SUBTIDAL SURVEY OF PHYSICAL AND BIOLOGICAL FEATURES OF PORTAGE INLET AND THE GORGE WATERWAY

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SUBTIDAL SURVEY OF PHYSICAL AND BIOLOGICAL FEATURES OF PORTAGE INLET AND THE GORGE WATERWAY

REPORT
& MAP FOLIO

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

The Victoria and Esquimalt Harbours Environmental Action Program (VEHEAP) is a multi-agency group currently implementing an environmental action plan for Victoria and Esquimalt Harbours, which includes Portage Inlet and the Gorge Waterway. A key element of the program is the Harbours Ecological Inventory and Rating (HEIR) project which consists of a systematic inventory of the backshore, intertidal and subtidal ecological features of the harbours, and a subsequent ecological rating of these features (the Harbours Ecological Inventory and Rating or HEIR project). This report contains subtidal inventory information for the Gorge Waterway and Portage Inlet which will be incorporated into the overall HEIR project.

The Gorge Waterway is a long shallow, narrow inlet extending northwest of Victoria Harbour. The Gorge is strongly influenced by tidal currents (particularly at its narrowest constrictions) and tidal flow is constrained by tidal rapids at Gorge Narrows. Portage Inlet is a shallow basin at the upper end of the Gorge Waterway. Depths are generally less than 2m relative to chart datum, the seabed is relatively flat and formed of fine sediments. The Gorge Waterway and Portage Inlet encompass 110 hectares of subtidal area.

A subtidal inventory of the physical and biological features of the Gorge and Portage Inlet was conducted during the late spring and summer of 2000. A towed, underwater video system (Seabed Imaging and Mapping System, or SIMS) was used to obtain extensive, geo-positioned imagery of the seabed. Following preliminary classification and mapping of this video imagery, SCUBA and snorkel observations were conducted to ground truthing purposes and to obtain more detailed information on the biotic community and specific seabed features. The survey was conducted on a 100m trackline grid, however finer resolution (5-10m spacing) was used where important physical or biological features were anticipated (e.g. Gorge Narrows). The video survey encompassed a total of 50.3 km of vessel tracklines and approximately 17 hours of video imagery. These methods are comparable to recently conducted subtidal surveys of Victoria Harbour, Esquimalt Harbour and Esquimalt Lagoon.

The video imagery was reviewed by a geologist and biologist using a standard substrate and biotic classification system which records data for each second of video imagery. Classified features include:

- substrate type
- sediment class
- gravel content
- shell content
- organic material (wood and vegetative debris)
- man-made features
- total vegetation cover
- eelgrass
- kelps
- filamentous and foliose red algae
- green algae
- macroinvertebrates (e.g. anemones, tubeworms, sea urchins, subtidal clams, crab)

The report provides a map folio of these features at 1:12,000 scale for the Gorge Waterway and Portage Inlet. In addition, an HTLM format interactive CD-ROM of the mapped biophysical themes as well as georeferenced still and video imagery from the underwater survey is available as a product of this project.

The most notable biophysical features of the Gorge Waterway and Portage Inlet, as identified by the video survey are:

1. **Portage Inlet** (above the Craigflower Bridge)

   - shallow, mud sediment except around shore margins
   - mostly depositional sediments, current influence only at "outlet" to the Gorge Waterway
   - few man-made objects due to low use and depositional nature of sediments
   - eelgrass beds
   - foliose green algae (*Ulva)*
   - native oysters in subtidal mud sediments

2. **Upper Gorge** (Gorge Bridge to the Craigflower Bridge)

   - mix of depositional and current dominated sediments
   - man-made objects mostly associated with shoreline
   - extensive eelgrass beds
   - fringing filamentous red algae
   - shell/gravel bivalve beds
   - native oysters

3. **Lower Gorge** (Selkirk Trestle Bridge to the Gorge Bridge)

   - primarily current dominated regime except in basins
   - gravel present in most sediments except Upper Selkirk Waters which appears to be a depositional environment
   - man-made objects are more common in the non-depositional, higher-current areas
   - kelps are the dominant vegetation in narrow sections of the Lower Gorge
   - eelgrass beds above Selkirk Waters Trestle Bridge
   - current dominated bryozoan/ascidian/sponge community

The Gorge Narrows is a current dominated channel with characteristic features including rock and cobble/boulder sediments, moderate to dense cover of filamentous red algae, native oysters, Japanese oysters, mussels and a bryozoan/ascidian/sponge community.

The biophysical features of Gorge Waterway and Portage Inlet are influenced by three factors:

- a very protected tidal lagoon (Portage Inlet)
- restricted tidal exchange above the Gorge Narrows
- channel (3.5km) dominated by tidal current

This combination of coastal physical features is unique within the Capital Regional District. The physiography of Portage Inlet and the Gorge is more typically found on the Central Coast of British Columbia, where there are several tidal lagoons of similar form. On the basis of physical geography alone Portage Inlet and the Gorge Waterway are regionally significant areas, particularly within an urban setting.

Several of the subtidal biological features in Portage Inlet and the Gorge Waterway further emphasize the regional environmental significance of this area:

1. Extensive Eelgrass (*Zostera marina*) Beds

Approximately 80 hectares of eelgrass beds were mapped in Portage Inlet and the Gorge. This represents over 80% of the eelgrass beds identified in the Victoria and Esquimalt Harbours area (including Esquimalt Lagoon).

2. Abundance of Bivalves, Particularly Native Oysters

The intertidal gravel bars within the Gorge containe extensive amounts of shell material including butter and littleneck clams. The subtidal surveys identified areas of native (*Ostrea lurida*) oysters in mud sediments. This species, although not rare, were historically abundant in only a few locations in British Columbia (Portage Inlet, Ladysmith Harbour, Boundary Bay, Nanoose Harbour). Portage Inlet and the Gorge may now support one of the largest populations of native oysters on the British Columbia coast.

3. High Current Epifaunal Invertebrate Communities

Gorge Narrows and the Lower Gorge support a relatively diverse and abundant community of sessile, suspension feeding invertebrates including colonial and solitary ascidians, sponges, and bryozoans. This is likely the largest representation of this community type in the Victoria and Esquimalt Harbour area.

4. Spawning Areas

Herring have historically spawned in Portage Inlet and the Upper Gorge, primarily within the eelgrass beds. In addition, the Colquitz River and Craigflower Creek, which drain into Portage Inlet, support spawning populations of cutthroat trout and coho salmon, and Portage Inlet serves as an estuarine rearing area for juvenile salmon.

The Gorge Waterway and Portage Inlet have been subject to historic environmental impacts, including infilling of intertidal habitat, sewage and nutrient input, and historic log booming in Upper Selkirk Waters. However, within the subtidal zone, a number of features with high ecological value (extensive eelgrass beds, native oyster beds, current dominated suspension feeding communities) remain intact, although perhaps at somewhat less than historic levels. The next step in the HEIR process is to develop ecological ratings for subtidal habitats in a manner compatible with the recent rating of intertidal habitats within the VEHEAP area. The challenge is to maintain and enhance these ecological values though management practices which also recognize the recreational and upland values inherent to the urban setting of the Gorge Waterway and Portage Inlet.

ACKNOWLEDGEMENTS

Doug Hartley of Arrawac Marine Services piloted the survey vessel for the SIMS video survey. Dale McCullough of Seaconsult Marine Research Ltd. was responsible for the SIMS field survey. Pam Thuringer of Archipelago Marine Research Ltd. supervised the biological classification and dive survey components of the project. Jason Clarke and Luc Bonneau, also of Archipelago assisted in the dive survey. Sarah Cook and Xanthe Brown of Archipelago Marine Research Ltd. conducted the biological classification of the video imagery. Sheri Ward (Coastal and Oceans Resources Inc.) and Angela Forrester (Archipelago Marine Research Ltd.) were responsible for GIS mapping. Sheri Ward also conducted the substrate classification and John Harper (Coastal and Ocean Resources Inc.) supervised the interpretation of the substrate data. Brian Emmett (Archipelago Marine Research Ltd.) acted as the project manager and supervised the interpretation of the biological data.

1.0 INTRODUCTION

1.1 BACKGROUND

The Victoria and Esquimalt Harbours Environmental Action Program (VEHEAP) is a multi-agency group currently implementing an environmental action plan for the Victoria and Esquimalt harbours area, which includes Portage Inlet and the Gorge Waterway (Figure 1). A key element of the VEHEAP plan is a systematic inventory of the backshore, intertidal and subtidal ecological features of the harbour areas, and a subsequent ecological rating of these features.

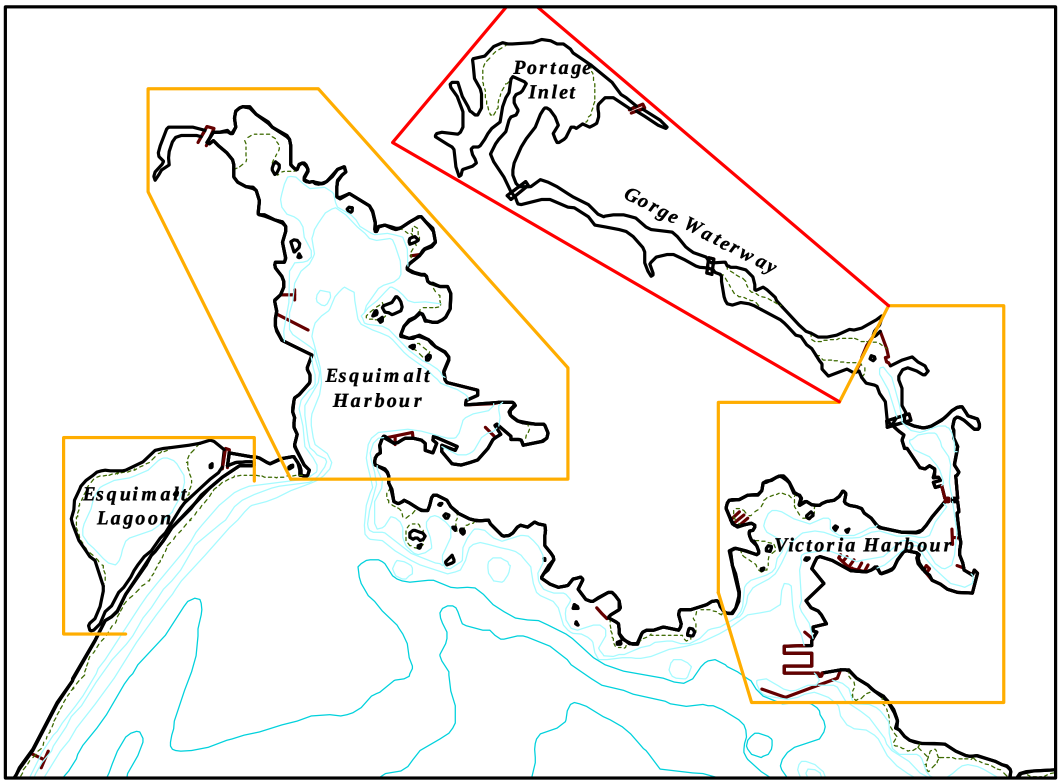

Figure 1. Victoria and Esquimalt Harbours. Portage Inlet and the Gorge Waterway subtidal survey area is shown in red. Yellow areas (Victoria and Esquimalt Harbours and Esquimalt Lagoon) have also been surveyed in a similar manner (see Section 1.1).

The Harbours Ecological Inventory and Rating (HEIR) project has been underway since 1997. Phase 1 of the project, an inventory and ecological rating of the intertidal and backshore zones of the harbours, was completed in 1999 (Westland 2000). Phase Two of the project will address the subtidal areas of the harbour and consists of two components:

Component 1 - a subtidal inventory of the harbour areas;
Component 2 - the development and application of a systematic ecological rating to these subtidal areas.

This project addresses the requirement for a subtidal inventory of biophysical features of Portage Inlet and the Gorge Waterway. A companion report (Archipelago Marine Research Ltd. 2000a) provides an inventory and mapping of subtidal areas of Esquimalt Lagoon. A subtidal inventory of Victoria Harbour, funded by Transport Canada, was completed in 1999 (Emmett *et al.* 2000). Transport Canada has also undertaken a subtidal inventory of Esquimalt Harbour (Archipelago Marine Research Ltd. 2000b). These initiatives complete the subtidal inventory component of the HEIR project (Figure 1). The next step in the HEIR process is Component 2, the development of ecological ratings for subtidal habitats in a manner compatible with the recent rating of intertidal habitats within the VEHEAP area (Westland 2000). This will be undertaken when the information from the four subtidal inventory initiatives is made available to VEHEAP.

These inventory projects recognise the importance of using comparable methods. For this reason, underwater video and dive survey methods, as well as seasonal timing comparable to the previous Transport Canada inventories, have been used for the current surveys of Portage Inlet, the Gorge Waterway and Esquimalt Lagoon. These methods are outlined in Section 2.0.

1.2 OBJECTIVES AND PROJECT DELIVERABLES

The subtidal physical and biological survey was designed to address the following objectives:

1. Complete an inventory and mapping of physical and biological features.
2. Identify valued/sensitive habitat such as eelgrass beds, areas of dense or diverse algal vegetation and important invertebrate resources.
3. Describe important subtidal community features.
4. Identify physically degraded habitats including areas with extensive man-made debris, log and bark accumulations or sediment deposition.
5. Produce digital (GIS) maps compatible with the existing HEIR intertidal and Transport Canada subtidal inventories of Victoria and Esquimalt Harbours.

Project deliverables include:

1. A hardcopy map folio and accompanying interpretative report,
2. Electronic survey data including the Access database and associated GIS (ArcView) files,
3. An HTML format interactive CD-ROM providing mapped biophysical themes and georeferenced still and video imagery from the underwater survey,
4. Copies of the underwater video imagery in SVHS format.

1.3 SURVEY AREA

The Gorge Waterway and Portage Inlet encompass 110 hectares of subtidal area and 20 km of shoreline (defined as the higher high water mark). For descriptive and analytical purposes, the survey area was divided into three sub-areas as follows (Figure 2):

A. Lower Gorge – Selkirk Trestle Bridge to the Gorge Bridge,
B. Upper Gorge – Gorge Bridge to the Craigflower Bridge,
C. Portage Inlet – above the Craigflower Bridge.

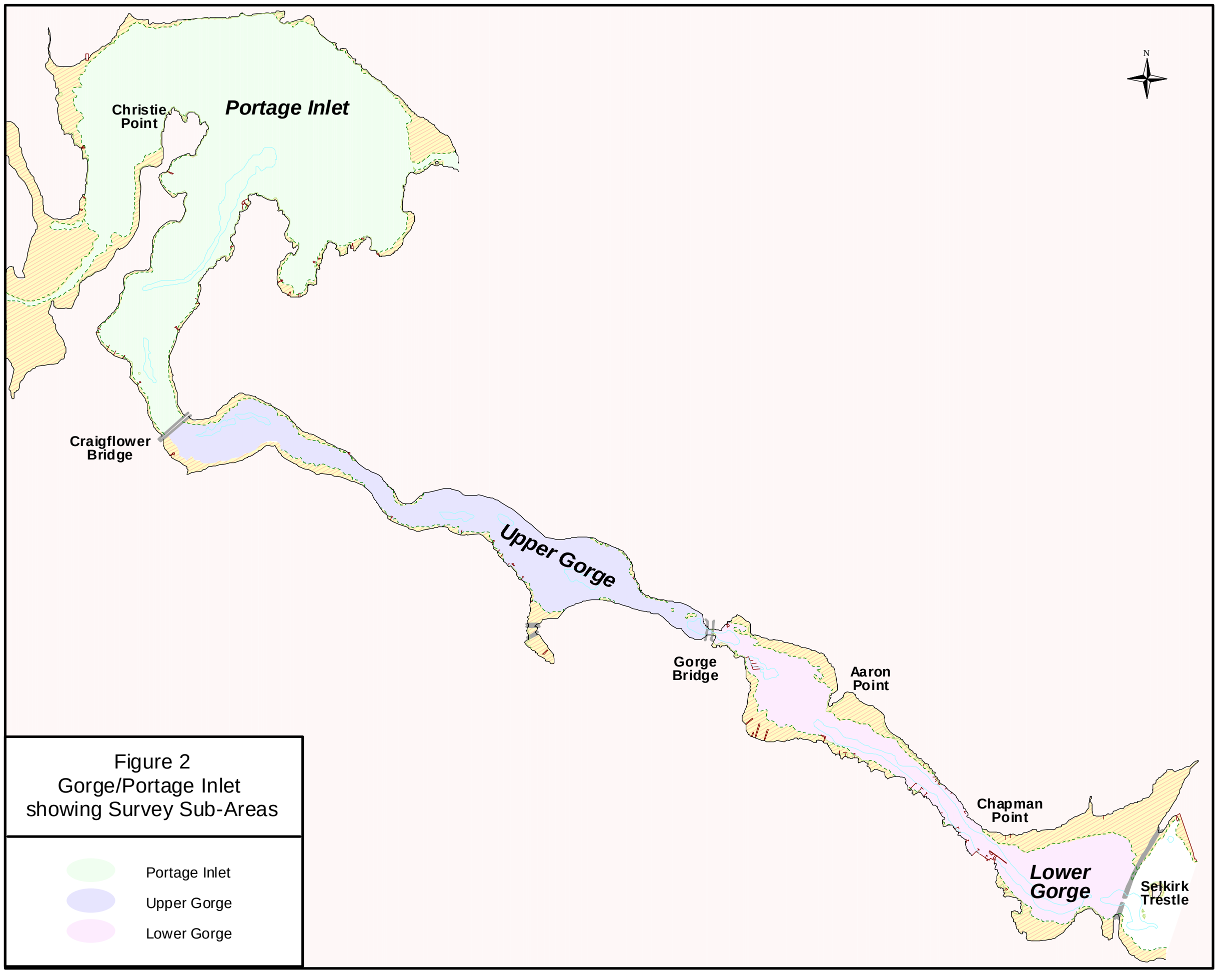

Figure 2
Gorge/Portage Inlet
showing Survey Sub-Areas

The Gorge Waterway is a long shallow, narrow inlet extending northwest of Victoria Harbour. The Gorge Waterway is strongly influenced by tidal currents (particularly at its narrowest constrictions) and tidal flow is constrained by Gorge Narrows, a tidal rapid with maximum currents in excess of 6 knots. The tidal amplitude and cycle below the Gorge Narrows are similar to Victoria Harbour, with a mean range of 1.8m. The mean tidal range above the Gorge Narrows is about 50% of Victoria Harbour (<0.9m), and a long stand of high water is generally followed by a small drop to the next low water (DFO 1999, see Figure 3). Depths are less than 5m relative to chart datum except immediately above Gorge Narrows. Much of the shoreline is rocky or a mix of rock and sediment.

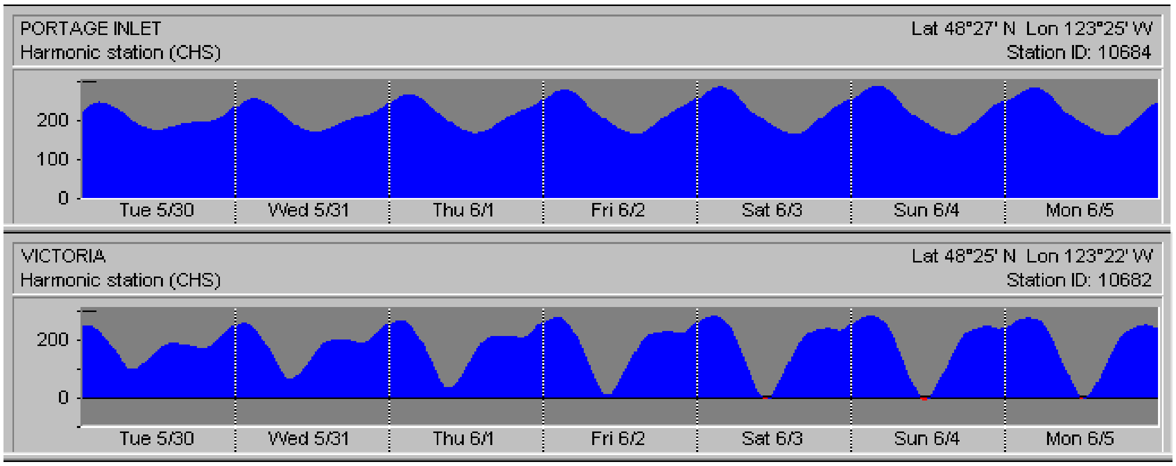

Figure 3. Tide Comparison for Victoria Harbour and Portage Inlet over a summer tidal cycle.

Portage Inlet is a shallow basin at the upper end of the Gorge Waterway. Depths are generally less than 2m relative to chart datum, the seabed is relatively flat and formed of fine sediments. The inlet receives freshwater drainage from the Colquitz River and Craigflower Creek. Due to the restricted tidal circulation above Gorge Narrows, Portage Inlet exhibits a number of unique characteristics including warm (>20^{o}C) water temperature and elevated salinity (due to evaporation) in summer, and reduced salinity and cold temperatures in winter.

From the late 1950's to the early 1970's a number of proposals were considered to increase flushing and/or the depth of Portage Inlet and the Gorge by introducing tidal flow from Esquimalt Harbour via a canal or pipeline, or by damming the Gorge at or below Gorge Narrows. These proposals initiated a number of studies of: (a) the tidal circulation and nutrient cycle (Waldichuk 1967), (b) biota (Northwest Biological 1964, Brown *et al*. 1966, Lambert 1967) and (c) planning alternatives (e.g. Neate 1970). Since that time there have been few published biological surveys of the area.

2.0 METHODS

The project plan called for use of a towed, underwater video system (Seabed Imaging and Mapping System, or SIMS) to obtain extensive, geo-positioned imagery of the seabed. Following preliminary classification and mapping of this video imagery, SCUBA and snorkel observations were used to ground truth the imagery and obtain more detailed information on the biotic community of specific seabed features.

2.1 FIELD SURVEY

SIMS involves the use of a GPS positioned, towed video camera that collects imagery of the seabed (see Harper *et al.* 1998a&b; Harper *et al.* 1999). Towing speed is approximately 2 knots or 3.5 km/hr. Each image (defined as one second of video imagery) is geo-referenced to differential global positioning system (DGPS) standard ($\pm$5m) and is mapped using ArcView software. Time (GMT) and depth of the video camera (corrected to chart datum) are recorded for each image.

The SIMS survey of the Gorge Waterway and Portage Inlet took place over three days, May 8th, 9th and 15th, 2000. A 15 foot inflatable boat equipped with a portable winch was used to tow the SIMS camera in these shallow water areas. Visibility over the seabed ranged from 0.5 to 1.0m.

The video survey encompassed a total of 50.3 km of vessel tracklines (Figure 4 – Map Folio). In general, the survey used a 100m trackline grid, however finer resolution (5-10m spacing) was used in areas anticipated to contain important physical or biological features (e.g. Gorge Narrows). In addition, alongshore tracklines were set on the centerline and both margins of the Gorge Waterway and along the 0m contour in Portage Inlet. A total of 60,838 image points, were collected. This represents 16.9 hours of video imagery and direct observations of about 50,000m^2 (5.0 ha) of seabed, assuming an average field of view width of 1.0m.

2.2 CLASSIFICATION AND MAPPING

The video imagery was reviewed by a geologist and by a biologist using a substrate and biotic classification system initially developed for the British Columbia Land Use Coordination Office (LUCO) (Harper *et al*. 1998b). Using this system, substrate and biota classes are provided for each image, resulting in a data record for each second of video imagery. The geology database contains nine seabed substrate data fields including substrate type, sediment class and gravel content (Table 1). Man-made features are also classified as part of the geological inventory. The biological database captures detail on seabed biota within two general categories, vegetation and fauna, and contains a total of 13 data fields (Table 2). Primary, secondary and tertiary vegetation types are classified for each image and also evaluated for percent cover. Each classified faunal type is assigned a distribution code. A data dictionary for the geology and biology classification system is given in Appendix A. In Portage Inlet and the Gorge Waterway, the biotic component of the classification system included prominent, non-aggregating macroinvertebrates (e.g. crabs, Appendix A), which were not classified in the initial LUCO system.

Of the 60,838 video images, 41,620 (68.4%) were classified for substrate and 54,102 (88.9%) were classified for biota. The remaining imagery could not be classified primarily due to poor visibility. In many cases vegetation such as eelgrass could be identified but the underlying substrate was obscured by poor visibility. As the position of each image is known, plots of the various substrate and biota classes are generated, providing the basis for characterizing habitat. Selected biophysical features are then mapped as polygons by manually contouring the point data. Certain features (e.g. crab distribution) are represented as point features on the trackline plots. All reported depths are expressed relative to chart datum.

The database files are in MDB format (Microsoft Access). Information was then extracted from these databases and exported to an ArcView geographic information system (GIS). The basemap is taken from the vector version of Canadian Hydrographic Service (CHS) chart 3415 and includes the CHS shoreline, depth contours and selected navigational and shoreline features. Generalised shoreline types were derived from shoreline data provided in Westland (2000).

A number of representative video images were captured to digital image files (either as still images or video files) to illustrate seabed types and biota. Selected video images from the dive survey were also used. These image captures are geo-referenced to the biophysical maps on an interactive CD-ROM, which has been produced as a separate HTML data product of the project. The video images are intended to assist the reader in understanding both the application of the classification system and the mapped harbour features.

Table 1. Geology Data Fields (See Appendix A for further detail)

FIELD	DESCRIPTION
INDEX	Unique point identification number
DATE	Month/day/year
TIME(UTC)	UTC time of frame (hr:min:sec)
SUBSTRATE	the general substrate of the seabed (rock, veneer, clastics, biogenic)
SED_CLASS	11 classes of clastic sediment
BOULDER	% pebbles on the seabed by class
COBBLE	% cobbles on the seabed by class
PEBBLE	% boulders on the seabed by class
GRAVEL	% gravel; sum of pebbles, cobbles and boulders by class
ORGANICS	% of visible wood or organic debris on the seabed by class
SHELL	% of coarse shell on the seabed by class
MORPH	Primary secondary and tertiary morphologic features of the seabed
MAN_MADE	man-made objects seen on the seabed
GEOMAPPER	last name of individual responsible for the mapping interpretation
COMMENT	field for recording non-standard information

Table 2. Biology Data Fields (See Appendix A for further detail)

FIELD	DESCRIPTION
INDEX	unique point identification number
DATE	month/day/year
TIME(UTC)	UTC time of frame (hr:min:sec)
FISH_DEPTH	water depth (m) of towfish/camera corrected to chart datum
VEGMAP	code for vegetation map types
VEG1	primary vegetation assemblage on the seabed
COV1	coverage of the VEG1 vegetation
VEG2	secondary vegetation assemblage on the seabed
COV2	coverage of the VEG2 vegetation
VEG3	tertiary vegetation assemblage on the seabed
COV3	coverage of the VEG3 vegetation
TOT_COV	total coverage of vegetation on the seabed
FAUN1	primary faunal type
DIST1	Distribution of the FAUNA1 type
FAUN2	secondary faunal type
DIST2	Distribution of the FAUNA2 type
FAUN3	tertiary faunal type
DIST3	Distribution of the FAUNA3 type
BIOMAPPER	last name of the biology mapper
COMMENT	field for non-standard data comments

2.3 DIVE SURVEYS

After completing the image classification and a preliminary review of the mapped results, SCUBA dive observations were conducted on June 28th and 29th, 2000 at sites selected from a review of the video imagery. Subsequent snorkel observations in the Upper Gorge and Portage Inlet were conducted on July 5 and 6, 2000. The objectives of the dive observations were to:

1. Ground truth the position and extent of highly valued features such as eelgrass beds.
2. Compile a detailed community description for selected subtidal features such as vegetated rocky areas.
3. Collect additional video imagery of the biophysical features and community structure.

Observations were made at 8 dive sites and 19 snorkel sites in the survey area (Figure 4 – Map Folio). Most sites above the Gorge Narrows were too shallow for SCUBA observations. The position (DGPS) of each site was recorded. A summary of the habitat observations (position, depth, substrate, algal species and estimated percent cover, invertebrates and estimated abundance, fish species) for each of these sites is given in Appendix B. In addition, spot dives or snorkel observations were made to verify the extent of the eelgrass beds mapped during the SIMS survey (Figure 4 – Map Folio).

3.0 RESULTS

This section summarises the physical and biological features obtained from the classification of the video imagery, and provides a description of subtidal community features from the SCUBA dive observations. Tabulated summaries of the video imagery classification are provided within the text of the following subsections. These tables summarise the estimated area or number of classified features. The mapped physical and biological features (Figures 5 to 19) are provided in Section 6.0, the report Map Folio. Selected video images, both from the SIMS survey and dive observations, are provided in Appendix C.

3.1 SUBSTRATE TYPE

Substrate type provides a general description of material at the surface of the seabed. The distribution of these substrates in the Gorge and Portage Inlet is mapped in Figure 5 and the area of the various substrate types summarised in Table 3.

Table 3. Substrate Type

SUBSTRATE TYPE	SUBTIDAL AREA (HA)				
	DESCRIPTION	PORTAGE INLET	UPPER GORGE	LOWER GORGE	TOTAL
Sediment	gravel, sand, or mud-sized material	69.1	19.5	19.0	107.6
Rock	bedrock outcrop	0.0	0.6	0.6	1.2
Rock with Sediment Veneer	intermittently visible bedrock covered with a veneer of sediment	0.0	0.1	0.02	0.12
Biogenic	seabed surface obscured by material of biological origin such as vegetation	0.0	0.3	0.02	0.32
TOTAL		**69.1**	**20.5**	**19.6**	**109.2**

Most of the substrate is classified as sediment (mud, sand, gravel), which forms 98% of the subtidal seabed area. Portage Inlet is exclusively formed of sediment. Dense eelgrass (*Zostera marina*) cover obscured the seabed in a small area of the Upper Gorge (Figure 5), but substrate in this area is also likely sediment, as eelgrass does not grow on rocky substrate. Areas of rock substrate are contiguous with intertidal and backshore rocky shorelines (see shore type, Figure 5). These rock areas include Gorge Narrows, Aaron Point and the shore margins of the Lower Gorge. There are no rocky islets in the survey area, and only one rock outcrop located on the west side of Gorge Narrows. Gorge Narrows is a unique physical feature, being a tidal rapid with currents exceeding 6 knots. The Narrows are over 5m deep upstream of the tidal rapids and formed primarily of bedrock; all sediment except boulders and large cobbles have been swept away from this location.

3.2 SEDIMENT SIZE CLASS

Sediment size classes are assigned to the *sediment* and *rock with sediment veneer* substrate types. The distribution of these sediments in the Gorge and Portage Inlet is mapped in Figure 6 and the subtidal area of the various sediment size classes summarised in Table 4. Further detail on sediment class codes are provided in Table A-3 and A-4 of the data dictionary (Appendix A). Sediment types were very difficult to classify in many areas due to poor visibility and the presence of numerous oysters (or oyster shells), which could easily be mistaken as pebble-sized material. For this reason trace to 5% gravel is included in the mud/sand and sand size categories (Table 4). The snorkel-site observations were invaluable in providing additional detail on sediment types, particularly in Portage Inlet and the Upper Gorge.

Table 4. Sediment Size Class

SEDIMENT SIZE	SUBTIDAL AREA (HA)			
	PORTAGE INLET	UPPER GORGE	LOWER GORGE	TOTAL
Gravel (>30% gravel)	0.6	1.8	2.5	4.9
Gravelly Mud/Sand (5-30% gravel)	9.6	7.7	12.0	29.3
Sand (Trace-5% gravel)	0.0	0.0	0.0	0.0
Mud/Sand (Trace-5% gravel)	6.8	5.8	5.2	17.8
Mud	52.1	4.8	0.0	56.9
TOTAL	**69.1**	**20.1**	**19.7**	**108.9**

Most of the sediments in Portage Inlet and the Upper Gorge are classified as mud or mud /sand. The mud sediments are located in Portage Inlet and just downstream of the Craigflower Bridge. The lower part of Portage Inlet, the basin off Gorge Kinsman Park (Upper Gorge) and upper Selkirk Waters are primarily mud/sand sediments. Gravelly mud/sand sediments dominate the narrow sections of the Lower Gorge. Generally, locations of mud or mud/sand without gravel are depositional areas where sediments are slowly accumulating over time (e.g. Portage Inlet).

Figure 6 shows areas of sediment with greater than 30% gravel cover. These areas are mostly located in the tidal influenced, narrower areas of the Gorge Waterway. Further detail on gravel cover is provided in Figure 7. Percent gravel categories are determined by standard geological size ranges (Appendix A; Table A4). Gravel cover provides a good index of energy in that the higher the gravel content, the higher the assumed energy generated by waves or tidal currents. Within Portage Inlet, gravel (Trace to 5%) is confined to the shore margins where wave energy levels are higher. In the Gorge the highest gravel content (50 to >80%) is restricted to the narrow portions of the waterway including (1) the "outlet" of Portage Inlet, (2) the narrowest portion of the Upper Gorge, (3) Gorge Narrows and (4) the area of the Lower Gorge just above Selkirk Waters. Most of the Lower Gorge above Selkirk Waters contains trace or greater gravel content, indicating the influence of tidal current throughout this area. Areas of higher gravel content are usually erosional areas where currents have removed the finer sediment from the glacial parent material and left a "lag" deposit of coarse gravel. These gravel areas are usually associated with areas of shell debris (see Section 3.3), forming both intertidal and subtidal shell/gravel bars.

Boulder and cobbles (Figure 8) are found in most areas with greater than 30% gravel content. The highest amount of this material is located in Gorge Narrows, where very strong currents are capable of transporting all but the coarsest sediment. In addition, there is a small area of boulder and cobble at the south end of the Selkirk Trestle Bridge, likely a result of rip rap placed for the bridge approach.

3.3 ORGANIC MATERIAL AND SHELL COVER

The distribution of organic material, as estimated from the video images, is shown in Figure 9. Most of the organic material is vegetative detritus associated with the more densely vegetated parts of the survey area. In particular, the areas of highest (>30%) detritus cover are associated with the eelgrass beds in Portage Inlet and the basin in the Upper Gorge near the Gorge/Kinsman Park. Within the eelgrass beds, most of the vegetative detritus are eelgrass fragments but, in other areas, it may include tree branches, leaves and other marine algae. The quantity and extent of this material is expected to vary considerably throughout the year. In addition, large quantities of the intertidal filamentous green algae (e.g. *Enteromorpha*) are often observed drifting in Portage Inlet and the Upper Gorge in summer (Northwest Biological 1964). This material will also contribute to the vegetative detritus load in these areas. Vegetative detritus content of Gorge Narrows was relatively low (less than 30%) as most of this material is rapidly flushed through the area due to the high tidal current.

Concentrations of wood debris (logs, branches, bark and wood fragments) were observed along the northern shoreline of Portage Inlet (Figure 9) and likely result from material washed into the inlet by Colquitz River and Craigflower Creeks. A small area of wood debris was also noted in the lower Gorge, near the docks opposite Chapman Point and in the intertidal zone northwest of Aaron Point. Only a small amount of wood debris was observed in the intertidal zone near Cecelia Creek and very little noted in upper Selkirk Waters just above the trestle bridge, an area which served as a log booming area until the late 1970's (Drinnan and Couch 1994).

Large accumulations of shell (either whole shell or shell fragments) were observed in certain areas of the Gorge Waterway and the lower portion of Portage Inlet (Figure 10). Immediately above the Craigflower Bridge the seabed is covered with up to 100% shell material. Most of these are whole bivalve shells, mostly butter (*Saxidomus giganteus*) and Japanese littleneck clam (*Tapes japonica*) shell which form hummocks varying both in height and location on the seabed floor. Within this area, small patches of eelgrass were observed, indicating a mud and/or sand substrate not far beneath the shell veneer. Similar aggregations of bivalve shells, including native oyster (*Ostrea lurida*), occur in the narrowest section of the Upper Gorge and just above Gorge Narrows. Above Gorge Narrows these shells have accumulated against the bedrock wall to a depth of over 2m. This large shell deposit is current-transported shell that is swept through the Gorge Narrows and deposited just outside the high current area. Most of the rest of the survey area contains trace to 5% shell content, again primarily fragments or whole bivalve shells.

3.4 MAN-MADE OBJECTS

A variety of man-made objects were identified from the imagery and classified in the database. These objects are summarised in Table 5 and the distribution mapped in Figure 11. A total of 509 man-made objects were identified in 50 km of survey trackline (10 objects/km). In contrast, 6,482 man-made objects were identified in 79 km of trackline (82 objects/km) in Victoria Harbour (Emmett *et al*. 2000). This difference reflects both greater level of industrial and boat use of the harbour in contrast to the Gorge and Portage Inlet as well as the recent community initiatives to remove these materials from the Gorge Waterway.

The most common man made object found in the Gorge and Portage Inlet are bottles (or aggregations of bottles) and cans. These items make up 40% of the observed man-made objects. Log debris was relatively scarce (15 observations) with only three logs observed on the former log booming area in upper Selkirk Waters. Items reported as “Other” include bricks, golf balls, shopping carts, bicycle frames and traffic cones. The density of man-made debris is greatest in the Lower Gorge, which has a higher amount of boat traffic than the Upper Gorge or Portage Inlet. In the Upper Gorge and Portage Inlet, most man-made debris is associated with the shoreline, including several areas of public access (the Gorge and Craigflower Bridges). Some of the areas with lower concentrations of man-made objects are associated with deposition zones (e.g. Portage Inlet and portions of the Upper Gorge) where objects may be covered with sediment. Areas with concentrations of bricks on the seabed appear to be sites where old building debris may have been dumped.

Table 5. Man-made Objects

MAN-MADE OBJECT	# IMAGE POINTS
Bottles	112
Cans	84
Other	83
Garbage	80
Metal Objects	57
Tire	33
Aggregations of Bottles	22
Pipe	17
Logs	15
Cable/Wire/Rope	6
Total	509

3.5 VEGETATION COVER AND VEGETATION TYPE

Vegetation cover is the estimate of percent cover for all vegetation observed in each image (Appendix A, Table A8). Table 6 summarises the estimates of vegetated area in Portage Inlet and the Gorge Waterway by sub-area and percent cover categories: (1) sparse = trace to <5% cover; (2) low = 5-25% cover; (3) moderate = 25-75% cover; (4) dense = >75% cover. The distribution of subtidal vegetation in the harbour is shown in Figure 12.

Table 6. Estimate of Vegetated Area by Cover Category

SUB-AREA	SUBTIDAL AREA (HA)	VEGETATED AREA (HA)		
		SPARSE – LOW COVER	MODERATE – DENSE COVER	% OF SUB-AREA
Portage Inlet	70	28.1	26.7	78.3
Upper Gorge	20	3.7	15.4	95.5
Lower Gorge	20	5.0	12.4	87.0
Total	**110**	**36.8**	**54.5**	**83.0**

Over 80% of the Gorge Waterway and Portage Inlet is vegetated, with over half of the vegetated area being moderate to dense cover. This compares to an estimate of approximately 50% for Victoria Harbour, with only 20% of the vegetated area being moderate to dense cover (Emmett *et al*. 2000). Over 90% of the Upper Gorge is vegetated, mostly at moderate to dense cover. Vegetation was sparse or absent in the western arm of Portage Inlet, possibly due to sediment input and high turbidity from Craigflower Creek.

Sixteen marine vegetation types are identified in the SIMS classification table (see Appendix A, Table A-9). Some vegetation types are single species or genus groupings such as eelgrass (*Zostera*) and *Agarum*. Other types are broader taxonomic groupings such as filamentous red algae (FIR1 and FIR2) and soft brown kelps (BKS). Species in these vegetative types are grouped by similar morphologies (which aids recognition in the video imagery) and by habitat association (see definition of FIR1 and FIR2, Appendix A, Table A-9). The fifteen vegetation types provide a reasonably comprehensive description of the nearshore (<20m depth) vegetation of coastal British Columbia. The classification system permits a primary (most common) vegetation type, secondary (next most common) and tertiary (third most common) vegetation type to be identified for each image point.

Table 7. Frequency of Classified Vegetation Types

CODE	TYPE	IMAGE POINTS			
		PRIMARY	SECONDARY	TERTIARY	TOTAL
ZOS	Eelgrass	22,723	1,510	107	**24,340**
NOV	No Observed Vegetation	16,336	0	0	**16,336**
FIR1 & 2	Filamentous Red Algae	6,528	5,056	44	**9,661**
BKS	Kelps	4,613	1,719	106	**6,438**
FOG	Foliose Greens	3,601	1,995	412	**6,008**
FUC	*Fucus*	26	0	0	**26**
SAR	*Sargassum*	0	3	4	**7**
	Total	**53,827**	**10,283**	**673**	

Seven of the 16 vegetation types were identified in the Gorge and Portage Inlet (Table 7). Approximately 70% of the classified video images contained vegetation. The most common vegetation types are eelgrass, kelps, foliose green algae, and filamentous red algae. The brown algae *Sargassum* and rockweed (*Fucus* sp.) were also classified from the video imagery, with *Sargassum* being noted at Aaron Point and the north side of the Upper Gorge. *Fucus* is an intertidal species growing on rocky substrate, and *Sargassum* occurs in the lower intertidal and shallow subtidal zones (to –1.0m), also on rocky substrate. The SIMS observations for these species are not comprehensive and their distribution has not been mapped. Further information on subtidal vegetation is provided in Sections 3.6 to 3.9.

3.6 EELGRASS AND OTHER VASCULAR PLANTS

Figure 13 shows the location of eelgrass beds in Portage Inlet and the Gorge Waterway. Table 8 summarises area estimates of these eelgrass beds. Approximately 80 hectares of eelgrass beds (72% of the total subtidal area) were estimated in Portage Inlet and the Gorge Waterway, with over 45 hectares with moderate to dense cover (>25%). This contrasts with estimates of 2.0 hectares of eelgrass for Victoria Harbour (Emmett *et al*. 2000), 14.6 hectares in Esquimalt Lagoon (Archipelago Marine Research Ltd. 2000a) and less than 1.0 hectares in Esquimalt Harbour (Archipelago Marine Research Ltd. 2000b). Thus, Portage Inlet and the Gorge Waterway supports over 80% of the eelgrass in the Victoria/Esquimalt harbour area.

Table 8. Estimate of Eelgrass Area by Cover Category

SUB-AREA	SUBTIDAL AREA (HA)	VEGETATED AREA (HA)		
		SPARSE – LOW COVER	MODERATE – DENSE COVER	% OF SUB-AREA
Portage Inlet	70	25.2	25.4	72.3
Upper Gorge	20	3.2	14.8	90.0
Lower Gorge	20	4.7	5.6	51.5
Total	**110**	**33.1**	**45.8**	**71.7**

The eelgrass was densest and most extensive in the Upper Gorge, where 90% of the subtidal seabed contained eelgrass. About 70% of subtidal area of Portage Inlet contained eelgrass, but 50% of this area was less than 25% cover. Eelgrass was not present in the western arm of the inlet. As suggested above (Section 3.4) sedimentation and turbidity resulting from Craigflower Creek may limit the distribution of vegetation (including eelgrass) in this area. About 50% of the Lower Gorge is vegetated with eelgrass, primarily in the two basins on either side of Aaron Point and above the Selkirk Trestle Bridge.

The presence of eelgrass in upper Selkirk Waters is notable for two reasons. First this area was a historic log booming area which was used until the late 1970s. Second, a series of dive observations in this area of Selkirk Waters were made in late February, 1996 in conjunction with an environmental status report (Emmett *et al*. 1996) for the area. This report states "a number of spot dives were made between Chapman Point and the Trestle Bridge to estimate the extent of eelgrass (*Zostera marina*) in this area. The substrate is primarily silt and eelgrass is extremely patchy (trace to 10% cover) over the entire area". The SIMS survey indicates that eelgrass in upper Selkirk Waters has expanded rapidly over the last four years, and covers an area of about 5 hectares, with 2.9 hectares being classified as moderate to dense cover. This increase in eelgrass cover has also been noted by the Veins of Life Watershed Society (J. Roe pers. comm.).

During the dive observations it was noted that 20-30% of the eelgrass shoots contained seed pods. Sexual reproduction (production of seeds) may be a response to environmental stress such as elevated water temperature or changing salinity (Phillips & Watson 1984). As water temperatures in Portage Inlet and the Gorge often exceed 20^0C in summer (21^0C to 25^0C on June

28, 2000 at the Selkirk Trestle Bridge) sexual reproduction (seed production) could be more pronounced in the Gorge and Portage Inlet than other areas of the harbour.

Notable species found in the eelgrass beds, particularly in the area bounded by the Selkirk Trestle Bridge and the Gorge Narrows, were the white bubbleshell (*Haminoea vesicula)* and Taylor's sea hare *(Phyllaplysia taylori)*. Both of these species were present in abundance. Taylor's sea hare is restricted to eelgrass beds, where its colouration (green-yellow with longitudinal stripes) blends with the eelgrass shoots. Bubbleshells and associated egg masses were highly abundant. The genus *Haminoea* are known to be abundant on occasion during the summertime in locations where eelgrass grows on mud (Kozloff 1988). Interestingly, a biological survey of Portage Inlet conducted over 35 years ago (Northwest Biological 1964) also report an abundance of bubble shells in the eelgrass during the summer months.

The field observations identified widgeon grass (*Ruppia maritima*) in the lower intertidal zone at the most southern bay of the eastern arm and northwestern shoreline of Portage Inlet (Figure 13). Widgeon grass is an aquatic perennial plant found throughout coastal British Columbia in brackish water estuaries, tidal flats and sloughs.

3.7 KELPS

Kelps are a group of brown algae generally characterised by a holdfast, stalk and blade. The holdfast anchors the plant to the substrate. Figure 14 shows the distribution of kelp in the Gorge and Portage Inlet. Table 9 summarises the kelp area estimates. As with all the vegetation distribution maps, Figure 14 includes areas where kelp was identified as either primary, secondary or tertiary vegetation.

Table 9. Estimate of Kelp Area by Cover Category

SUB-AREA	SUBTIDAL AREA (HA)	VEGETATED AREA (HA)		
		SPARSE – LOW COVER	MODERATE – DENSE COVER	% OF SUB-AREA
Portage Inlet	70	0	0	0
Upper Gorge	20	0	0	0
Lower Gorge	20	8.4	3.6	60
Total	**110**	**8.4**	**3.6**	**10.9**

A few images with kelp were classified in the Upper Gorge, however they were less than several square meters in size and are not mapped in Figure 14. Below Gorge Narrows, kelp covered 60% of the subtidal area. This distribution possibly results from the differing tidal and physicochemical regime above and below Gorge Narrows referred to in Section 1.3. The densest kelp cover was along the southwest side of the Lower Gorge and in the center of the channel just above the Selkirk Trestle Bridge. These are areas of higher tidal current. Kelps were absent from the basin between Gorge Narrows and Aaron Point and the shallower parts of upper Selkirk Waters.

Subsequent dive observations in the Lower Gorge identified *Laminaria saccharina* as the only kelp species in this area. This species was also identified in Selkirk Waters and the Upper Harbour in 1999 (Emmett *et al*. 2000). The broad bladed kelp *Agarum* sp. was not recorded in the Gorge or Portage Inlet, and was also absent from Selkirk Waters and Upper Victoria Harbour (Emmett *et al*. 2000).

3.8 FOLIOSE GREEN ALGAE

The largest area of foliose green algae (primarily *Ulva* sp.) was in Portage Inlet, where this species co-occurred with eelgrass in the eastern portion of the inlet (Figure 15, Table 10). *Ulva* also occurs in shallower intertidal areas along the shoreline of both Portage Inlet and the Gorge. It is important to recognise that fast growing algae such as *Ulva* may be denser and more widely distributed in mid-summer as compared to the May survey date and, correspondingly, sparser or absent in winter. A second species of green algae (*Enteromorpha sp.*) is reported to be abundant on the intertidal flats of Portage Inlet (Northwest Biological 1964, Brown *et al*. 1966).

Table 10. Estimate of Foliose Green Algae Area by Cover Category

SUB-AREA	SUBTIDAL AREA (HA)	VEGETATED AREA (HA)		
		SPARSE – LOW COVER	MODERATE – DENSE COVER	% OF SUB-AREA
Portage Inlet	70	6.5	1.2	11.0
Upper Gorge	20	0.2	0.2	2.0
Lower Gorge	20	1.0	0.1	5.5
Total	**110**	**6.7**	**1.5**	**7.5**

3.9 FILAMENTOUS RED ALGAE

The distribution of filamentous red algae in Portage Inlet and the Gorge Waterway is patchy, and polygon areas could not be reliably estimated. These algae are common and densest in the higher current areas of Gorge Narrows and the narrow portion of the Lower Gorge, but are confined to the shoreline zone (e.g. depths of about 0m) in Portage Inlet and the Upper Gorge (Figure 16). Field observations confirmed that *Polysiphonia* spp. and *Neoagardhiella baileyi* are the two most common filamentous red algal species. The red algae *Prionitis* sp. was common in the lower intertidal and shallow subtidal zones on bedrock through Gorge Narrows.

3.10 MACROFAUNA

Thirty faunal types are included in the SIMS classification table (see Appendix A, Table A-11 for a complete description of the faunal classification). Some types are single species or genus groupings such as the anemone *Metridium.* Others are broader taxonomic groupings such as brittle stars and bryozoan complexes. Unlike the vegetation types, the classified faunal types do not provide a comprehensive description of the nearshore (<20m depth) fauna, but rather were developed to document larger, aggregating macrofauna. In addition several faunal codes describing non-aggregating mobile species (e.g. crabs, the sea cucumber *Parastichopus californicus*) were added to the original classification system in order to map out prominent mobile resource features. The classification system permits a primary (most common) faunal type, secondary (next most common) and tertiary (third most common) faunal type to be identified for each image point. A distribution code (Appendix A, Table A-10) is used to describe the pattern of distribution within the image point. Macrofauna were classified for about 20% of the 54,000 classified images (Table 11).

Table 11. Faunal Types

CODE	TYPE	# OF IMAGE POINTS
OYS	Oysters, primarily native oysters (*Ostrea lurida*)	3,792
HLF	Unmounded Infaunal burrows	2,562
BRY	Bryozoans	2,483
ANM	*Metridium*	1,839
MUS	Mussels (*Mytilus* sp.)	56
CAN	Crab (*Cancer* sp.)	17
TUC	Calcareous tube worms (e.g. *Serpula*)	5
TEA	Anemone (*Tealia* sp.)	2
TUBP	Parchment Tubeworms	1
CUC	Burrowing Sea cucumber-*Cucumaria*	1
UNK	Unknown	3
Total		**10,761**

Subtidal aggregations of native oysters (*Ostrea lurida*) were one of the most notable observations of both the SIMS survey (Table 11) and subsequent field observations. Native oysters are relatively abundant on the unvegetated mud substrate of Portage Inlet (Figure 17). This species also is abundant immediately upstream of the Craigflower Bridge, along the margins of the Upper Gorge and in Gorge Narrows. Field observations confirmed that native oysters were also growing within the eelgrass beds both near the ferry dock immediately downstream of the Gorge Narrows and upstream of the Narrows. Within Portage Inlet, a few oysters were observed growing in the mud and on twigs within the eelgrass bed in the eastern half of the inlet, although not in the same abundance as found outside the eelgrass in the western, more shallow portion of the inlet. Below Portage Inlet, native oysters are found on rock as well as muddy substrate, and on branches in the intertidal zone. Japanese oysters (*Crassostrea gigas*) were also observed in Portage Inlet and the Gorge, but are restricted to the intertidal zone. Japanese oysters are most abundant in Gorge Narrows on rocks and the walkway wall.

Ostrea lurida occurs in estuaries and salt water lagoons from Alaska to lower California, but is generally not found in abundance (Qualye 1988). Native oysters are historically reported to have occurred on the shell and gravel bars of the Gorge, and subtidally in Portage Inlet (Elsey 1933). Lambert (1967) conducted a survey of native and Japanese oysters in Portage Inlet, but observations were confined to the intertidal zone. Both Lambert and Elsey report observations of deposits of native oyster shell on the shores of Portage Inlet and the Gorge, indicating the historic presence of this species in this area. The abundance of native oysters in Portage Inlet and the Gorge is a unique feature of the Victoria and Esquimalt Harbours area and, likely, is of regional significance.

Aggregations of mussels (*Mytilus* sp.) were observed on rock downstream, upstream and through the Gorge Narrows, from the intertidal zone to a depth of –1.0m. Field observations noted horse mussels, *Modiolus sp.* in the mud or attached to native oyster shells in Portage Inlet and upstream of the Craigflower Bridge.

Crab were not abundant in Portage Inlet or the Gorge at the time of the survey. Only 17 crab (0.4 per km of trackline) were identified from the video imagery (Table 11), most below Gorge Narrows (Figure 18). By way of contrast, there were over 3,000 crab observations (30 per km of trackline) in the video survey of Esquimalt Harbour (Archipelago Marine Research Ltd. 2000b). It is important to recognize that crabs are highly mobile and may be more abundant at other times of the year. Dungeness crab (*Cancer magister*) can not readily be distinguished from the graceful crab (*C. gracilis*) in the video imagery and both species have been classified as *Cancer* sp.

Starfish were uncommon and only observed below Gorge Narrows (*Pisaster brevispinus* and *Evasterias troschelii).*Both Elsey (1933) and Lambert (1967) also report that starfish are not found in the Gorge and Portage Inlet and suggest that native oysters are abundant subtidally due to the absence of these predators.

Plumose anemone (*Metridium senile)* were found on hard substrates including rock, boulder, cobble, wood and other man made debris. *Metridium* was most abundant in the higher current areas such as Gorge Narrows and the narrow section of the Lower Gorge, but also was distributed in a patchy fashion throughout Portage Inlet (Figure 19). Another anemone (*Tealia* sp.) was far less common than *Metridium*, but also occurred in Gorge Narrows and the Lower Gorge.

Aggregations of sponges, ascidians and bryozoans found in the high current areas of Gorge Narrows and in the Lower Gorge are shown in Figure 19 (species are listed in Appendix B). These species are difficult to identify and were only assigned a genus if positively identified. The bedrock and boulders of Gorge Narrows were covered primarily with two species of sponge, the purple sponge, *Haliclona permollis* and yellow bread crumb sponge, *Halichondria* spp. Another branched yellow bryozoan (unidentified) and yellow sponge (unidentified) were also present in the Gorge. The purple sponge was most abundant on the north face of the bedrock directly under the Gorge Bridge between 0m and –3m depth. Fine filamentous red algae, *Polysiphonia* spp. (20-40% cover), native oysters, the lined anemone, *Haliplanella lineata* as well as *Metridium* sp. are the other prominent species in this area. The red algae *Prionitis* sp. was common in the lower intertidal and shallow subtidal zones on the bedrock through the Gorge Narrows and on the bedrock pinnacle in the middle of the channel.

Compound ascidians are more abundant in the bryozoan complex in the Lower Gorge than at the Narrows. A variety of solitary and compound ascidians including two species of *Aplidium*, sea pork (*Aplidium californicum*), and the red ascidian (*Aplidium solidum*) were noted. Orange and transparent sea squirts (*Cnemidocarpa finmarkiensis* and *Corella willmeriana*) were two solitary ascidians also found in this area. Unidentified purple, yellow and orange sponges, and the breadcrumb sponge *Haliclona permollis,* were common on cobble and whole shell. The branched yellow bryozoan observed in Gorge Narrows was also noted in the Lower Gorge.

Brittle stars, *Amphioda urtica*, were very abundant throughout the Lower Gorge, with at least several hundred individuals within a $0.5m^2$ area. The brittle stars were buried in the muddy substrate with each white arm exposed by only a few millimeters (not identifiable in the video survey) whereby at first glance the bottom appears full of tiny worms. The slime tube worm

Myxicolla infundiblum was also common within this area. A few spiny pink sea stars, *Pisaster brevispinus* were present, the only location where sea stars were observed by either direct field observations or by SIMS imagery. Filamentous red algae, (both a fine filamentous red algae, *Polysiphonia* spp., and *Neoagardhiella baileyi)* were observed on the angular cobble along with the bladed kelp *Laminaria saccharina*.

Piddock clams (*Ziphaea pilsbryi*), which are commonly observed in clay substrate in both Victoria and Esquimalt Harbours including lower Selkirk Waters near Halkett Island, (Emmett *et al*. 2000) were not classified in the Gorge or Portage Inlet. Favourable clay substrate may not occur at or near the seabed surface above the Selkirk Trestle Bridge. Species normally associated with more exposed marine waters such as swimming scallops (*Chlamys hastata*), rock scallops (*Crassadoma gigantea*), and red sea urchins (*Strongylcentrotus franciscanus*), which were identified in Inner and/or Outer Victoria Harbour (Emmett *et al*. 2000), were not observed in Portage Inlet or the Gorge.

4.0 DISCUSSION

The environmental features of Gorge Waterway and Portage Inlet are influenced by three physical factors:

1. a very protected tidal lagoon (Portage Inlet),
2. restricted tidal exchange above the Gorge Narrows,
3. a long (3.5km) channel dominated by tidal current.

This combination of coastal physical features is unique within the Capital Regional District. Areas with some similar features include Sooke Basin (tidal channel) and Sidney Island Lagoon (extensive eelgrass beds and intertidal mudflats). However, the physiography of the Portage Inlet and the Gorge is more typically found on the Central Coast of British Columbia, where there are several tidal lagoons of similar form (e.g. Kildidt Lagoon). On the basis of physical geology alone Portage Inlet and the Gorge Waterway are regionally significant areas, particularly within an urban setting.

There are also a number of subtidal biological features in Portage Inlet and the Gorge Waterway which further emphasize the regional environmental significance of this area:

1. Extensive eelgrass (*Zostera marina*) beds
Approximately 80 hectares of eelgrass beds were mapped in Portage Inlet and the Gorge. This represents over 80% of the eelgrass beds identified in the Victoria and Esquimalt Harbours area (including Esquimalt Lagoon).
Abundance of bivalves, particularly native oysters
2. The intertidal gravel bars within the Gorge contained extensive amounts of shell material including butter and littleneck clams. Intertidal sampling is required to identify the extent and abundance of the existing clam beds. The subtidal surveys identified areas of native (*Ostrea lurida*) oysters. This species, although not rare, were historically present over relatively extensive areas in only a few locations in British Columbia (Portage Inlet, Ladysmith Harbour, Boundary Bay, Nanoose Harbour – Elsey 1933). In most of these areas the Japanese oyster (*Crassostrea gigas*) has been introduced and extensively cultivated. Portage Inlet and the Gorge may now support one of the largest populations of native oysters on the British Columbia coast.
3. High Current Epifaunal Invertebrate Communities
Gorge Narrows and the channel of the Lower Gorge support a relatively diverse and abundant community of sessile, suspension feeding invertebrates including colonial and solitary ascidians, sponges, and bryozoans. This is likely the largest representation of this community type in the Victoria and Esquimalt Harbour area.
4. Herring Spawning
Herring spawn in Portage Inlet and the Upper Gorge, primarily within the eelgrass beds. Herring also spawn in other areas of the Capital Regional District, including the Victoria Waterfront between Ogden Point and Ross Bay, Esquimalt Lagoon and in Esquimalt Harbour (Hay and MacCarter 1999), however Portage Inlet, in particular, is one of the most important herring spawning areas in the harbours region.

5. Fish Bearing Streams
Both the Colquitz River and Craigflower Creek, which drain into Portage Inlet, support spawning populations of cutthroat trout and coho salmon. Portage Inlet serves as an estuarine rearing area for juvenile salmon.

Table 12 further summarises the biophysical features of Portage Inlet and the Gorge. These biological features remain highly valued despite historic environmental impacts, including infilling of intertidal habitat, sewage and nutrient input, and historic log booming in the Upper Selkirk waters area. Indeed it appears that the eelgrass habitat has recently expanded in Upper Selkirk Waters in an abandoned log booming area (Section 3.6).

Emmett *et al*. (2000) identified a number of valued and degraded subtidal areas within Victoria Harbour. Valued areas included eelgrass beds, areas of high algal diversity and abundance, subtidal bedrock outcrops and gravelly channels. For the reasons outlined above (extensive eelgrass, native oyster beds, current dominated suspension feeding communities) essentially all of the subtidal area of the Gorge and Portage Inlet should be considered valued habitat. This is not a novel concept; a report to the municipality of Saanich (Neate 1970) recommended that “the area be treated as a nature reserve and that improvements be designed with this in mind”. A previous report to VEHEAP on environmental priorities for Victoria and Esquimalt Harbours (Foy *et al.* 1995) suggested designation of Portage Inlet and the Gorge as an “Environmentally Significant Area”. Westland (2000) rates the ecological value of approximately 50% of the intertidal and backshore areas of Portage Lagoon and the Gorge Waterway as high or very high. The remaining areas have lower ratings primarily due to intertidal infilling, seawall construction or significant alteration of the backshore. Within the subtidal zone, the foundation for the high ecological values remains intact, although perhaps at somewhat less than historic levels. The challenge is to maintain and enhance these ecological values though management practices which also recognise the recreational and property values inherent to the urban setting of the Gorge Waterway and Portage Inlet.

Table 12. Summary of the biophysical features of the Gorge Waterway and Portage Inlet

Sub-area	Biophysical Features		
	Physical	Vegetation	Fauna
Portage Inlet	• Shallow, mud sediment except around margins. • Mostly depositional sediments, current influence only at "outlet". • Few man-made objects due to low use and depositional nature.	• Eelgrass beds. • *Ulva* (foliose green algae).	• Native oysters in subtidal mud sediments. • Salmon bearing streams (Colquitz and Craigflower Creeks). • Juvenile salmon rearing. • Herring spawning.
Upper Gorge	• Mix of depositional and current dominated sediments. • Man-made objects mostly associated with shoreline.	• Extensive eelgrass beds. • Fringing filamentous red algae.	• Shell/gravel bivalve beds. • Native oysters. • Herring spawning.
Lower Gorge	• Primarily current dominated regime, except in basins. • Gravel present in most sediments except Upper Selkirk Waters which appears to be a depositional environment. • Man-made objects more common in the non-depositional, higher-current areas.	• Kelps are dominant vegetation in narrow sections. • Eelgrass above Selkirk Trestle Bridge.	• Current dominated bryozoan/ascidian/ sponge community.
Gorge Narrows	• Rock and cobble/boulder sediments due to extremely high currents. • Man-made objects more abundant due to proximity to Gorge Bridge.	• Moderate to dense filamentous red algae.	• Native oysters, Japanese oysters, mussels. • Current dominated bryozoan/ascidian/ sponge community.

5.0 REFERENCES

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PERSONAL COMMUNICATIONS

Roe, John. Veins of Life Watershed Society, Victoria, BC

APPENDIX A

Video Classification

Data Dictionary

The UVI database is in ACCESS97. There are three separate tables or databases included:

- **Navigation (NavData) –** includes all navigation data for the survey, including both geographic and UTM locational fixes and uncorrected depth data.
- **Geology (GeoData) –** information of seabed substrate and on seabed geomorphology.
- **Biology (BioData)–** information on epiflora and epifauna classifications.

The UVI Seabed Database is summarized in Tables A-1, A-2 and A-8. The associated data dictionary and field descriptions are outlined to provide users with a defined procedure for professionally classifying video imagery. The data are from the data logging system (date, time, latitude, longitude) or professional classifications.

A.1 Navigation Database (NavData)

A summary of the data fields contained in the navigation database is provided in Table A-1 and detailed explanation of each field follows.

INDEX
A unique identification number identifying the record and linking the navigation, geology and biology data records.

ID2
Temporary index number

DATE
The date is entered in a “month-day-year” format. The date information is provided by the DGPS data string and automatically entered into the database.

TIME(UTC)
The UTC time (GMT) in a combined “hour:minute:second” format. The UTC time is provided in the DGPS data string and automatically entered into the database.

TAPE_NO
The videotape number associated with the fix point.

FISH_DEPTH
Depth of the video tow fish corrected to tidal datum using predicted tidal data.

Table A-1 Summary of Navigation Data Fields

Field	Description
INDEX	unique point identification number
ID2	temporary index number indicating sequence on each GPS data file
DATE	month/day/year
TIME	UTC time of frame (hr:min:sec)
TAPE_NO	videotape number
FISH_DEPTH	depth of tow fish, corrected to chart datum
UTM_N	UTM northing position
UTM_E	UTM easting position

UTM_N
The UTM northing, computed from the DGPS geographic positional data using batch program “Convert”, developed by CHS and incorporating project and GEOD considerations. Required for use in ArcView with UTM base maps (e.g., NDI/DXF charts).

UTM_E
The UTM easting, computed from the DGPS geographic positional data using batch program “Convert”, developed by CHS and incorporating projection and GEOD considerations. Required for use in ArcView with UTM base maps (e.g., NDI/DXF).

IMAGE
A text field indicating if an image capture exists.

A.2 Geology Database (GeoData)

The geology database (Table A-2) provides a comprehensive summary of seabed characteristics including substrate size, percentages of coarser seabed materials and seabed morphology.

Table A-2 Summary of Geology Data Fields

Field	Description
INDEX	unique point identification number
DATE	month/day/year
TIME(UTC)	UTC time of frame (hr:min:sec)
SUBSTRATE	the general substrate of the seabed (rock, veneer, clastics, biogenic)
SED_CLASS	11 classes of clastic sediment
BOULDER	% pebbles on the seabed by class
COBBLE	% cobbles on the seabed by class
PEBBLE	% boulders on the seabed by class
GRAVEL	% gravel; sum of pebbles, cobbles and boulders by class
ORGANICS	% of visible wood or organic debris on the seabed by class
SHELL	% of coarse shell on the seabed by class
MORPH	primary secondary and tertiary morphologic features of the seabed
MAN_MADE	man-made objects seen on the seabed
GEOMAPPER	last name of individual responsible for the mapping interpretation
COMMENT	field for recording non-standard information

INDEX

A unique identification number identifying the record and linking the navigation, geology and biology data records.

DATE

The date is entered in a "month-day-year" format. The date information is provided by the GPS data string and automatically entered into the database.

TIME(UTC)

The UTC time (GMT) in a combined "hour:minute:second" format. The UTC time is provided in the GPS data string and automatically entered into the database.

SUBSTRATE

The general classification schema follows other provincial mapping guides in terms of substrate classes. Four general classes of substrate provide a very general index of substrate composition:

rock (R) – bedrock outcrop; may be partially covered with a veneer of sediment

veneer over bedrock (vR) – intermittently visible bedrock covered with a thin veneer of clastic sediments.

clastic (C) – seabed comprised of mineral grains of gravel, sand or mud sized material.

biogenic (B) – surface of seabed comprised of material of biogenic origin such as vegetation.

wood (W) – wood debris or bark completely covering the mineral grains.

SED_CLASS

Seabed sediment characteristics are based on visual estimates of clast sizes (Table A-3) on the seabed and percentage occurrence. Each clast category will be estimated in terms of *projected area surface cover*. The *projected area surface cover* is defined as the total projected area in a horizontal plane of each sediment category, estimated to the nearest 10%.

Table A-3 Sediment Categories Used in the UVI Classification

Sediment Category	Size (intermediate axis)	General Category
boulder	>25.6cm	GRAVEL
cobble	6.4 to 25.6cm	
pebble	4mm to 6.4cm	
granules	2-4mm	
sand	0.062 to 2mm	SAND
mud	<0.62mm	MUD
shell (coarse)	>2mm	ORGANICS
organic debris	n/a	
wood debris	n/a	

A description of 11 sediment classes based on a systematic application of percentage of gravel and the sand: mud ratio estimates. The classification system is summarized in Table A-4.

Table A-4 Sediment Class Code

Gravel Content	>90% Mud	Mud/Sand Mixture	>90%Sand
>80%	gravel: **G**		
30-80%	-	muddy-sandy gravel: **msG**	sandy gravel: **sG**
5-30%	-	gravelly mud/sand: **gMS**	gravelly sand: **gS**
T-5%	slightly gravelly mud: **(g)M**	slightly gravelly mud/sand: **(g)MS**	slightly gravelly sand: **(g)S**
0%	mud: **M**	mud/sand: **MS**	sand: **S**

ORGANICS

An estimate of the percent of organics or wood debris covering the surface of the seabed (Table A-5).

SHELL

An estimate of the percent coarse shell (>2mm) covering the surface of the seabed (Table A-5).

BOULDER

An estimate of the percent boulders (>25.6cm) covering the surface of the seabed (Table A-5)

Table A-5 Gravel, Shell and Organic Cover Classes

Class Code	% Clast or Cover
1	none
2	T-5%
3	5-30%
4	30-50%
5	50-80%
6	>80%

COBBLE

An estimate of the percent cobbles (6.4cm to 25.6cm) covering the surface of the seabed (Table A-5).

PEBBLE

An estimate of the percent pebbles (2mm to 6.4cm) covering the surface of the seabed in one of 6 classes (Table A-5).

GRAVEL

The total estimate by class (Table A-5) of pebbles, cobbles and boulders. The percent gravel estimate should be consistent with the categories in the SED_CLASS field.

MORPH

The MORPHOLOGY field provides a qualitative indication of features on the seabed. The classification is provisional. Classes are summarized in Table A-6.

Table A-6 Codes for Man-Made Objects

Code	Object
B	bottle or can
BB	aggregation of bottles or cans
C	cable/wire/rope
CN	cans
G	Garbage such as undistinguishable trash
L	log/logs
M	metal object
O	other; specific object listed in comment field
P	pipe
T	tire
WD	wood debris

MAN_MADE

A code for man-made objects that are visible on the seabed (Table A-7).

GEOMAPPER

The last name of the individual responsible for the interpretation of the GeoData fields.

COMMENT

A data field for recording information that may not be captured by the standard data fields.

A.3 Biology Database (BioData)

The biology database provides an overview of the seabed biota and is subdivided into both an *Epiflora* or vegetation section and a *Fauna* or animal section (Table A-8). The data is derived entirely from interpretation of the imagery; no measurements are made as part of the interpretation.

INDEX
A unique identification number identifying the record and linking the navigation, geology and biology data records.

DATE
The date is entered in a “month-day-year” format. The date information is provided by the GPS data string and automatically entered into the database.

TIME(UTC)
The UTC time (GMT) in a combined “hour:minute:second” format. The UTC time is provided in the GPS data string and automatically entered into the database.

FISH_DEPTH
Depth of video tow fish corrected to tidal datum using predicted tidal data.

VEGMAP
Temporary code for vegetation map types.

VEG1
The VEG1 field indicates the primary vegetation type. Marine plant assemblages which are categorised in coastal waters to 20m are summarised in Table A-9; all surveyed areas should be assignable to one of these categories

COV1
The coverage (Table A-10) of the VEG1 type.

VEG2
The VEG2 field indicates the secondary vegetation type (Table A-9).

COV2
The coverage (Table A-10) of the VEG2 type.

VEG3
The VEG3 field indicates the tertiary vegetation type (Table A-9)

Table A-7 Summary of Biology Data Fields

Field	Description
INDEX	unique point identification number
DATE	month/day/year
TIME(UTC)	UTC time of frame (hr:min:sec)
FISH_DEPTH	depth of tow fish, corrected to chart datum
VEGMAP	code for vegetation map types
VEG1	primary vegetation assemblage on the seabed
COV1	coverage of the VEG1 vegetation (1,2,3 or 4)
VEG2	secondary vegetation assemblage on the seabed
COV2	coverage of the VEG2 vegetation (1,2,3 or 4)
VEG3	tertiary vegetation assemblage on the seabed
COV3	coverage of the VEG3 vegetation (1,2,3 or 4)
TOT_COV	total coverage of vegetation on the seabed
FAUN1	primary faunal type
DIST1	distribution of the FAUNA1 type
FAUN2	secondary faunal type
DIST2	distribution of the FAUNA2 type
FAUN3	tertiary faunal type
DIST3	distribution of the FAUNA3 type
BIOMAPPER	last name of the biology mapper
COMMENT	field for non-standard data comments

COV3
The coverage (Table A-10) of the VEG3 type.

TOT_COV
The total coverage of vegetation on the seabed following Table A-10. This is an independent estimate and not necessarily the sum of the COV1, COV2 and COV3 fields.

Table A-8 Vegetation Coverage Codes

Code	Class	Abundance
0	None	no visible vegetation
1	Sparse	less than 5% cover
2	Low	5 to 25% cover
3	Moderate	26 to 75% cover
4	Dense	>75% cover

Table A-9 Vegetation Classification (Gorge/Portage and Esquimalt Lagoon)

ALGAL GROUP	SUBGROUP	CODE	DESCRIPTION
Green Algae	Foliose Greens	FOG	Primarily *Ulva*, but also include *Enteromorpha* and *Monostroma.*
	Filamentous Greens	FIG	The various filamentous green/red assemblages (*Spongomorpha/Cladophora* types).
Brown Algae	Fucus	FUC	*Fucus* and *Pelvetiopsis* species groups.
	Sargassum	SAR	*Sargassum* is the dominant and primary algal species.
	Soft Brown Kelps	BKS	Large laminarian bladed kelps, including *L. saccharina* and *groenlandica*, *Costaria costata*, *Cymathere triplicata.*
	Dark Brown Kelps	BKD	The LUCO chocolate brown group,. *L. setchelli*, *Pterygophora*, *Lessoniopis. Alaria* and *Egregia* may also be present. Generally more exposed than soft browns.
	Agarum	AGR	*Agarum* is the dominant species but other laminarians may also occur. Generally found deeper than the other Laminarian subgroup.
	Macrocystis	MAC	beds of canopy forming giant kelp.
	Nereocystis	NER	beds of canopy forming bull kelp.
Red Algae	Foliose Reds	FOR	A diverse species mix of foliose red algae (*Gigartina*, *Iridea*, *Rhodymenia*, *Constantinia*) which may be found from the lower intertidal to depths of 10m primarily on rocky substrate.
	Filamentous Reds	FIR1	A diverse species mix of filamentous red algae (including *Gastroclonium*, *Odonthalia*, *Prionitis*) which may be found from the lower intertidal to depths of 10m, often co-occuring with the foliose red group described above.
	Filamentous Reds	FIR2	A mix of red algae (primarily *Neoagardhiella* and *Gracilaria*) which grow on shallow, sub-tidal cobble and pebble in fine sand and silt bottoms.
	Halosaccion	HAL	*Halosaccion glandiforme*
	Coralline Reds	COR	rocky areas with growths of encrusting and foliose forms of coralline algae.
Seagrasses	Eelgrass	ZOS	eelgrass beds.
	Surfgrass	PHY	Areas of surfgrasses (*Phyllospadix*), which may co-occur with subgroup BKS or BKD above.
	Widgeon Grass	RUP	*Ruppia* sp.
No Vegetation		NOV	No vegetation observed
Cannot Classify		X	Imagery is not clear, classification not possible.

FAUNA1

FAUNA1 is the primary faunal type noted on the seabed (Table A-11). The faunal classification focuses on sessile, aggregating species or species groups. They are not all epifauna - we have included tube worms, bivalves, burrowing anemones which, although strictly speaking are infauna, are important, visible elements of soft bottom communities. Species have been grouped by feeding habit as this can help to relate faunal composition to the physical environment.

This not a comprehensive faunal classification system; one maps all fauna in all areas. Blank areas do not mean no animals, simply no animal groups which fit easily in the groupings given below.

DIST1

An estimate of the *distribution* of individuals of the FAUNA1 type based on Table A-12.

FAUNA2

FAUNA2 is the secondary faunal type (Table A-11).

DIST2

An estimate of the *distribution* of individuals of the FAUNA2 type based on Table A-12.

FAUNA3

FAUNA3 is the secondary faunal type (Table A-11).

DIST3

An estimate of the *distribution* of individuals of the FAUNA3 type based on Table A-12.

BIOMAPPER

The last name of the individual providing the professional interpretation and classification of biological features visible in the imagery.

COMMENT

Field for recording non-standard information on the seabed biology.

Table A-10 Faunal Distribution Classes

Code	Descriptor	Distribution
1	few	a rare (single) or a few sporadic individuals
2	patchy	a single patch, several individuals or a few patches
3	uniform	continuous uniform occurrence
4	continuous	continuous occurrence with a few gaps
5	dense	continuous dense occurrence

Table A-11. Faunal Classification with Emphasis on Sessile, Aggregating Species or Species Groups (Gorge/Portage and Esquimalt Lagoon)

Species or Species Complex	Code	Description
Bryozoan Complex	BRY	Bryozoans, Ascidians, sponges - generally on rock substrate.
Tunicates	TUN	Aggregations of tunicates primarily *Ciona* and colonial forms.
Anemone	ANS	Anemones aggregates - strawberry type, generally in high current areas on rock substrates.
	ANM	Aggregations of *Metridium* and other "predator" species.
	TEA	*Tealia* sp.
	ANP	Burrowing anemone (*Pachycerianthes*) on unconsolidated substrates.
Corals	CUP	cup coral (*Balanophyllia elegans*)
	SPN	sea pens (orange and white)
	SWP	sea whips (*Balticina septentrionalis*)
Tube worms	TUB	Aggregations of parchment tube dwelling polychaete worms such as *Mesochaetopterus* found in sand and silty substrates.
	TUC	Calcarious tube dwellers such as *Serpula*.
Crabs	CAN	*Cancer* sp. (*C. magister, C. gracilis*)
	RRK	*Cancer productus* (Red Rock Crab)
Subtidal Clams	GCL	Geoduck clams.
	HCL	Horseclams.
	PCL	Piddock Clams
	BCL	Butter Clams
	OYS	Oysters
	MUS	Mussels
	OCL	Other clam species.
Brittle Stars	BRT	Aggregations on sand and silt bottoms, may co-occur with burrowing worms.
Sand Dollars	SDD	Aggregations of sand dollars.
Sea Urchins	RSU	Red sea urchin.
	GSU	Green sea urchins.
	PSU	Purple sea urchin.
Sea Cucumber	CUC	Burrowing sea cucumber (*Cucumaria miniata*)
	PAR	California Sea cucumber (*Parastichopus californicus)*
Infaunal "holes"	HLM	Mounded worm, clam or crustacean holes but species or species group cannot be distinguished.
	HLF	Unmounded (flat) worm or clam holes but species or species group cannot be distinguished.
Blue green bacteria (alga)	BEG	"*Beggiatoa* sp"
Unknown	UNK1	macro fauna visible but cannot be identified
No Fauna	NOF	no fauna observed

APPENDIX B

Subtidal Dive Observations

Location	Date Time	Vertical Elevation (relative to chart datum (m)	Substrate	Vegetation		Invertebrates			Fish
				Species	% cover	Scientific Name	Common Name	Abund.	
***Dive Site 28 to 26**	June 28/	-0.4	Sandy mud	*Zostera marina* (eelgrass)	50- 70%	*Haminoea vesicula*	White Bubbleshell (with eggs)	A	Striped perch (*Embiotoca lateralis*)
Selkirk	2000			*Smithora naiadum*		*Phyllaplysia taylori*	Taylor's sea hare	C	Pile perch (*Rhacochilus vacca*)
Eelgrass				(epiphytic on eelgrass)		*Cancer magister*	Dungeness crab	P	Stickleback (*Gasterosteus aculeatus*)
	14:15			*Laminaria saccharina*	5 - 30%	*Metridium sp.*	plumose anemone	P	Shiner perch (*Cymatogaster aggregata*)
						Clinocardium nuttalli	Cockle	P	
***Dive Site 27 to 26**		-0.9	Sandy mud	*Zostera marina* (eelgrass)	50 - 70%	*Haminoea vesicula*	White Bubbleshell (with eggs)	A	Striped perch
Selkirk	15:50			*Smithora naiadum*		*Phyllaplysia taylori*	Taylor's sea hare	C	Shiner perch
				(epiphytic on eelgrass)		*Cancer magister*	Dungeness crab	P	
Eelgrass				*Laminaria saccharina*	5 - 30%				
Dive Site 25	June 29/	-2.0	muddy sand with cobble (5%)	*Neoagardhiella baileyi*	10%		Unidentified purple/yellow/orange sponge	C	Pile perch
	2000		shell fragments	*Laminaria saccharina*	5 - 20%		compound and social ascidiams including:	C	
	10:00			Fine filamentous red algae on cobble (*Polysiphonia* spp.)	5 - 10%	*Aplidium solidum*	Red ascidian	C	
						Aplidium californicum	Sea pork	C	
				Enteromorpha sp.	5 - 10%	*Cancer magister*	Dungeness crab	P	
Bryozoan Complex NW						*Amphioda urtica*	Brittle star	A	
						Pagurus sp.	Hermit crab	A	
						Metridium sp.	plumose anemone	P	
						Haminoea vesicula	White Bubbleshell (with eggs)	P	
							Branched yellow bryozoan	P	
Dive Site 26	10:33	-2.3 to -3.0	mud/whole shell/cobble	Fine filamentous red algae on cobble	5 - 25%		compound and social ascidians including:	A	Striped perch
			(angular cobble)	(*Polysiphonia* spp.)		*Aplidium solidum*	Red ascidian	C	
Bryozoan Complex SE				*Laminaria saccharina*	5 - 20%	*Aplidium californicum*	Sea pork	C	
				Neoagardhiella baileyi	5%		Branched yellow bryozoan	P	
				Enteromorpha sp.	10%		Unidentified purple/yellow/orange sponge	C	
						Cnemidocarpa finmarkiensis	Orange sea squirt	P	
						Pisaster brevispinus	Spiny pink sea star	P	
						Amphioda urtica	Brittle star	A	
						Corella willmeriana	Transparent sea squirt	P	
						Myxicolla infundibulum	Slime tube worm	C	
						Metridium senile	short plumose anemone	P	
						Tresus sp.	Horse clams	C	
						Dialula sandiegensis	Leopard dorid (nudibranch)	P	
						Tealia sp.	Anemone	P	
						Evasterias troschelii	Mottled sea star	P	
						Eudistylia vancouveri	Northern feather duster worm	P	

*dive observations made between dive sites

Vertical height/depth given in metres relative to chart datum.
Invertebrates: A = Abundant, C = Common, P = Present.
Vegetation: % cover estimated for dominant vegetation.

Location	Date Time	Vertical Elevation (relative to chart datum (m)	Substrate	Vegetation		Invertebrates			Fish
				Species	% cover	Scientific Name	Common Name	Abund.	
Dive Site 22a	11:33	0.0 to -3.6	cobble/boulder/pebble	*Ulva* sp.	5- 10%	*Ostrea lurida*	Native oyster	C	Pipefish -
Ferry Dock				Fine filamentous red algae (*Polysiphonia* spp.)	5 - 20%	*Mopalia muscosa*	Mossy chiton	C	*Syngnathus griseolineatus*
Gorge Narrows						*Haliclona permollis*	Purple sponge	P	Stickleback
						Haliplanella lineata	Lined anemone	C	Pile perch
						Metridium sp.	plumose anemone	P	
						Cancer magister	Dungeness crab	P	
Dive Site 22	12:14	-1.9 (below falls)	bedrock	Fine filamentous red algae (*Polysiphonia* spp.)	20 - 40%	*Ostrea lurida*	Native oyster	A	Pile perch
		-3.7 (under bridge)	boulder and cobble	*Prionitis* sp.(on rock in middle of channel)	60-70%	*Halichondria* spp.	Bread crumb sponges	A	
Gorge Narrows		-5.4 (upstream of bridge)					Unidentified yellow sponge	C	
		-1.0 (north bank, upstream)					Colonial ascidians as above	C	
							Branched yellow bryozoan	P	
						Haliclona permollis	Purple sponge	A	
						Haliplanella lineata	Lined anemone	A	
						Mytilus sp.	Mussels (upstream/downstream to -1.0m depth)	P	
						Metridium sp.	Plumose anemone	C	
						Mopalia muscosa	Mossy chiton	C	
Dive Site 24	14:15	-1.5 to 0.0m	muddy sand	*Zostera marina* (eelgrass)	40-50% (0.0 to -1.5)		compound ascidians	P	Pile perch
			debris-tires, rope, leaf litter		<10% (0.0 to +0.3)	*Metridium* sp.	Plumose anemone	P	
Dock Dive		0.0m to +0.3		*Laminaria saccharina*	5 - 20%	*Haminoea vesicula*	White Bubbleshell (with eggs)	P	
				Ulva sp.	10 - 30%	*Haliclona permollis*	Purple sponge	P	
South side Gorge				*Enteromorpha* sp.	10 - 20%		Unidentified yellow sponge	P	
				Fine filamentous red algae (*Polysiphonia* spp.)	5%		Unidentified bryozoan	P	
Dive Site 23	14:48	-2.0 to -1.4 (base of bedrock)	mud/sand with whole shell	None		*Metridium* sp.	Plumose anemone	P	Pile perch
			and cobble			*Haminoea vesicula*	White Bubbleshell (with eggs)	P	Striped perch
Dock Dive		-1.7 to 0.0m	muddy sand	*Zostera marina* (eelgrass)	30-50% (-0.1 to -1.5)				
North side Gorge					<10% (-0.1 to +0.3)				
				Laminaria saccharina	<5%				
				Fine filamentous red algae (*Polysiphonia* spp.)	5 - 10%				
				Enteromorpha sp.	10%				

Vertical height/depth given in metres relative to chart datum.
Invertebrates: A = Abundant, C = Common, P = Present.
Vegetation: % cover estimated for dominant vegetation.

Location	Date Time	Vertical Elevation (relative to chart datum (m)	Substrate	Vegetation		Invertebrates		
				Species	% cover	Scientific Name	Common Name	Abund.
Snorkel Sites 1 - 4 (Portage Inlet)	July 5/ 2000	0.0 to -1.0m	mud			*Ostrea lurida*	native oyster	clumps
Snorkel Site 5 Portage Inlet		+0.3 to -0.2m	mud with some shell (oyster)	*Enteromorpha* sp.	20%	*Ostrea lurida* *Modiolus sp.*	native oyster horse mussel	clumps P
Snorkel Sites 6 - 9 (Portage Inlet)		- 1.2m	mud	*Zostera marina* (eelgrass)	20 - 30%	*Ostrea lurida*	native oyster	P
Snorkel Site 10 Portage Inlet Outlet		-0.5m	Shell (50%) in mud	*Enteromorpha* sp.	20%	*Ostrea lurida*	native oyster	C
Snorkel Site 11 Portage Inlet Outlet	July 6/ 2000	-0.5m	Shell (75%) in mud	*Zostera marina* (eelgrass)	very sparse	*Ostrea lurida*	native oyster	C
Snorkel Sites 12 - 13 Portage Inlet Outlet		0 to -0.2m	Shell (whole and fragment,primarily butter clam)			*Ostrea lurida*	native oyster	C
Snorkel Sites 14 - 15 Upper Gorge		0m	Shell in mud/sand with cobble/boulder (<5%)	Filamentous red algae	10-25%	*Ostrea lurida*	native oyster	C
Snorkel Sites 16 - 17 Upper Gorge		0 to -0.2m	Shell in mud/sand with angular cobble/boulder	*Zostera marina* (eelgrass)	very sparse	*Ostrea lurida*	native oyster	C/A
Snorkel Sites 18 - 19 Upper Gorge		0m	Shell (80%) in mud/sand			*Ostrea lurida*	native oyster	C (at 18)

Vertical height/depth given in metres relative to chart datum.
Invertebrates: A = Abundant, C = Common, P = Present.
Vegetation: % cover estimated for dominant vegetation.

APPENDIX C

Video Images of Characteristic Biophysical Features

Bryozoans

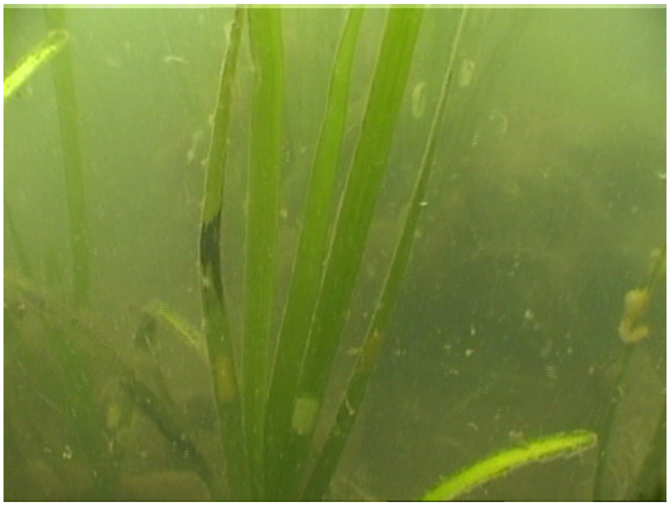
Neoagardhiella baileyi and sponges.

Sponges on rock.

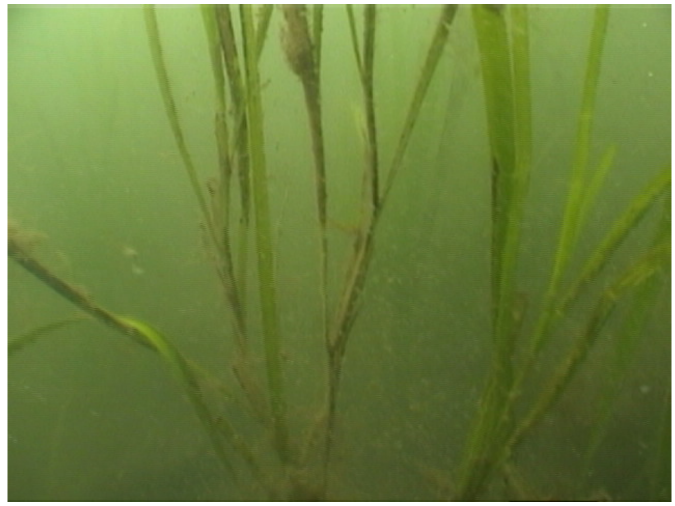
Tealia sp.on log.

Gravelly sediment with sponge and man-made debris.

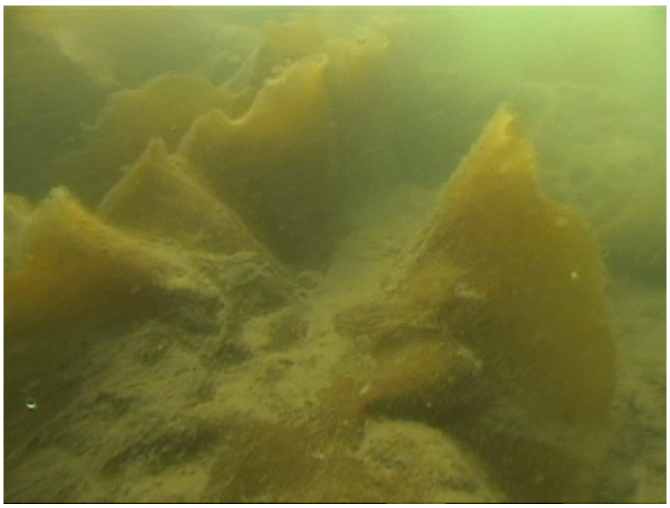
Typical biophysical features of higher current areas in the Lower Gorge.



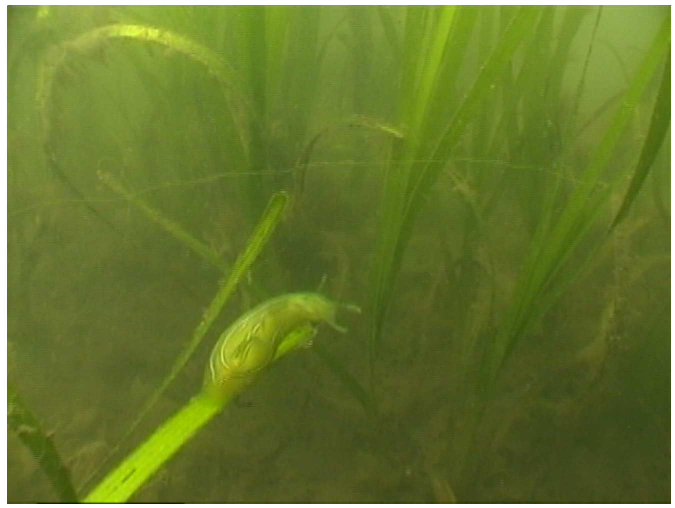
Vegetative eelgrass shoots (unbranched,wide).



Reproductive eelgrass shoots (branched,narrow).

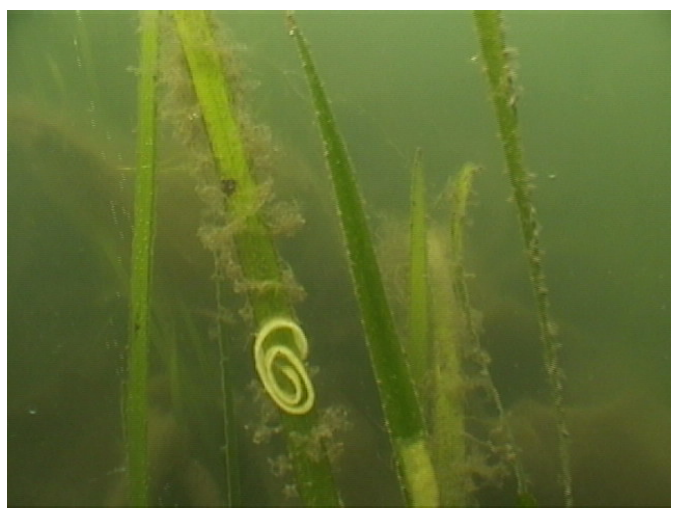


Bladed kelp, *Laminaria saccharina.*



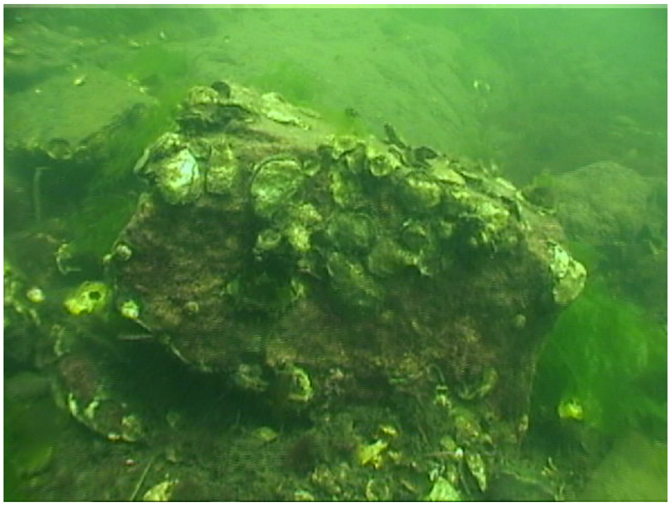
Taylor's sea hare, *Phyllaplysia taylori*, on eelgrass.

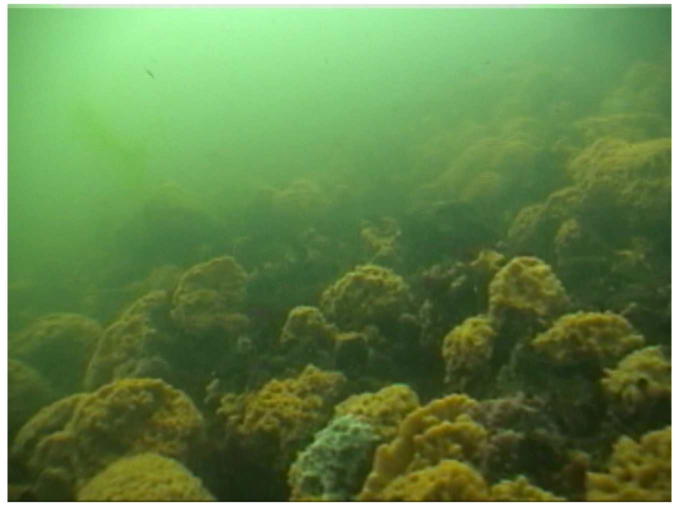
White bubbleshell, *Haminoea vesicula*, on eelgrass.

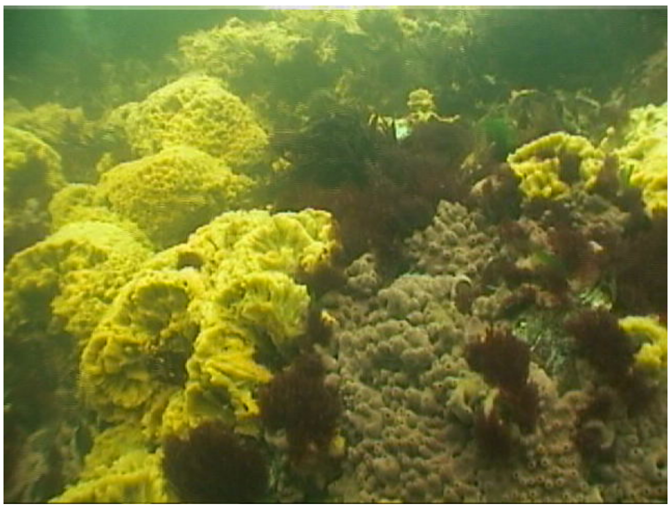


Egg mass of *Haminoea* on eelgrass blade.

Typical biophysical features of Selkirk Waters.

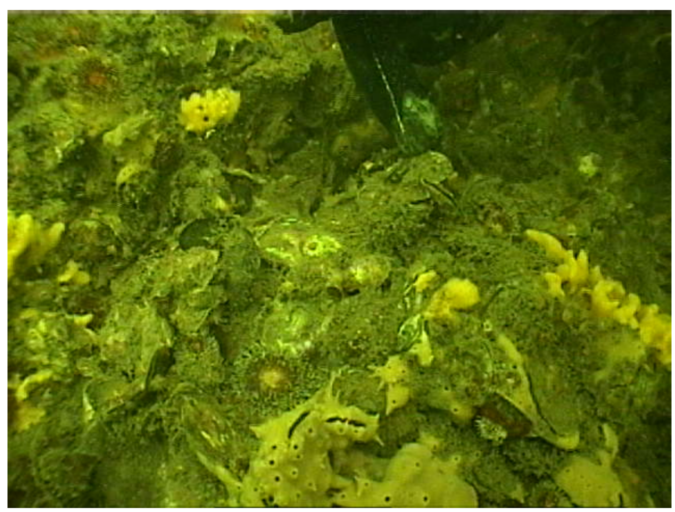

Native oysters (*Ostrea lurida*) on rock.


Sponges on boulder.


Bread crumb sponge, purple sponge and
Filamentous red algae on rock.


Shell wall.

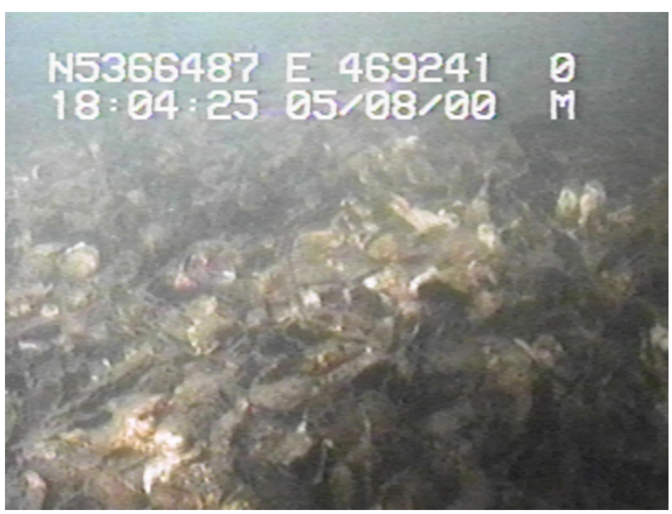

Native oysters and *Metridium* on rock.


Sponge encrusted native oysters.

Typical biophysical features in Gorge Narrows(high current area).

Native oysters in the mud of Portage Inlet.

Shell cover upstream of Craigflower Bridge (Upper Gorge).



Shell and gravel sediment in the Upper Gorge (high current area).