 3 cirripedia, 2 decapods
		34.2	"	Sebastes caurinus	3 oligochaetes, 1 egg mass

APPENDIX VII - FOOD ORGANISMS PERCENT OCCURRENCE IN FISH STOMACHS FROM VARIOUS SITES

ORDER OF FISH STUDIED	SITE	DATE	NO. OF FISH SAMPLED	NO. OF EMPTY STOMACHS	RANGE FISH LENGTH (CM)	$\bar{X}$ FISH LENGTH (CM)	ORGANISM FOUND IN FISH STOMACH	% ORGANISM OCCURRENCE IN STOMACHS CONTAINING FOOD	$\bar{X}$ NO. ORGANISMS IN STOMACHS IN WHICH THEY OCCURRED
Perciformes	French Creek Outside Breakwater	30/08/84	5	2	6.0 - 11.8	9.3	Calanoid	33	48
							Harpactecoid	33	1
							Cyclopoid	33	1
							Nematode	33	34
							Eggs	67	3
Scorpaeniformes	French Creek Outside Breakwater	30/08/84	7	3	6.1 - 19.5	13.5	Decapod	75	2.3
							Nematode	25	5
Perciformes	French Creek Outside Breakwater	27/11/84	19	1	16.8 - 28.7	24.2	Amphipod	83	29
							Tanaidacea	22	5.3
							Oligochaete	11	1.5
							Decapod	72	9
							Nematode	22	2
							Polychaete	61	28.5
							Turbellaria	11	8.5
							Gastropod	44	5.5
							Harpactecoid	17	3
							Isopods	6	2
							Bivalve	6	1
							Cumacea	6	2
							Calanoid	6	1
							Cirripedia	6	1
Scorpaeniformes	French Creek Outside Breakwater	27/11/84	10	1	25.4 - 53.0	36.9	Polychaete	22	1.5
							Amphipod	22	1.5
							Calanoid	11	1
							Decapod	44	13.8
							Nematode	33	2
							Oligochaete	33	2.7
							Fish roe	1	1
							Eggs	22	8
							Gastropod	11	1
							Perciforme	33	1.5
							Scorpaeniforme	22	1

FOOD ORGANISMS PERCENT OCCURRENCE IN FISH STOMACHS FROM VARIOUS SITES

ORDER OF FISH STUDIED	SITE	DATE	NO. OF FISH SAMPLED	NO. OF EMPTY STOMACHS	RANGE FISH LENGTH (CM)	$\bar{X}$ FISH LENGTH (CM)	ORGANISM FOUND IN FISH STOMACH	% ORGANISM OCCURRENCE IN STOMACHS CONTAINING FOOD	$\bar{X}$ NO. ORGANISMS IN STOMACHS IN WHICH THEY OCCURRED
Perciformes	French Creek Inside Marina Creek	04/09/84	4	1	15.6 - 38.0	30.7	Cirripedia	33	1
							Bivalve	67	11
							Amphipod	33	40
							Cyclopoid	33	1
Scorpaeniformes	French Creek Inside Marina Basin	03/12/84	8	2	16.2 29.4	21.6	Decapod	67	3.5
							Harpactecoid	17	1
							Nematode	33	1.5
							Eggs	33	11.5
							Oligochaete	17	2
							Turbellaria	17	1
							Perciforme	17	1
							Scorpaeniforme	17	1
Gasterosteiformes	French Creek Inside Marina Basin	03/12/84	4	3	12.6 - 32.3	23.0	Nematode	100	81
Clupeiformes	French Creek Inside Marina	03/12/84	1	0	-	10.3	Calanoid	100	868
							Harpactecoid	100	3
Pleuronectiformes	French Creek Inside Breakwater	03/12/84	1	0	-	12.0	Polychaete	100	1
Perciformes	French Creek Inside Breakwater	14/09/84	8	4	6.6 - 22.3	10.4	Polychaete	25	1
							Calanoid	50	1.5
							Eggs	25	1
							Ostracod	25	1
Scorpaeniformes	French Creek Inside Breakwater	14/09/84	2	0	23.5 - 28.6	26.1	Decapod	100	1
							Oligochaete	50	1

FOOD ORGANISMS PERCENT OCCURRENCE IN FISH STOMACHS FROM VARIOUS SITES

ORDER OF FISH STUDIED	SITE	DATE	NO. OF FISH SAMPLED	NO. OF EMPTY STOMACHS	RANGE FISH LENGTH (CM)	$\bar{X}$ FISH LENGTH (CM)	ORGANISM FOUND IN FISH STOMACH	% ORGANISM OCCURRENCE IN STOMACHS CONTAINING FOOD	$\bar{X}$ NO. ORGANISMS IN STOMACHS IN WHICH THEY OCCURRED
Perciformes	Comox Marina Outside Breakwater	08/11/84	2	0	24.0 28.0	26.0	Polychaete	50	14
							Oligochaete	100	5
							Amphipod	100	5.5
							Calanoid	50	3
							Harpactecoid	50	1
							Nematode	50	1
							Decapod	100	1.5
							Bivalve	50	7
Scorpaeniformes	Comox Marina Outside Breakwater	08/11/84	5	0	23.2 - 49.9	30.5	Nematode	20	1
							Decapod	60	1.7
							Oligochaete	60	3.7
Perciformes	Comox Marina Outside Breakwater	29/11/84	7	0	22.5 - 32.2	27.5	Cirripedia	29	1
							Egg Mass	29	1
							Bivalve	29	5.5
							Isopod	14	1
							Polychaete	29	11.5
							Oligochaete	29	1.5
							Amphipod	71	18.8
							Chitonida	29	11.5
							Nematode	14	1
							Egg	14	1
Scorpaeniformes	Comox Marina Outside Breakwater	29/11/84	19	1	25.1 - 81.0	44.2	Decapod	50	4.9
							Nematode	39	3.7
							Actinaria	6	1
							Egg Mass	33	1
							Polychaete	28	2
							Gastropod	6	2
							Eggs	22	12.5
							Bivalve	6	9
							Oligochaete	22	2.8
							Fish roe	6	3
							Turbellaria	6	1
							Scorpaeniforme	11	1
							Perciforme	11	1
							Amphipod	6	1

FOOD ORGANISMS PERCENT OCCURRENCE IN FISH STOMACHS FROM VARIOUS SITES

ORDER OF FISH STUDIED	SITE	DATE	NO. OF FISH SAMPLED	NO. OF EMPTY STOMACHS	RANGE FISH LENGTH (CM)	$\bar{X}$ FISH LENGTH (CM)	ORGANISM FOUND IN FISH STOMACH	% ORGANISM OCCURRENCE IN STOMACHS CONTAINING FOOD	$\bar{X}$ NO. ORGANISMS IN STOMACHS IN WHICH THEY OCCURRED
Perciformes	Comox Marina Inside Breakwater	13/09/84	2	1	16.0 - 20.7	18.4	Decapod	100	25
							Polychaete	100	14
							Calanoid	100	3
Scorpaeniformes	Comox Marina Inside Breakwater	13/09/84	5	2	18.6 - 31.5	24.5	Decapod	100	2.3
							Anguilliforme	33	1
							Nematode	33	4
Perciformes	Comox Marina Inside Breakwater	06/12/84	9	1	18.3 - 30.4	23.8	Fish roe	13	1
							Chitonida	13	5
							Polychaete	38	1.3
							Egg	25	3
							Gastropod	13	1
							Amphipod	38	4.7
							Calanoid	13	12
							Harpactecoid	13	72
							Decapod	13	3
							Isopod	13	4
							Tanaidacea	13	3
Scorpaeniformes	Comox Marina Inside Breakwater	06/12/84	4	0	34.8 - 58.0	47.4	Decapod	50	5
							Polychaete	25	3
							Gastropod	25	8
							Oligochaete	25	8
							Harpactecoid	25	3
							Calanoid	25	2
							Nematode	50	3.5
							Egg	25	1
							Egg Mass	25	1
							Perciforme	25	1
Clupeiformes	Comox Marina Inside Breakwater	06/12/84	3	1	9.8 - 10.5	10.1	Amphipod	50	1
							Calanoid	50	1

FOOD ORGANISMS PERCENT OCCURRENCE IN FISH STOMACHS FROM VARIOUS SITES

ORDER OF FISH STUDIED	SITE	DATE	NO. OF FISH SAMPLED	NO. OF EMPTY STOMACHS	RANGE FISH LENGTH (CM)	$\bar{X}$ FISH LENGTH (CM)	ORGANISM FOUND IN FISH STOMACH	% ORGANISM OCCURRENCE IN STOMACHS CONTAINING FOOD	$\bar{X}$ NO. ORGANISMS IN STOMACHS IN WHICH THEY OCCURRED
Perciformes	Nanaimo Inside Marina Basin	22/11/84	16	3	11.1 - 28.4	22.2	Calanoid	46	1.3
							Amphipod	92	3.5
							Decapod	23	1.7
							Gastropod	23	2
							Polychaete	54	2.1
							Bivalve	46	7.8
							Nematode	23	1
							Cirripedia	8	1
							Egg	22	1
							Harpactecoid	15	1
							Gasterosteiforme	8	3
							Egg Mass	8	1
Scorpaeniformes	Nanaimo Inside Marina Basin	22/11/84	8	2	16.3 - 53.0	35.2	Calanoid	17	4
							Nematode	50	1.3
							Amphipod	17	1
							Decapod	50	1.2
							Oligochaete	17	3
							Polychaete	17	1
							Bivalve	17	2
							Cyclopoid	17	1
							Eggs	17	2
							Fish roe	17	1
							Gasterosteiforme	17	14
							Perciformes	17	1
							Egg Mass	17	1
Gasterosteiformes	Nanaimo Inside Marina Basin	22/11/84	3	1	4.5 - 11.3	6.9	Turbellaria	50	1
							Amphipod	100	2.5
							Polychaete	100	5.5
							Harpactecoid	50	1
							Calanoid	50	4
Pleuronectiformes	Nanaimo Inside Marina Basin	22/11/84	1	1	-	10.2	-	-	-

FOOD ORGANISMS PERCENT OCCURRENCE IN FISH STOMACHS FROM VARIOUS SITES

ORDER OF FISH STUDIED	SITE	DATE	NO. OF FISH SAMPLED	NO. OF EMPTY STOMACHS	RANGE FISH LENGTH (CM)	$\bar{X}$ FISH LENGTH (CM)	ORGANISM FOUND IN FISH STOMACH	% ORGANISM OCCURRENCE IN STOMACHS CONTAINING FOOD	$\bar{X}$ NO. ORGANISMS IN STOMACHS IN WHICH THEY OCCURRED
Perciformes	Nanaimo CPR Dock	23/11/84	7	1	18.5 - 25.2	21.3	Polychaete	67	14.8
							Amphipod	100	8.5
							Isopod	17	2
							Decapod	17	2
							Bivalve	83	2.2
							Nematode	17	1
							Cirripedia	50	11.3
							Tanaidacea	17	3
							Gastropod	33	1
							Calanoid	33	1.5
							Acarina	17	1
							Copepod Nauplii	17	1
Scorpaeniformes	Nanaimo CPR Dock	23/11/84	8	0	24.8 - 40.7	34.3	Decapod	75	7
							Egg Mass	75	1
							Polychaete	13	1
							Nematode	25	1.5
							Cirripedia	13	3
							Oligochaete	13	3

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