AECOM

Appendix 4:

Benthic Communities

(Envirosphere 2009a)

Seabed Biological Communities in the Minas Passage

Submitted to:

Minas Basin Pulp and Power Limited
Hantsport, Nova Scotia

May 29, 2009

by

Envirosphere Consultants Limited
Windsor, Nova Scotia

MINAS BASIN | Envirosphere CONSULTANTS LIMITED

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Oceanographic surveys in the Minas Passage, Cape Sharp area, which included possible sites for tidal device installations and cable routing, were carried out on August 18-20, and September 23-24, 2008. Included were a seabed sampling and video and still photographic survey to gather information on seabed characteristics and seabed biological communities, the former for project planning and engineering and the latter to provide baseline information for monitoring the project and to provide information for assessment of habitat and the impacts of the proposed project on the marine biota. The video and seabed sampling targeted sites representing dominant bottom types in the area in general, as well as in the general area considered for tidal device installations and cable routes. Video images were obtained from stations representative of the majority of key areas. Rock and biota samples were obtained at 4 locations in an area of sandstone bedrock outcrops, one of the dominant substrate types. Bottom dwelling organisms were identified and counted in images to give a semi-quantitative assessment of community composition and the distribution of animal communities.

1. INTRODUCTION

Nova Scotia's Bay of Fundy has one of the highest tidal regimes in the world and some of the greatest potential for generation of electricity from the tides. In part to further its commitment to a sustainable future for Nova Scotians, the Province of Nova Scotia has undertaken to establish a Tidal Power demonstration research and test facility, and selected Minas Basin Pulp and Power Limited of Hantsport, Nova Scotia, to develop the necessary infrastructure and coordinate use of the site by interested companies and organizations which produce tidal energy use devices (tidal device providers) and which will partner in the project. The project to develop the test facility was inaugurated in January 2008 and includes engineering and environmental components, the latter to provide information on the physical conditions such as currents, relating to the supply of tidal energy as well as for adequate device design; seabed geology and geotechnical information for device installation; and background information on the oceanography, biology, fisheries, and socioeconomic environment, relating to the governmental and public environmental assessment/ regulatory processes under which the project must operate.

To acquire information on geological features of the seabed at the site, geophysical and geotechnical information (multibeam bathymetry, sidescan, sub-bottom profiling) in the target area was collected on July 7-9 and October 1-4, 2008. A seabed photography and sampling program was undertaken in August and September 2008 both to provide information on seabed geology, providing an initial survey of distribution and composition of bedrock and unconsolidated material on the seafloor to aid in site selection; and to determine distribution of biological communities and habitat necessary to meet regulatory requirements and to provide a baseline for monitoring during project operation.

The local distribution of benthic (seabed) plants and animals in the study area is expected to be strongly dependent on several key factors: depth (and light penetration); substrate type, food supply, suspended sediment, and water movements including currents types, waves and tides. Bottom type and depth in particular is important to delineating the kinds of benthic communities, which can occur. In the study area, because of the high currents, seabed type is restricted to hard bottom substrates such as bedrock and boulder, cobble and gravel, and consequently animal and plant types occur which are adapted to such environments (e.g. barnacles, anemones) or species, which can live on a wide range of bottom types (crabs, lobster).

Benthic communities on the deep rocky seabed in the study area are virtually unknown because of the difficulty of sampling the hard bottom and the complications involved in sampling in high current regimes, as most equipment made for sampling the seabed does not work well there. The present survey, employing video and still photographs, gives information on one component of the benthic community, organisms that can be readily be seen at the surface and are typically larger than 1 cm in diameter, although some of the imagery has higher resolution allowing discrimination of finer details, down to 1 mm in some cases.

2. METHODS

2.1 FIELD SURVEY

Equipment

Survey Vessel: The survey was carried out from the MV *Tide Force*, a 50-foot wide-bodied lobster boat operated by Mr. Mark Taylor, a fisherman operating out of Hall's Harbour. The vessel has standard lobster hauling gear and an A-frame on the back deck suitable for deploying and retrieving heavy equipment. The August survey was divided into two legs (August 18, 1300 hrs to August 20, 0100 hrs) and August 20 (1300 hrs to August 21 (0130 hrs), with the vessel returning to Halls Harbour in the middle. Scientific crew included Patrick Stewart, M.Sc. (Envirosphere Consultants), Colin Anderson and Robert Budgell (Oceans Ltd), and Simon Melrose (Oceans Limited)(second leg for instrument deployment). The vessel was piloted by Mark Taylor assisted by deckhand Roy Sollows. The September survey was carried out in one leg from September 23-25, 2008, with P. Stewart, C. Anderson, R. Budgell, and Ulrich Lobsiger of Ulrich Lobsiger Consulting, and piloted by M. Taylor.

Video System: A self-contained underwater video system consisting of a Sony Hi-8 handicam in an Amphibico underwater housing and an Amphibico self-contained SLD10 underwater light, both mounted in a protective aluminum frame (Figure 1), were lowered to the seabed attached to a ½" 'polysteel' anchor line with ~200 lbs of chain. The vessel lobster 'trap hauler' equipment was used and functioned satisfactorily to lower and raise the camera. In its mount, the camera lens was about 40 cm from the base of the frame, which is the closest view of the bottom possible. The field of view is about 52.5 cm wide and 40 cm high (0.2 m^2) when sitting on the bottom, and has sufficient depth of field when at the typical close focus and wide-angle settings, to provide views of the panorama beyond the base of the frame. The system allowed us to work in moderate currents, which were expected, and could be adjusted for higher current regimes by the addition of additional anchor weight. In practice, however, the near bottom turbidity, which arose under higher currents appeared to be obscuring the video; and heavier anchor weights give less control of placement on the equipment on the bottom when using the trap hauler.

Underwater Still Camera: A Benthos® deep sea camera with strobe, mounted in a steel frame (Figure 2), was used to obtain still photographs of the seabed at various sites. Still photo coverage was intended to complement the video coverage, both providing additional imagery of the bottom and higher resolution images, which were needed in identifying biological communities. The camera system used 35 mm film; a roll of 100ASA black and white film developed on board was used to calibrate the exposure and focus of the system; subsequently 400 ASA colour print film was used. The camera has a nominal field of view in water of 35° x 50°, and a trigger length of 1.2 m from the focal plane; at this configuration, the nominal area sampled is approximately 75 x 113 cm (0.85 m^2).

Rock and Sediment Sampling Equipment: Both a 2 m scallop drag and an 0.2 m^2 Van Veen grab sampler (Figures 13 & 14) were used to sample the seafloor at several of the sites on the August survey only. Both were deployed after the video survey was completed.

Survey Methods

Sampling Locations: Stations for the geological survey were pre-selected by the project geologist (Gordon Fader, Atlantic Marine Geological Consulting Ltd, Halifax) to enable sampling to groundtruth characteristics key geological features of the seabed and for engineering design of installations and cable routing. Prior to this survey, the study area has experienced negligible study or sampling activity; consequently there were many unknowns to be addressed in the sampling program.

Figure 1. Underwater video camera and frame

Video Survey: Several groups of stations were selected initially as priority areas and were targeted for initial video and photo acquisition. In the event of unforeseen events such as abrupt weather changes or catastrophic events, and given the short and largely unknown time window of lower currents at slack tide, these stations would provide a basic profile if no other information was acquired. These included a group of stations in areas initially proposed for device installation; three groups of stations in areas suspected of having different bottom types and conditions along the cable corridor, and in an offshore area believed to be volcanic bedrock. After these stations were completed, the remaining selected stations were done opportunistically. A similar strategy was employed to cover stations during the September survey, in this case targeting stations, which had inadequate coverage earlier, as well as new areas. The project sampling approach is presented in more detail in the two field reports (Envirosphere Consultants and Oceans Limited 2008a & 2008b).

.

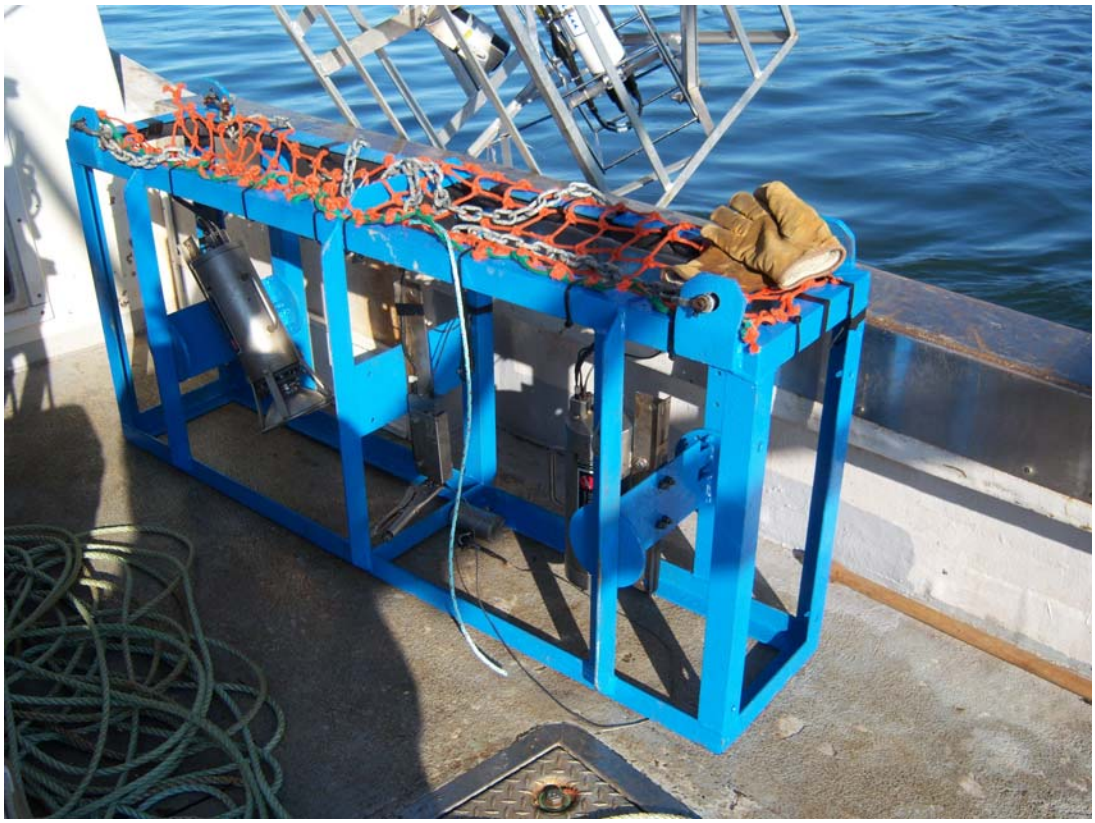

Figure 2. Benthos deep sea camera and frame.

The video camera was turned on and left running for each series of stations. Stations were close enough together that the transfer time between stations was typically 5-10 minutes and the videos lasted typically from 0.5 to 1.5 hrs. At each station the time and coordinates were recorded as the camera entered the water, and then the camera was lowered to the bottom, with some slack given to the line upon bottom contact, allowing the camera to settle and sit on the bottom. The camera was

raised off the bottom and 'hopped' (suspended while the vessel drifted for about a minute, and then dropped to the bottom again) two to three more times at each station). Time, DGPS coordinates, and sounder depth were recorded for each bottom contact of the system. A similar procedure was used with the Benthos® camera, and the two camera systems were deployed on alternate high and low tides.

Currents limited use of the camera to approximately 1 hour before and one hour after slack tide, shorter on spring and flood tides, as images were poorer at higher currents due to higher turbidity.

Bottom Sampling—Bottom sampling at four stations (see Envirosphere Consultants and Oceans Limited (2008a)), in an area thought to be likely for device installation, was conducted on August 19 & 20, 2008. Both the scallop rake and Van Veen grab were deployed. Bottom sampling was not conducted on the September survey. The scallop drag captured a lobster at one site and a 'pot bellied sculpin' both of which were returned to the water. Full details of the survey approach are presented in Envirosphere Consultants and Oceans Limited (2008 a & b).

2.2 ANALYSIS

Individual images and video were reviewed, and content was recorded in a database (MSAccess), including: type of bottom; orientation of camera and whether it was on bottom or not; types of organisms and approximate number in the frame or percentage cover; absolute depth below mean low water (MLW), derived from a digital elevation model developed on the basis of the multibeam bathymetry survey by Seaforth Engineering, Dartmouth; and the characterization of the site from the geological interpretation (Fader 2009). Stations on a series of offshore transects (those with the letter "T" in the station name (Figure 3, below), which were located west of the initial proposed cable route and in an area initially considered for, but rejected as, one of the installation sites, were reviewed but not analyzed for this report; the cable route was finalized in early April 2009, which resulted in moving it further east. The interpretation of biological communities at these stations was consistent, however, in terms of relationship of communities with depth and bottom type, with that contained in this report for the remaining stations. Images and video clips of all the stations sampled are contained in field reports (Envirosphere Consultants and Oceans Ltd. (2008 a & b)).

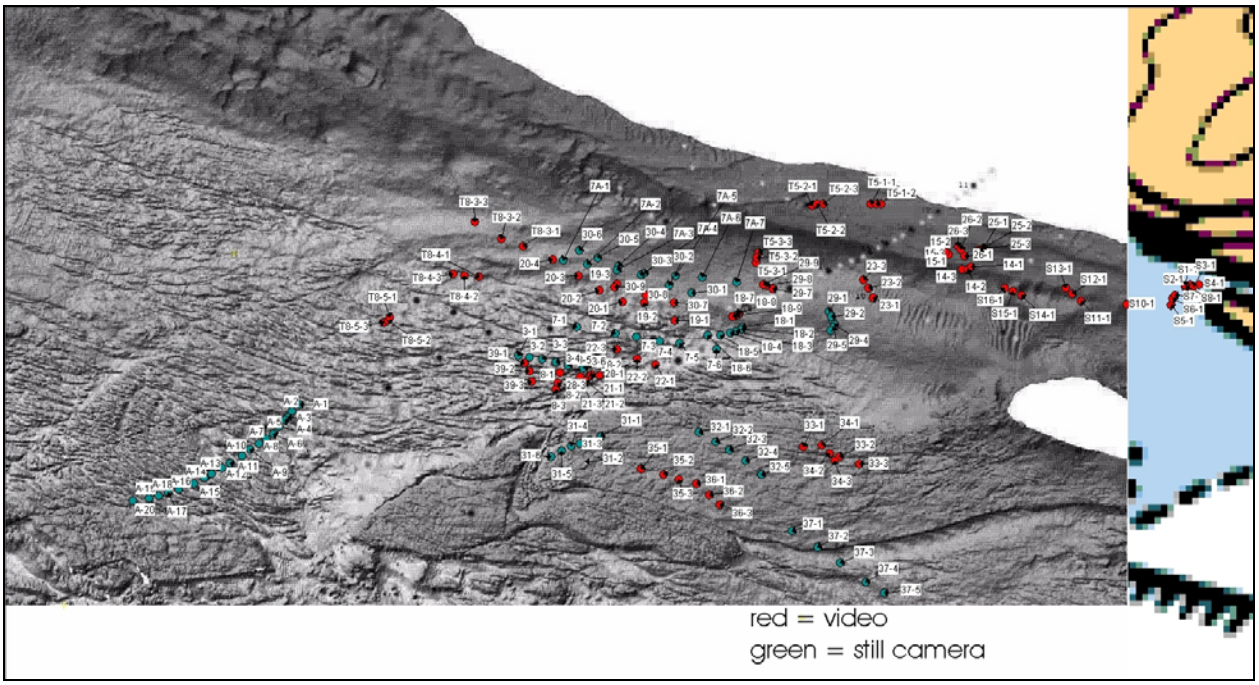

Figure 3. Photo stations, September 2008.

Counts of organisms in individual frames were made on reviewing image captures and DVD of the video. Abundances were reported as number per frame, due to a wide variation in heights off the bottom, and areas sampled by the video and Benthos® camera. The image taken by the video camera occupied an area of approximately 0.2 m^2 when sitting flat on the seabed. In this situation, a scale bar mounted on the camera frame was directly in contact with the seabed, and provided exact dimensions. In some cases where the same bottom object occurred in several images but at different heights from the seabed, an area conversion factor to relate to images with known sizes was developed. The Benthos® camera sampled approximately 0.85 m^2 when at the normal photo depth of approximately 1.2 m off the bottom.

Only a descriptive analysis of communities based on zones of seabed based on the geological interpretation, and a qualitative analysis of frequency of occurrence of various organism groups, was carried out, due to the variety of bottom types, difficulty of obtaining representative samples of each type, and the variable quality obtained. The number of images in which each organism or organism group occurred was used as well to estimate the relative frequency of occurrence for the dataset as a whole and for each bottom type.

3. RESULTS

3.1 GENERAL

Sampling and the discussion in the present report includes all the geological types and regions crossed by the cable routes as of May, 2009 (Figure 4). Two hundred forty-one (241) locations were occupied, and acceptable video or still photo images were obtained from most (Figure 4). These were, in fact, sublocations in a hierarchy, which consisted of major stations (specific sites selected to uniformly cover key areas); and within-station replicates (the camera was 'bounced' off the bottom 30 seconds apart three times at each station, but because of currents, covered from a few metres to larger distances between bounces). The Benthos® camera was 'bounced' approximately 6 times at each station, capturing different sublocations due to drift at each station. Further, in the lab, each video record could often be 'video-captured' at several points as the camera moved at a given sub-location, commonly giving multiple images per location.

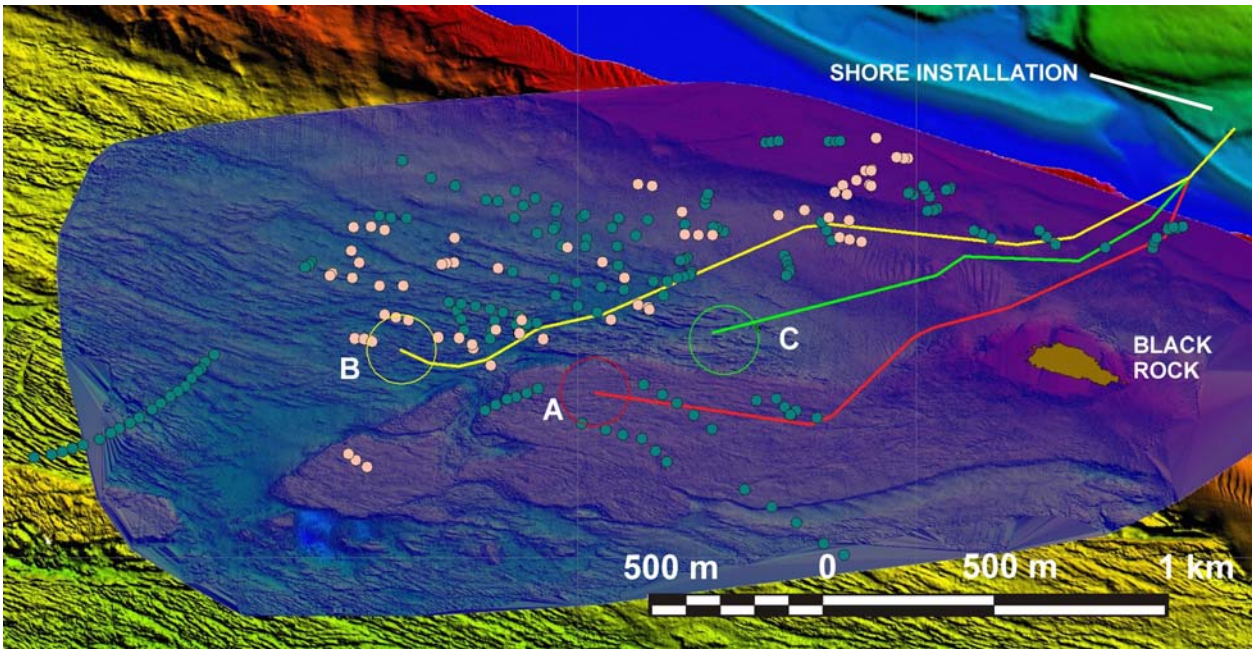

Figure 4. Photo stations in relation to tidal device installation sites and cable routes. Pink and green dots are locations where seabed images were obtained in August and September, 2008, respectively.

Image quality of both the video system and Benthos® camera was good under ideal conditions. The best images produced by the video system were those taken when the camera frame rested on the bottom, early in the sampling sequence before cooling of the camera housing caused the lenses to fog up, a problem which was recognized, but couldn't be remedied at the time. Identification of biological organisms in images was more difficult, but movement supplied a cue in many cases (e.g. hermit crabs which are usually active). The best video images were outwardly similar to the best still photography, although on close inspection the Benthos® still camera gave high resolution (mm scale in some cases). The best images were captured by the

Benthos® camera when the camera frame was accidentally closer to the bottom than planned or rested sideways on the bottom. Both camera systems experienced loss of contrast and resolution of images when off the bottom (the normal operating distance for the Benthos® camera is about 1 m off the bottom so all images taken normally were slightly hazy), due to turbidity caused by particulates in the water. Consequently the ability to accurately count and identify organisms was impossible in many cases.

3.2 GEOLOGICAL CHARACTERISTICS

The seabed geology of the study area has been summarized by Fader (2009). Four main geological zones occur: 1) a nearshore platform or shelf which slopes gradually from mean low water, seaward for approximately 150 m and then drops sharply down an escarpment to about 20-25 m below MLW; 2) a deeper area of predominantly unconsolidated sediments, boulder and cobble, in places with cobble/gravel waves, and depths up to 45 m; 3) a zone of offshore sedimentary bedrock (sandstone, siltstone, mudstone) ridges and intervening troughs occupied by cobble and boulder, the predominant type of bottom in northern Minas Passage, roughly at a depth of 50 m ; and 4) a string of level, volcanic bedrock (basalt) platforms extending east-west through the area with top depths of 27-33 m (Figure 5). Most of the images collected in the

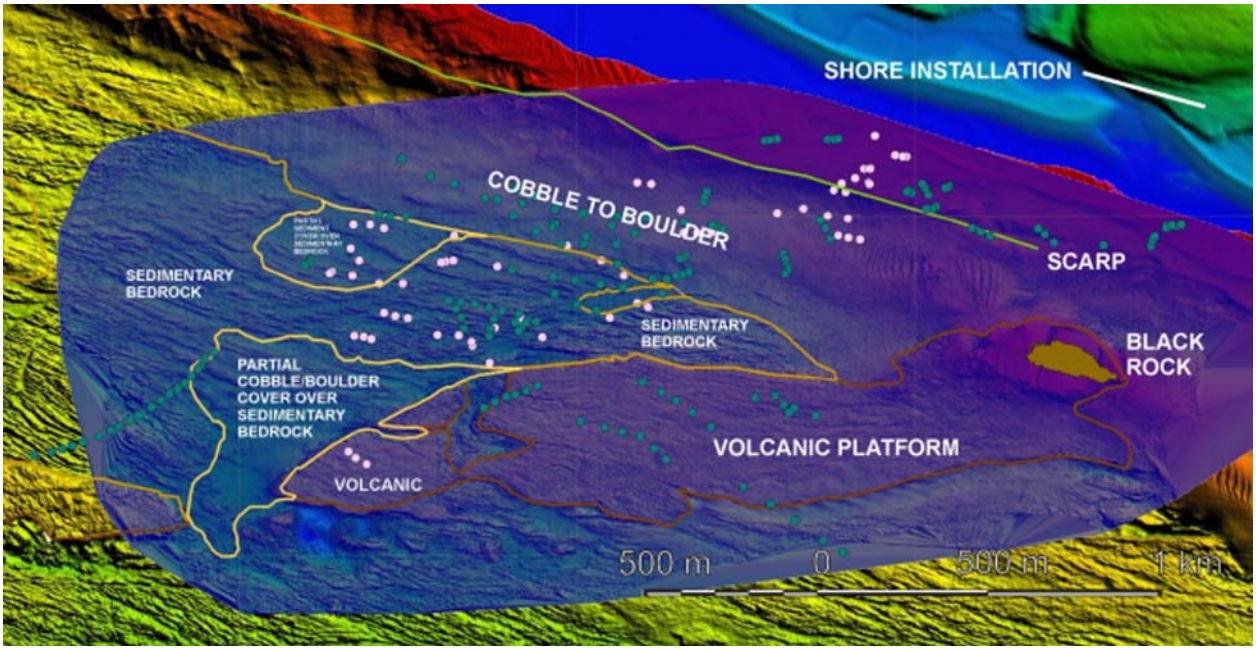

Figure 5. Geological zones in the study area, redrawn from Fader (2009).

survey were in the sedimentary ridge and trough area, with lesser though equal coverage of both the deepwater unconsolidated (boulder/cobble) area and the bedrock platforms. The eastern parts of the deepwater unconsolidated area and the sedimentary ridge and trough area (including the

area proposed for installation Site C), both just west of Black Rock were not sampled[1] (Figure 5); however the bottom types there are expected to be consistent with the occurrence elsewhere, based on the geological interpretation (Fader 2009).

3.3 BIOLOGICAL COMMUNITIES

Relationship to Substrate

Images revealed general features of the seabed biological communities, including distinctive species and associations, associated with geological features, as summarized below:

Nearshore Shelf—Shallow Water Unconsolidated Sediments

The inner portions of the nearshore shelf at the proposed cable landfall consists of a level gravel flat representing an extension of the intertidal beach zone, and extending from mean low water (MLW) seaward to a depth of approximately 8-9 m, and then drops down a steep slope to about 16 m to up to 20 m. The shallower portions of this area are occupied by sparse development of *Fucus* sp (rockweed) (Figure 6). Moving seaward and beginning the descent along the steep slope or scarp on the edge of the shelf, the occurrence of cobble increases and other plants including dulse (*Palmaria palmata*) and coralline algae encrusting on rock surfaces occur; animals visible in images include Hermit crabs (*Pagurus* sp), barnacles, and erect bryozoans (*Flustra foliacea*) (Figure 7 & 8). Seaweeds and coralline algae are absent at the bottom of the slope, where the substrate transitions into a predominantly boulder and cobble bottom. [This cross-shelf zonation is discussed in more detail in a later section].

Boulder and Cobble—Deep Water Unconsolidated Sediments

This area of bottom dominated by cobbles and boulder, separates the nearshore shelf from the bedrock zones (a sedimentary bedrock zone and volcanic bedrock platform offshore (Figure 5)). Shallowest parts of the zone, located at the base of the nearshore shelf at the installation site and in the vicinity of the proposed cable route, are occupied by cobbles often formed into waves by tidal currents, but in deeper water extending from depths of 16-20 m to depths of 45 to 50 metres consists of clean cobble and boulder mixtures, and with cobble waves, particularly nearshore. The biological community in these areas is usually not heavily populated with organisms, consisting of occasional encrusting organisms such as a yellow encrusting sponge (*Halichondria* sp) on the tops of larger rocks and boulders (Figures 9 &10), organisms attached to the sides of rocks (‘edge fauna’) including the bryozoan *Flustra foliacea* and a stalked ascidian, *Boltenia ovifera*, and mobile organisms, typically Hermit crabs *Pagurus* sp. Colonization of larger rocks by encrusting sponges is usually limited to above 10-20 cm of bottom, suggesting that a bed load of coarse material moving with tidal currents within that distance of the bottom, prevents

[1] Images were obtained from Site C in February and March 2009.

colonization by encrusting organisms near the seabed. In some locations, presumably where there is more shelter from currents, sponge cover can extend closer to the bottom.

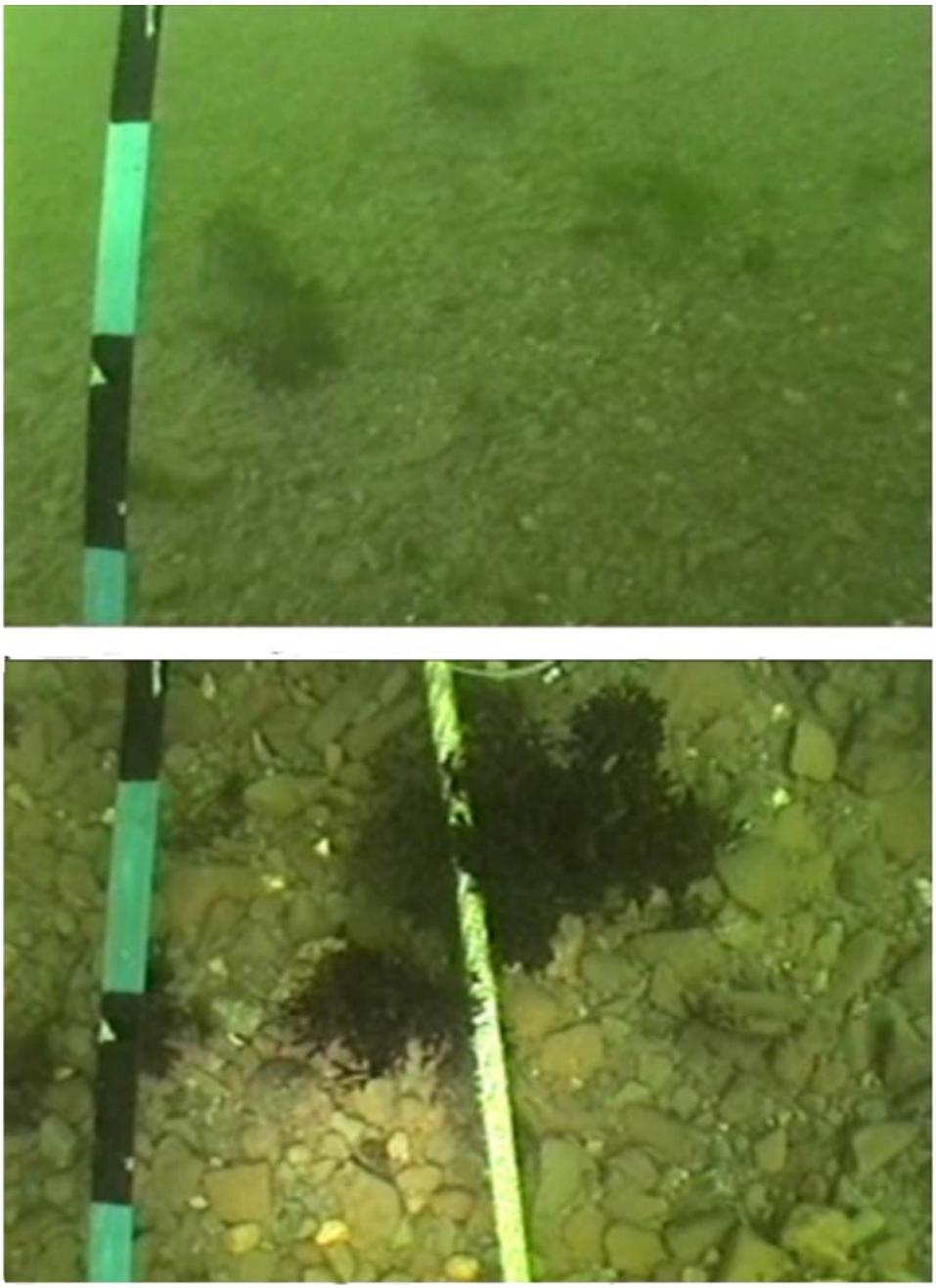

Figure 6. Level gravel with patchy rockweed, *Fucus* sp, on nearshore shelf.

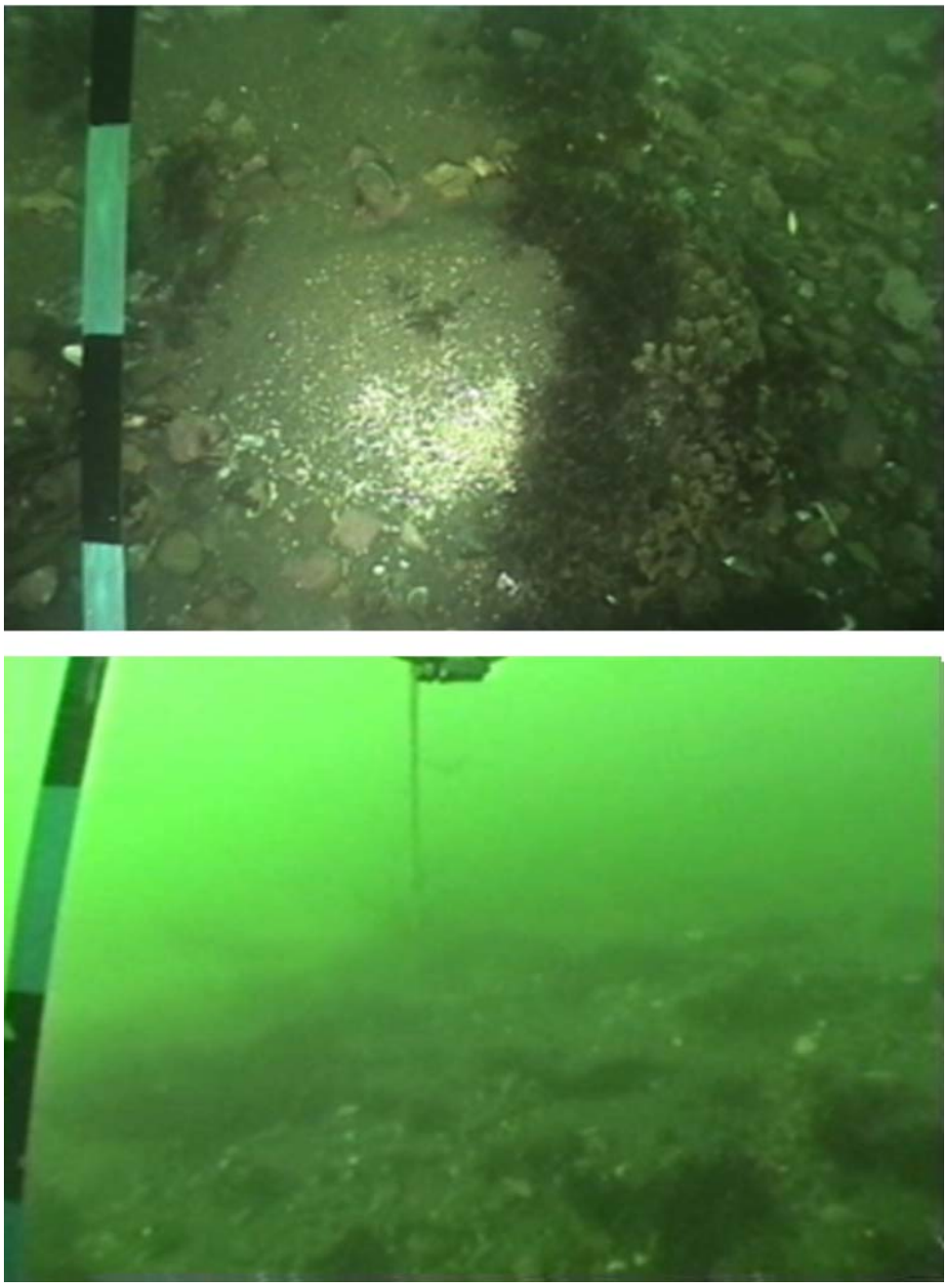

Figure 7. Outer part of shelf platform, displaying mixed gravel to cobble bottom, with rockweed, *Fucus* sp, coralline algae encrusting on gravel, and a bryozoan *Flustra foliacea*. Top image contains an embedded boulder with dense barnacle development.

Figure 8. Cobble substrate on upper slope of nearshore shelf with *Fucus* sp, *Palmaria* sp, coralline algae, *Flustra* sp, and barnacles.

Figure 9. Hermit crab and *Halichondria* sp sponge in Cobble and Boulder seabed zone.

Figure 10. Examples of biological community, Cobble and Boulder seabed zone. Upper left, clean cobbles and boulders with occasional encrusting sponges and hermit crabs. Upper Right, encrusting yellow *Halichondria* sp sponge on boulders showing bedload scour effects around margins, hermit crab and red sea anemone (*Stomphia* sp). Lower Left, boulder with 'biolayer' and 'edge fauna' including the bryozoan *Flustra* sp and two stalked ascidians, *Boltenia ovifera*. Lower Right, *Halichondria* sponge and *Flustra.* Scale units 10 cm.

Sedimentary Bedrock Outcrops

Sedimentary (sandstone/siltstone) bottom consisting of linear bedrock ridges separated by troughs containing cobble to boulder and occasionally finer sediment such as coarse sand/ granule, occurs seaward of the boulder and cobble zone. This bottom type appears to be the dominant bottom type not only in the study area but the northern Minas Passage in the study area as a whole. The bedrock outcrops are themselves highly irregular in surface features, but the troughs also create highly irregular bottom (Figures 11 & 12). The outcrops support encrusting organisms including Breadcrumb sponge (*Halichondria* sp), barnacles, an 'edge fauna' consisting of tubes and filaments and occasional stalked ascidians (likely *Boltenia ovifera)* extending into crevices in the bedrock and off the edges of the outcrops. Most of the sandstone bedrock surfaces are covered, sometimes almost completely, by a thin, fragile layer of particulate material, apparently laid down by surface tube dwelling organisms, presumably

Figure 11. Biological communities on sedimentary bedrock ridges. Left, Breadcrumb Sponge and barnacles on a bedrock prominence. Upper Right, bedrock with 'biolayer' of surface dwelling, tube-building organisms, barnacles, and 'edge fauna'. Lower Right, continuous surface biolayer and a hermit crab on a sandstone boulder.

amphipods and polychaetes, but the exact identity isn't known. In some of the images, presumably where this 'biolayer' has been removed or sloughed off, small circular patches of biolayer appear to be developing, evidently constructed by the organisms. Various other fauna, which dwell on surfaces (barnacles, hydroids, surface dwelling bivalves [some information was obtained on fauna of rock surfaces from bottom samples]), as well associated organisms including low densities of hermit crabs and seastars (*Asterias* sp and *Henricia sanguinolenta*).

Troughs between bedrock outcrops typically have boulders and cobbles, similar to those in the Boulder and Cobble zone nearer to shore, with occasional rocks apparently representative of the parent bedrock material including sandstone and siltstone/mudstone fragments (Figures 13 & 14). Also in the troughs are occasional flat exposures of red mudstone. Troughs are in deep water (45-50 m) and the biological community is similar to that of the Boulder and Cobble Zone, described above. Encrusting fauna (e.g. Breadcrumb Sponge) is common in patches on rocks, and edge fauna (e.g. tube building worms, stalked Ascidians (*Boltenia ovifera*), bryozoa (*Flustra*

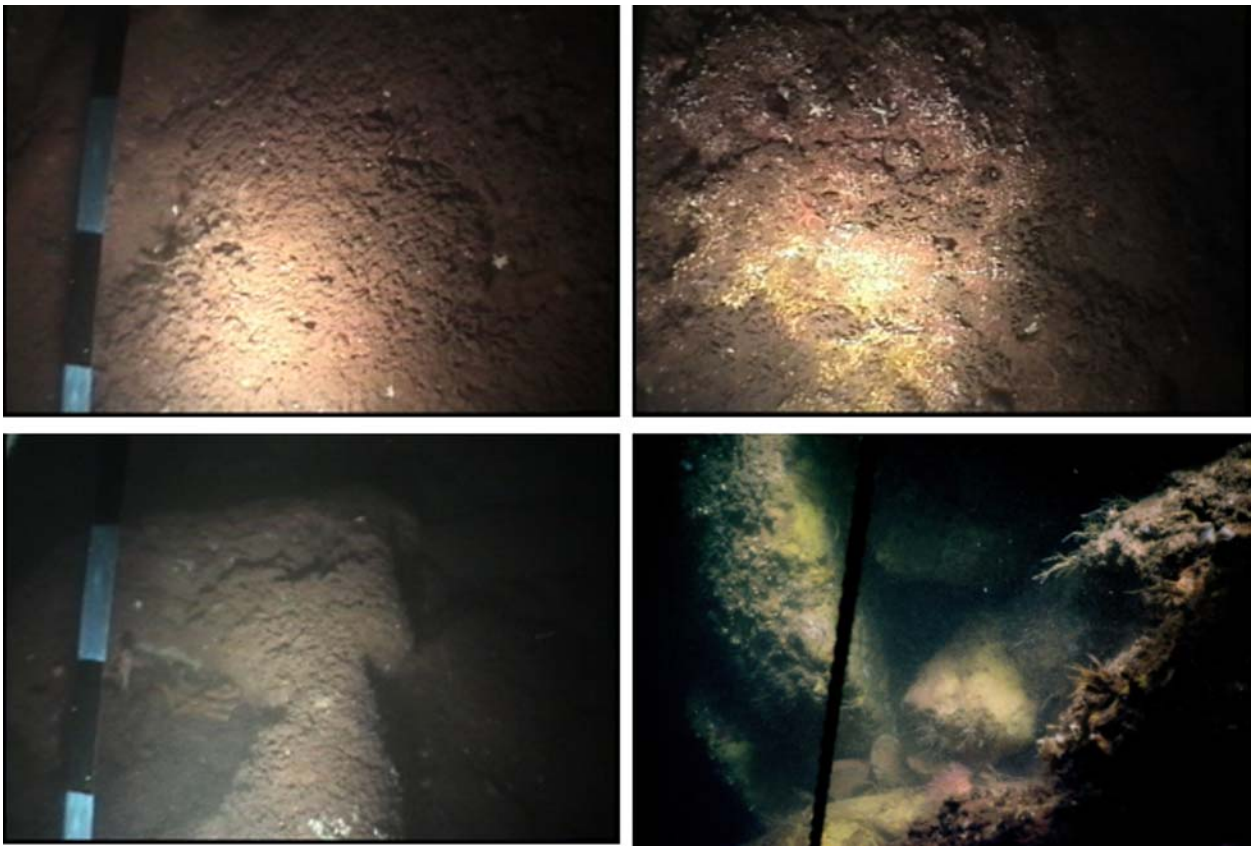

Figure 12. Biological communities on sedimentary bedrock ridges. Upper Left, continuous 'biolayer' of surface dwelling, tube-building organisms, including small hermit crabs. Upper Right, interpreted as patches of biolayer recolonizing a disturbed surface, with small sea stars visible. Lower Left, sedimentary (sandstone) outcrop with heavy 'biolayer' colonization, drift Finger Sponge, and a stalked ascidian, *Boltenia.* Lower Right, crevice in sandstone bedrock outcrop with edge fauna of tube building organisms, encrusting sponges and biolayer.

foliacea) occur on occasional large rocks. Troughs also support low densities of hermit crabs, seastars (*Asterias* sp and the blood star *Henricia sanguinolenta),* and occasional red anemones (*Stomphia* sp). In some of the images, as occurs in the Boulder and Cobble zone nearer shore, colonization of larger rocks by encrusting sponges is limited to above 10-20 from the bottom, suggesting that a bedload of coarse material occurs within that distance of the bottom, and prevents colonization.

Also in the sedimentary troughs, red mudstones frequently show evidence of pits reminiscent of holes bored by boring clams, although there is an alternate geological interpretation that these are fossil root casts. Several species of boring clams are known from Minas Basin in similar rock types in shallow water. One of the only fish seen in the survey, Longhorn sculpin, *Myoxocephalus octodecemspinosus*, occurred in the sedimentary bedrock zone (Figure 15).

Volcanic Bedrock Platform

Volcanic bedrock platforms (Figure 16-20) display a range of surface characteristics, including level platform like formations with cracks, platforms with boulders strewn over top, as well as irregular rocky crags and surfaces. The surface of the platforms range from about 31 to 34 m.

Figure 13. Biological communities of troughs between sedimentary bedrock ridges. Upper left, mostly clean, boulders and cobble with blood star, *Henricia sanguinolenta*, sandstone cobble with 'biolayer' and other organisms. A red mudstone table is uncovered in the lower right corner of the photo. Upper Right, sandstone boulder with biolayer of surface dwelling, tube-building organisms amid smooth cobbles of other types. Lower left, boulders embedded in cobble, one with yellow sponge (*Halichondria* sp) and clean zone at base, believed to be indicative of bedload scour, and one with hermit crab. Lower Right, clean cobble and boulder, including two mudstone cobbles with burrows of boring clams.

Level volcanic bedrock surfaces support a surface biolayer different than that on sedimentary bedrock (typically darker and ressembling short hairs) and characteristically extensive patches of a flat, ridged yellow sponge (*Halichondria* sp). These areas commonly display the blood star *Henricia sanguinolenta* and the red sea anemone, *Stomphia* sp., commonly clustered along cracks. Where bedrock prominences and boulders occur, high concentrations of sponges, barnacles, and *Stomphia* occur, and *Henricia* sea stars occur commonly. On some of the rock prominences, a surface ‘biolayer’ occurs which resembles the one that occurs on sedimentary

Figure 14. Occurrences of mudstone with holes possibly indicating the present or past occurrence boring clams. The holes have also been suggested to be fossil roots.

Figure 15. Longhorn sculpin over sedimentary bedrock ridge. Ridge shows a red anemone, *Stomphia* sp., several encrusting sponges, including Breadcrumb Sponge, a blood star *Henricia sanguinolenta*, baracles and a surface biolayer.

bedrock. Boulders with surface encrustations of sponges often show the absence of the organisms within several centimeters of the seabed, with growth likely prevented by movement of coarse material in bedload several centimeters off the bottom.

Figure 16. Biological communities of volcanic bedrock platform. Upper Left, 'biolayer' type, which occurs on volcanic bedrock, sea anemones (*Stomphia sp)*, and unidentified seastar. Upper right, distribution of patches of *Halichondria* sponge on flat bedrock surfaces, including red *Stomphia* sp anemones. Lower Left, biolayer typical of volcanic bedrock, unidentified sponge, and red *Stomphia* sp. anemones. Lower Right, encrusting sponge, volcanic bedrock 'biolayer', red blood stars (*Henricia sanguinolenta*), unidentified seastar, and red *Stomphia* anemone.

Figure 17. Biological communities on volcanic platform. Encrusting sponge on top of boulders, and both a linear and broader 'biolayer' of tube-building organisms.

Figure 18. Biological communities on boulders and prominences on volcanic bedrock platform.

Figure 19. Volcanic bedrock prominence with encrusting sponge and 'biolayer' similar in appearance to that found on sedimentary bedrock. Red *Stomphia* anemone, edge fauna and some barnacles are also visible.

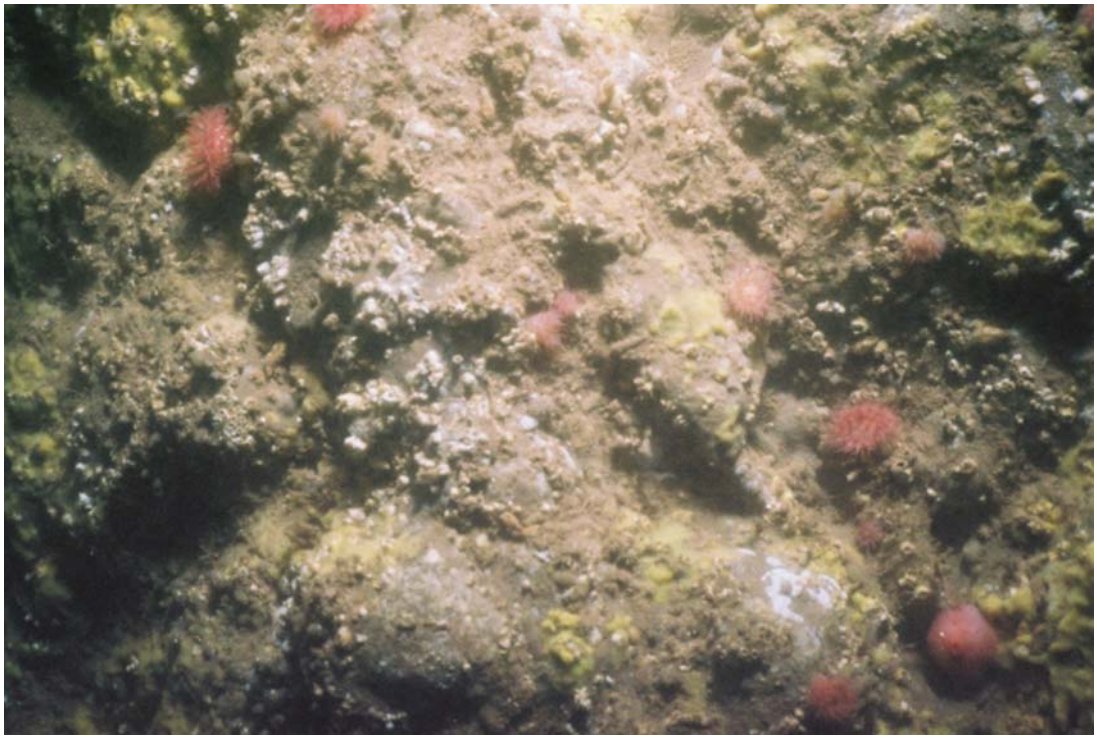

Figure 20. Anemones, sponges, barnacles and biolayer on rough volcanic bedrock.

Dominance of Biological Types

Barnacles and the 'biolayer' on sedimentary bedrock, but occasionally on volcanic rock, were the most frequently encountered biological elements of the study area. Interpreting the occurrence of barnacles in the images was difficult because of their generally small size, and the possible confusion with other small, shelled organisms; hence occurrence may be overestimated. Barnacles occurred in 37.6% of images overall, highest on volcanic bedrock and sedimentary bedrock, 81% and 48% of images respectively (Table 1). The sedimentary 'biolayer' occurred in all areas, predominantly on the sandstone outcrops and associated boulders (35.6% of images).

Of the remaining organisms, hermit crabs occurred in 28.8 % of images overall and in all geological subdivisions; snail-shell like objects in images, which could not be determined to be either snails or hermit crabs inhabiting them, were also common (26.8% of images and all areas); 'edge fauna', filamentous growth protruding from the side of rocks occur in 26.8% of images, most common on volcanic or sedimentary bedrock and in only one image on the shallow gravel to cobble shelf; and unidentified juvenile and adult seastars (24.4% of total, most common on volcanic bedrock platforms (42.9% of images) and on cobble and boulder bottoms (32.6%))(Table 1). White patches of undetermined identity, presumed to be sponges or other encrusting organisms (e.g. bryozoans) occurred on bedrock, boulders, and cobble in all areas, but infrequently on the nearshore shelf.

Three species which were readily identifiable and were also among the most commonly occurring were *Stomphia* (a red sea anemone), a yellow encrusting sponge characterized by surface ridges, and the blood star, *Henricia sanguinolenta*, occurring in 16-17% of images. Of the three species, only *Henricia* occurred on the nearshore shelf. *Stomphia* and the sponge were particularly common on the volcanic platform, and *Henricia* was relatively common there (28.6% of images) (Table 1).

Community Characteristics

Each of the major geological categories for the study area demonstrated characteristic species which most commonly occurred there. Arranged by area, these included:

*Volcanic Platform—B*ased on frequency of occurrence in images, barnacles, the yellow, ridged encrusting sponge, and *Stomphia* sp, were the dominants, characterizing the volcanic platform community. Other groups, which occurred quite frequently, included unidentified small organisms forming a layer on rock surfaces (possibly an encrusting sponge or bryozoan), unidentified juvenile and adult seastars, the 'edge fauna', breadcrumb sponge, and *Henricia* (Table 2).

Sedimentary Outcrops and Troughs—The 'biolayer' formed on surfaces of sedimentary outcrops occurred most frequently in this area, but barnacles, 'edge fauna', and snail shells either containing snails or (likely) hermit crabs, were also common (Tables 1 & 2). An unidentified organism causing white patches on the rocks, hermit crabs, *Henricia*, and unidentified seastars,

Table 1. Relative occurrence of biological organisms and features in seabed photographs from Minas Passage study site, August & September 2008.

Geological Subdivision	Volcanic Bedrock Platform		Sedimentary Bedrock Outcrops and Troughs		Deep Unconsolid-ated Cobble & Boulder		Shallow Unconsolid-ated Shelf		Total	
Total Photos Analyzed	21		102		46		36		205	
Number and % of images in which organism occurs	No.	%	No.	%	No.	%	No.	%	No.	%
Communities										
Edge fauna[1]	9	42.9	41	40.2	4	8.7	1	2.8	55	26.8
Biolayer[2], Volcanic Type	9	42.9	0	0.0	0	0.0	0	0.0	9	4.4
Biolayer, Sedimentary Type	5	23.8	55	53.9	9	19.6	4	11.1	73	35.6
Biolayer, Sedimentary Type, small patches	0	0.0	6	5.9	3	6.5	0	0.0	9	4.4
Linear Biolayer	1	4.8	4	3.9	1	2.2	0	0.0	6	2.9
Encrusting Organisms										
Breadcrumb Sponge	7	33.3	12	11.8	2	4.3	0	0.0	21	10.2
White encrusting sponge/White Patches[3]	2	9.5	33	32.4	10	21.7	1	2.8	46	22.4
White sponge, similar to Breadcrumb	1	4.8	1	1.0	0	0.0	0	0.0	2	1.0
Yellow encrusting sponge unidentified	0	0.0	19	18.6	4	8.7	4	11.1	27	13.2
Yellow ridged sponge	16	76.2	4	3.9	14	30.4	0	0.0	34	16.6
Brown encrusting sponge	1	4.8	0	0.0	0	0.0	0	0.0	1	0.5
Red encrusting sponge	0	0.0	1	1.0	0	0.0	0	0.0	1	0.5
Encrusting bryozoan	0	0.0	0	0.0	0	0.0	1	2.8	1	0.5
Solitary Organisms										
Barnacles	17	81.0	49	48.0	6	13.0	5	13.9	77	37.6
Red Anemone (*Stomphia sp)*	15	71.4	11	10.8	9	19.6	0	0.0	35	17.1
Henricia sanguinolenta	6	28.6	23	22.5	3	6.5	1	2.8	33	16.1
Seastar juv & adult unidentified	9	42.9	22	21.6	15	32.6	4	11.1	50	24.4
Tunicates	1	4.8	0	0.0	0	0.0	0	0.0	1	0.5
Hermit Crab	1	4.8	30	29.4	15	32.6	13	36.1	59	28.8
Hermit Crab or Snail	2	9.5	41	40.2	12	26.1	0	0.0	55	26.8
Boltenia ovifera	0	0.0	15	14.7	3	6.5	2	5.6	20	9.8
Finger Sponge (drift)	0	0.0	4	3.9	0	0.0	0	0.0	4	2.0
Linear worm tube	1	4.8	0	0.0	0	0.0	0	0.0	1	0.5
Bivalve unid	0	0.0	1	1.0	0	0.0	0	0.0	1	0.5
Flustra foliacea	0	0.0	2	2.0	6	13.0	12	33.3	20	9.8

Table 1 (continued). Relative occurrence of biological organisms and features in seabed photographs from Minas Passage study site, August & September 2008.

Geological Subdivision	Volcanic Bedrock Platform		Sedimentary Bedrock Outcrops and Troughs		Deep Unconsolid-ated Cobble & Boulder		Shallow Unconsolid-ated Shelf		Total	
Number and % of images in which organism occurs	No.	%	No.	%	No.	%	No.	%	No.	%
Hydroids?	0	0.0	1	1.0	0	0.0	0	0.0	1	0.5
Boring clams[4]	0	0.0	2	2.0	0	0.0	0	0.0	2	1.0
Sponge unid.	0	0.0	1	1.0	0	0.0	0	0.0	1	0.5
Mussel	0	0.0	1	1.0	0	0.0	0	0.0	1	0.5
Asterias sp	0	0.0	3	2.9	0	0.0	0	0.0	3	1.5
Seaweeds										
Fucus sp.	0	0.0	0	0.0	0	0.0	23	63.9	23	11.2
Coralline Algae (*Lithothamnium*)	0	0.0	0	0.0	0	0.0	16	44.4	16	7.8
Palmaria palmata (dulse)	0	0.0	0	0.0	0	0.0	10	27.8	10	4.9
Fish										
Blenny?	1	4.8	0	0.0	0	0.0	0	0.0	1	0.5
Fourhorn Sculpin	0	0.0	1	1.0	0	0.0	0	0.0	1	0.5

1. Organisms projecting from sides of rocks, including the bryozoan *Flustra foliacea* and fine tubes, possibly polychaetes.
2. Biolayers at the site is a thin, continuous or linear layer of (presumably) tube-building organisms such as amphipods and polychaetes.
3. White patches were observed infrequently on rocks, presumed to be sponges.
4. Living or dead burrows could not be distinguished.

were also common. Other organisms present at lesser frequencies include several species common to other areas, including the stalked Ascidian *Boltenia ovifera*, Breadcrumb sponge, and *Stomphia* sp.

Several rock samples were dredged from this area, which supported the amphipod *Jassa falcata,* hydroids (*Eudendrium arbusculum*), the attached gastropods *Anomia squamula* and *A. simplex,* various polychaete worms, some bivalve spat (early settled and attached stages) and the barnacle *Semibalanus balanoides* (Table 3). Some of the mudstones observed at the site had holes similar to those created by boring clams (Figure 14), also interpreted as fossil roots (G. Fader, Atlantic Marine Geological Consulting, personal communication 2008).

Deep Unconsolidated Boulder and Cobble—The commonly occurring elements of the community on this bottom type were hermit crabs (as well as objects thought to be snail shells either containing live snails or hermit crab); unidentified seastars; and a yellow, ribbed encrusting sponge (*Halichondria* sp), typically on occasional rock surfaces, as well as white

patches on the rocks. The 'biolayer' characteristic of the sedimentary outcrops area, and *Stomphia* sp., also occurred relatively frequently (Table 1).

Table 2. Benthic communities in the Minas Passage study area.

Community/Area	Depth (m)[1]	Substrate	Seaweeds	Macrofauna
Unconsolidated Sediments				
Coastal Platform-Intertidal	HWM to MLW	Level gravel to occasional cobble & boulder	Patchy rockweed (*Fucus* sp) & *Ulva lactuca* on flats. Includes *Ascophyllum* in tide pools.	Low abundance of amphipods, periwinkles, barnacles.
Coastal Platform – Subtidal	MLW - 6.5 m	Gravel to cobble.	Coralline algae, occasional rockweed (*Fucus).*	Barnacles, bryozoans (*Flustra),* rock surface community.
Slope and toe of Coastal Platform	6.5 - 25 m	Stable gravel to cobble.	Coralline algae, occasional rockweed (*Fucus).*	Rock surface community (tube builders).
Shallow Nearshore (Cobble/ Boulder)	25 – 50 m	Cobble to boulder, occasional gravel, minor sand	No seaweeds.	Breadcrumb sponge, sea stars (*Asterias),* bryozoans (*Flustra*), rock surface community (tube builders), mobile epifauna (e.g hermit crabs)
Bedrock				
Offshore Sandstone Bedrock ridges	45 – 50 m	Rough sandstone/ mudstone ridges separated by bands of cobble and boulder.	No seaweeds.	Breadcrumb sponge, seastars (*Asterias, Henricia*), rock surface community (tube builders (e.g. amphipods, *Jassa* sp), hydroids, attached bivalves (e.g. *Anomia*).
Offshore Volcanic Bedrock Plateau	31 - 34 m	Rough basalt commonly overlain by smooth basalt boulders.	No seaweeds.	Breadcrumb sponge, encrusting sponges, barnacles, sea anemones (*Stomphia),* seastars *Henricia* sp, patchy surface tube builders (amphipods/polychaetes), barnacles.

1. Depth below mean low water (MLW)

Table 3. Benthic organisms found on rocks dredged in sedimentary outcrops Stations 1 and 7, August 19 & 20, 2009 (number or organisms in brackets).

Station 1	Station 7, Sandstone Cobble	Station 7, Basalt Cobble
Bryozoan -Flustra foliacea	Hydroid Unidentified	Bryozoan unidentified
Hydroid – *Eudendrium arbusculum?*	Amphipods: *Jassa falcata* (23), *Corophium insidiosum* (1)	Amphipods: *Jassa falcata* (4)
Ascidian – *Ascidia callosa.*	Barnacles: *Semibalanus balanoides (*43)	Hydroid: *Eudendrium? sp*
	Snails (Jingle shells): *Anomia squamula* (1); *Anomia simplex* (1).	Polychaete worm fragment
	Clams: Horse mussel spat - *Modiolus modiolus (1)*	Bivalve spat (2)
	Polychaete worms: *Lepidonotus squamatus* (1); Terebellidae (1); Goniadidae (1); Maldanidae (1); *Spirorbis* (1); Ampharetidae (1)	
	Encrusting sponge, white (1); brown (1)	

Shallow Unconsolidated Shelf—Bladderwrack rockweed (*Fucus* sp.) occurred with greatest frequency; and a coralline algae (probably *Lithothamnium*) occurred in 44% of images, all in the outer edge of the shelf and slope at the site. Hermit crabs, the bryozoan *Flustra foliacea*, and dulse (*Palmaria palmata*) also occurred relatively frequently (Table 1).

Relationship of Biological Communities to Depth

The project area extends from shallows near mean low water on the nearshore platform, to deeper areas on the southern margin of the zone of sedimentary bedrock at depths greater than 50 m (Figure 21). Most of the study area is relatively deep, gradually increasing in depth to the southwest from the bottom of the shelf slope, where depth is 16 to 20 m depending on location, towards the central axis of Minas Passage. The slope edge of the nearshore shelf is at 8-9 m below MLW. From the base of the slope, the zone of unconsolidated cobble/boulder begins. This area, across which the cables will be routed, increases in depth to the southwest to the edge of the sedimentary bedrock at roughly 40-45 m below MLW. The sedimentary bedrock is relatively level, ranging from about 45 m to more than 50 m in the study area, across a highly irregular surface of bedrock ridges and troughs. The volcanic bedrock shelf is shallower (31-34 m), and gradually increases in depth to the west. Shallower water on the volcanic platform most likely will have an effect on bottom communities compared to the deeper communities on the sedimentary bedrock, but it is not possible to separate the effect, due to the variability and quality of the data, as well as the different substrate type and topography.

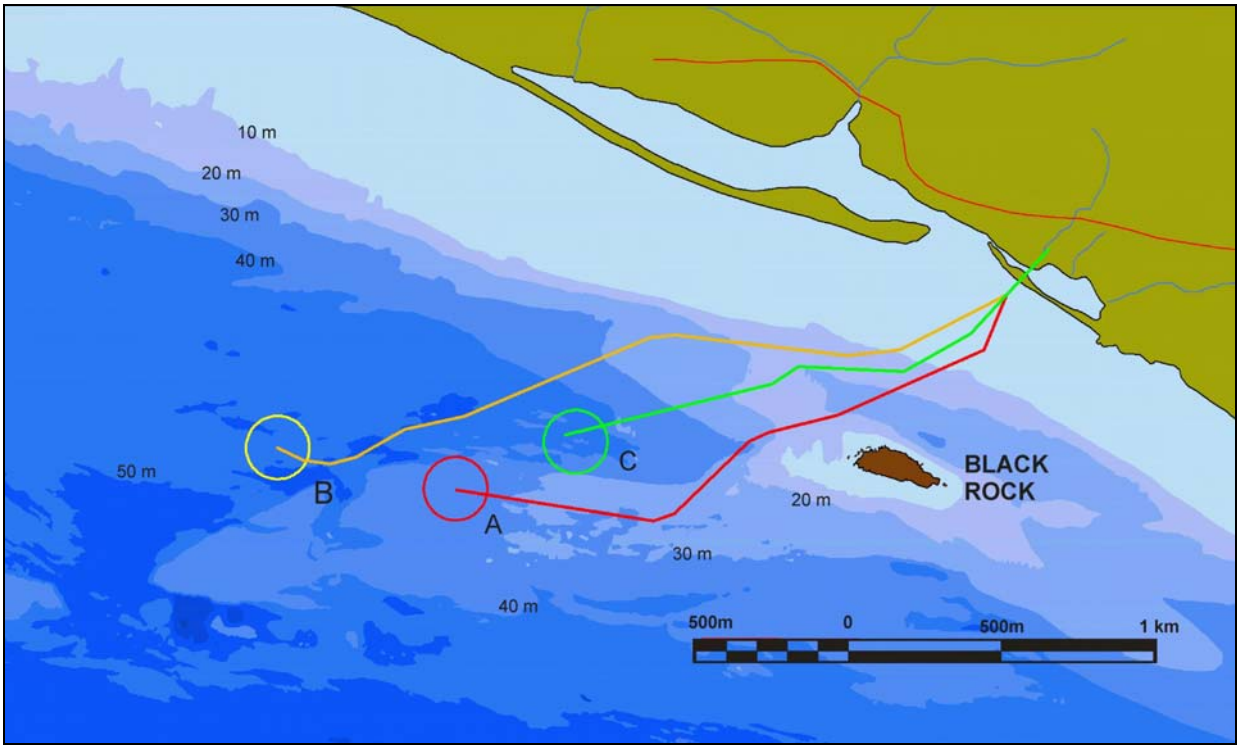

Figure 21. Depth distribution in study area (metres below MLW), installation sites, and proposed cable routes.

Primary factors in determining differences in communities relative to depth, including light penetration, temperature stratification, and food availability (in addition to changes in substrate type with depth) are mitigated by the rapid mixing at the site, which creates uniform temperatures through the water column and, possibly, exposure to particle (food) regimes which are likely not dependent on depth.

Distinct biological zonation is observed in a collection of video images extending from mean low water (MLW) to the edge of the nearshore shelf and down the slope to the point where it meets the unconsolidated boulder and cobble zone which characterizes the seabed between the shelf and the offshore bedrock areas (Figures 22-29). On the shelf, the biological community is characterized by occurrence of patches of rockweed (*Fucus* sp)(Figures 24 & 25). Below a depth of about 5 metres below MLW to about 7 m, substrate changes to predominantly cobble which supports several species of seaweeds (*Fucus*, *Palmaria,* and encrusting coralline algae (*Lithothamnium),* and includes hermit crabs (Figures 26 & 27)). Below this area, a mixed zone of cobble and boulder occurs (Figure 28), with a moderate diversity of organisms. This area appears to be productive and continues to support seaweeds such as *Palmaria palmata*. Lower on the shelf, cobble & boulder bottom is dominated by the biolayer community and seaweeds are no longer present (Figures 29-30).

4. CONCLUSIONS

Seabed communities at the proposed site tidal power demonstration project in Minas Passage show a moderate diversity of organisms visible and identifiable in video and photographs. Bottom sampling also revealed presence of various small invertebrates on the surface of rocks, typical of epifaunal communities in the Bay of Fundy. Overall, it can be presumed that the area supports an ecosystem that functions in the presence of the high tidal currents that characterize the area. A surface ‘biolayer’ of small tube building organisms, visible in images from the site, appears to be an important constituent of the community in areas of sedimentary and volcanic bedrock outcrops. Areas characterized by cobble and boulder, as well as inner parts of the nearshore shelf, support lower abundances and fewer types of organisms, and the extent of areas occupied by ‘biolayer’ organisms is lower in these places. The outer edge of the nearshore platform and slope on cobble bottom supports a subtidal seaweed community. Outwardly the types of organisms occurring at the site are representative of types which occur in Nova Scotia waters; however the uniqueness of the current regime at the site (i.e. the highest tides) may result in unique features, such as the biolayer fauna and the possibility of the occurrence of boring clams, on sedimentary bedrock outcrops, and the community dominated by anemones, encrusting sponges and seastars, on volcanic bedrock platforms at some of the highest current velocities, which may represent features which are unique from a conservation perspective.

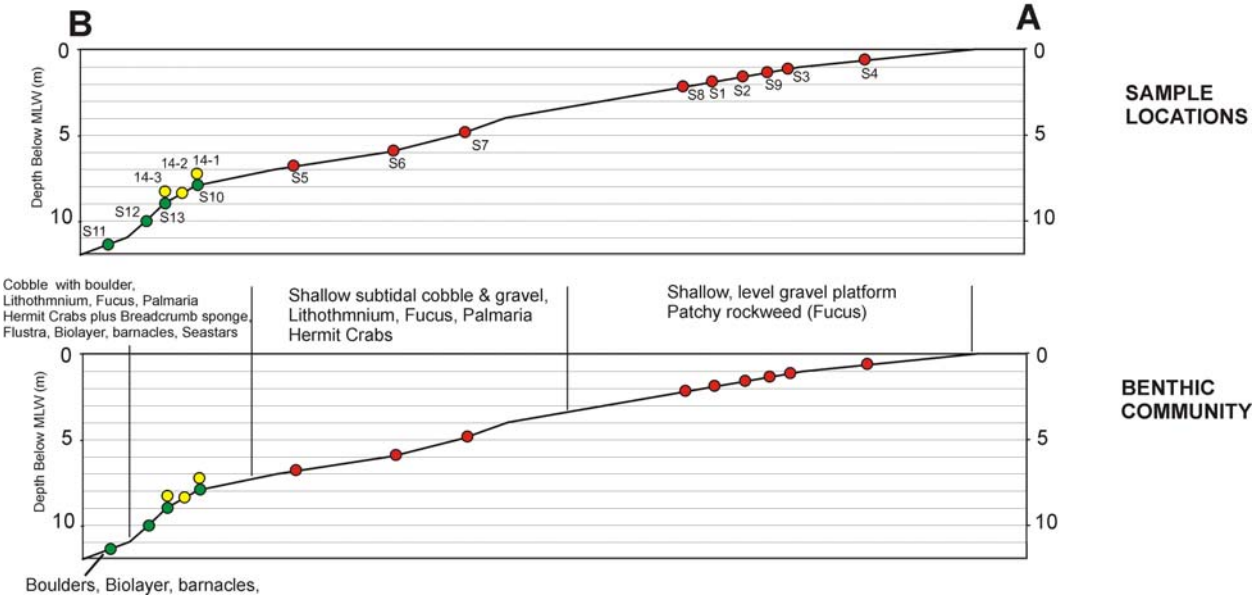

Figure 22. Cross-section of the nearshore shelf in the vicinity of the proposed cable corridor, showing seabed communities. Locations of stations used to determine the zonation for the site are shown in Figure 23.

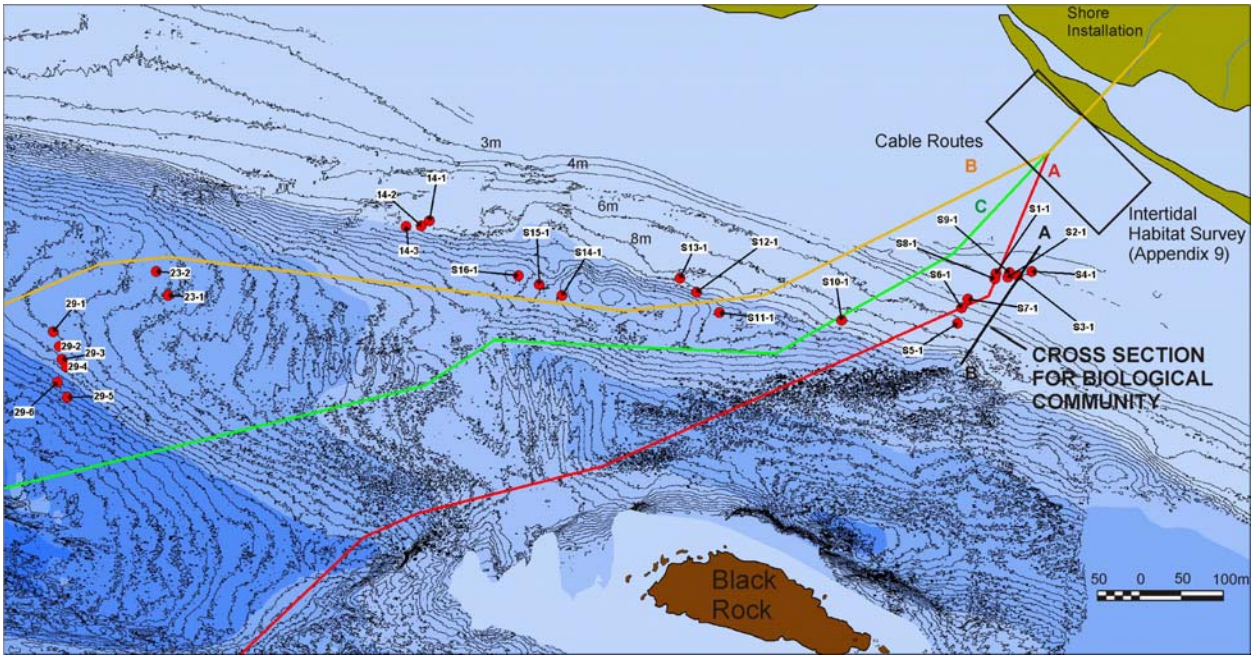

Figure 23. Location of sample cross-section to determine zonation of biological communities in the vicinity of the cable route.

Figure 24. Communities in relation to depth across nearshore shelf. Level gravel on the upper subtidal platform of the shelf at the shore installation site, Station S1. See Figures 22 & 23 for location.

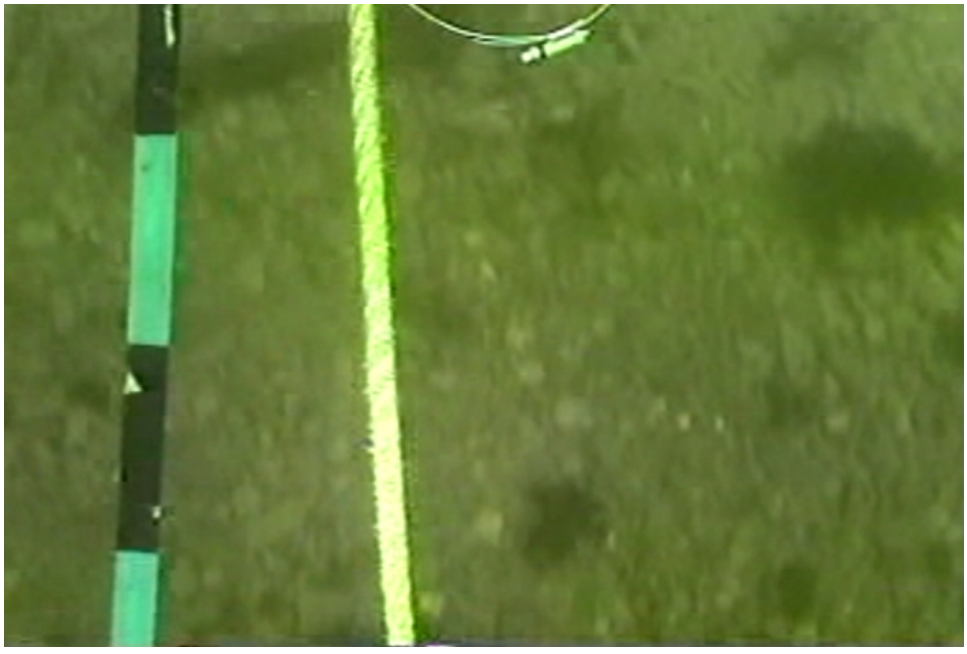

Figure 25. Level gravel with clumps of rockweed, *Fucus* sp, characteristic of the inner shelf (Station S1) at the shore installation site.

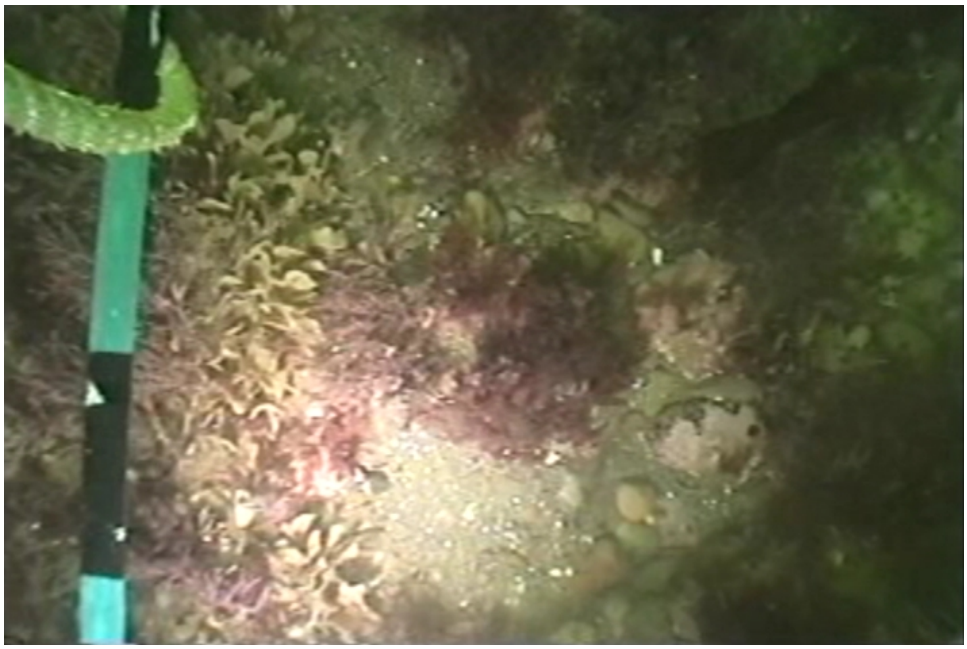

Figure 26 Development of the bryozoan *Flustra* sp, dulse (*Palmaria palmata)* and coralline algae on cobble at Station S6, in the middle of the nearshore shelf.

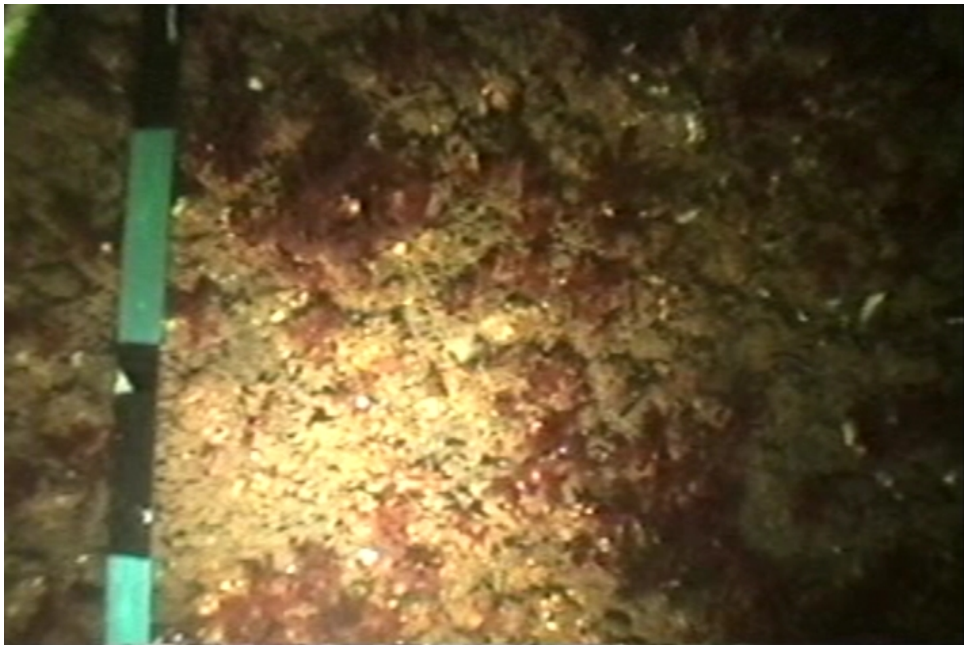

Figure 27. Biological community at Station S10, located near edge of nearshore shelf. Red seaweed, which is visible is dulse, *Palmaria palmata.*

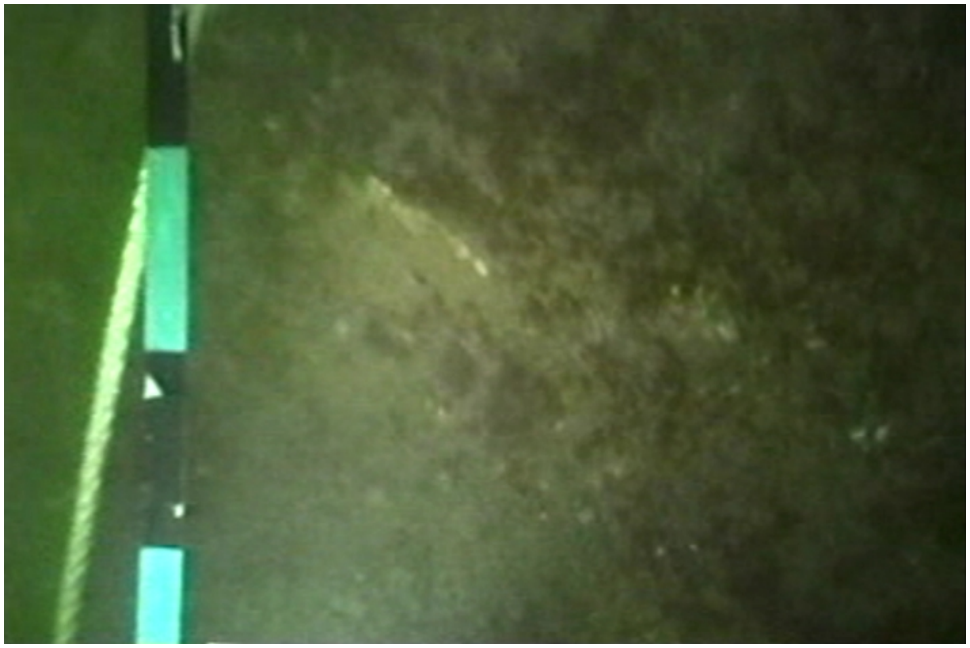

Figure 28. Cobble/boulder bottom at Station S10, on seaward slope of nearshore shelf.

Figure 29. Boulder and ‘biolayer’ community on a boulder located on the slope of the nearshore shelf, Station S11.

Figure 30. Boulder and cobble on lower slope of nearshore shelf, Station S12.

5. REFERENCES

Bousfield, E.L. and A.H. Leim. 1958. The Fauna of Minas Basin and Minas Channel. National Museum of Canada, Bulletin 166.

Bousfield, E.L. 1960. Canadian Atlantic Sea Shells. National Museum of Canada, Ottawa.

Envirosphere Consultants Limited and Oceans Limited. 2008a. Seabed Video Survey, Bottom Sampling, Oceanographic Measurements, Sound Levels & Current Meter Deployment—Minas Passage Study Site. August 18-20, 2008. Report to Minas Basin Pulp and Power Ltd.

Envirosphere Consultants Limited and Oceans Limited. 2008b. Seabed Video Survey, Oceanographic Measurements, Sound Levels & Current Meter Retrieval—Minas Passage Study Site. September 23-25, 2008. Report to Minas Basin Pulp and Power Ltd.

Fader, G.B.J. 2009. Appendix 3, Geology, Bathymetry, Ice and Seismic Conditions. Final Report to Minas Basin Pulp and Power Ltd, Bay of Fundy Tidal Power Project.

Wildish, D.J., D.L. Peer, A.J. Wilson, J. Hines, L. Linkletter and M.J. Dadswell. 1983. Sublittoral Macro-infauna of the upper Bay of Fundy. Can. Tech. Rep. Fish. Aquat. Sci. 1194.

APPENDIX A—ABUNDANCE AND COMPOSITION OF ORGANISMS IN SEABED IMAGES.

Table A1. Biological communities on seabed at proposed site of tidal power demonstration facility, Minas Passage, from survey conducted August & September 2009. Geological regions: 1=volcanic bedrock; 2=sedimentary ridges and troughs; 3=deep unconsolidated boulder/cobble; 4= shallow unconsolidated shelf and slope. Depth in metres below MLW. Abundance codes: (c) common; (a) abundant; (o) occasional; (r) rare.

Cruise	Station	Image Number	Geological Region	Description	Biological Community	Depth (m)	Comment
AUG08	9-1	9-1a	1	smooth boulders	yellow sponge ridged 25%	32.4	bedload effect, sponge only on top of rock
AUG08	9-1	9-1b	1	smooth boulders	yellow sponge ridged 25% linear biolayer 5% Barnacle (*B. crenatus*)	32.4	bedload effect, sponge only on top of rock
AUG08	9-2	9-2a	1	Fractured ed bedrock surface	yellow sponge ridged 80%	32.0	
AUG08	9-3	9-3a	1		yellow sponge 10% White fleck (Hermit crab/barnacle) Edge fauna, tube strings?	32.4	poor visibility
SEP08	31-1	31-1	1	volcanic bedrock table	yellow encrusting sponge 70% barnacle (c) red anemone 5	31.2	
SEP08	31-2	31-2	1	volcanic bedrock table	yellow encrusting sponge 5% brown encrusting sponge <1% barnacle (c) red anemone 16 biolayer volcanic type 90% Henricia 7	31.4	
SEP08	31-3	31-3	1	volcanic bedrock table	yellow encrusting sponge 5% barnacle (o) red anemone 7 biolayer volcanic type probable Henricia 9	31.3	higher concentrations of anemones in cracks in rocks.
SEP08	31-4	31-4	1	volcanic bedrock table	yellow encrusting sponge 20% biolayer volcanic type probable Henricia 2 red anemone 13 seastar juv 2	31.7	patchy concentration of yellow encrusting sponge; bedload effects on sponge
SEP08	31-5	31-5	1	volcanic bedrock table	yellow ridged encrusting sponge 15% biolayer volcanic type Henricia 4 red anemone 21 seastar juv 4 barnacles (c) edge fauna with tubes (r) tunicates? 10	35.5	boulder and some cobble to gravel sitting on bedrock table
SEP08	31-6	31-6	1	volcanic bedrock table	yellow ridged encrusting sponge 40% biolayer volcanic type probable Henricia 2 red anemone 1 seastar juv 3 barnacles (c) hermit crab? 1	35.5*	some bedload efect on sponge on boulder

Table A1. Biological communities on seabed at proposed site of tidal power demonstration facility, Minas Passage, from survey conducted August & September 2009. Geological regions: 1=volcanic bedrock; 2=sedimentary ridges and troughs; 3=deep unconsolidated boulder/cobble; 4= shallow unconsolidated shelf and slope. Depth in metres below MLW. Abundance codes: (c) common; (a) abundant; (o) occasional; (r) rare.

Cruise	Station	Image Number	Geological Region	Description	Biological Community	Depth (m)	Comment
SEP08	32-1	32-1	1	volcanic bedrock boulders	yellow ridged encrusting sponge 90% biolayer volcanic type probable Henricia 1 red anemone 9 barnacles (o) edge fauna tubes	29.7	
SEP08	32-2	32-2	1	volcanic bedrock with large boulder boulders	yellow ridged encrusting sponge 60% biolayer volcanic type probable red anemone? 4 barnacles (o) hermit crab? 1	28.9	
SEP08	32-3A	32-3A	1	volcanic boulders & cobble between	yellow ridged encrusting sponge 30% biolayer volcanic type probable barnacles (a) seastar? 1	28.9	
SEP08	32-3B	32-3B	1	volcanic outcrop	yellow ridged encrusting sponge 20% biolayer volcanic type probable barnacles (a) red anemone 2	28.4	
SEP08	32-4	32-4	1	volcanic outcrop	yellow breadcrumb sponge 15% biolayer sedimentary type barnacles (a) edge fauna tubes red anemone 3 seastar unid 2	28.4	
SEP08	37-1	37-1	1	volcanic outcrop	yellow breadcrumb sponge 25% white sponge 15% barnacles (o) edge fauna tubes (o) red anemone 6 Hermit crab/gastropod 2	31.8	
SEP08	37-2	37-2	1	volcanic outcrop	yellow breadcrumb sponge 15% white encrusting sponge 5% barnacles (o) edge fauna tubes (o) red anemone 3 seastar juv 1	34.3	
SEP08	37-3	37-3	1	volcanic outcrop	yellow breadcrumb sponge 5% barnacles (a) red anemone 12 seastar juv 1 biolayer sedimentary probable	38.7	
SEP08	37-4	37-4	1	volcanic outcrop	yellow breadcrumb sponge 25% barnacles (a)	40.8	

Table A1. Biological communities on seabed at proposed site of tidal power demonstration facility, Minas Passage, from survey conducted August & September 2009. Geological regions: 1=volcanic bedrock; 2=sedimentary ridges and troughs; 3=deep unconsolidated boulder/cobble; 4= shallow unconsolidated shelf and slope. Depth in metres below MLW. Abundance codes: (c) common; (a) abundant; (o) occasional; (r) rare.

Cruise	Station	Image Number	Geological Region	Description	Biological Community	Depth (m)	Comment
					red anemone 11 edge fauna tubes (o) biolayer sedimentary (20%) seastar juv 1 blenny? 1		
SEP08	37-5	37-5	1	volcanic outcrop	yellow breadcrumb sponge 40% barnacles (o) biolayer sedimentary probable edge fauna tubes (o)	40.0	
SEP08	37-6	37-6	1	volcanic outcrop & crevice	yellow breadcrumb sponge 50% barnacles (a) biolayer sedimentary 30% edge fauna tubes (o) red anemone 3 seastar juv 1 hermit crab 1 white patches (sponge) <1% linear worm tube on rock surface	40.0*	
AUG08	1-2	1-2b	Sedimentary Bedrock Outcrops and Troughs	rounded, unidentified	edge fauna Henricia? 1 white fleck (Hermit crab or snail) (o) biolayer (95%)	45.8	rounded boulder on level fractured bedrock. Thin coating on rocks with white patches. Hairy film (possibly also Flustra) in crevices and spaces between rocks.
AUG08	1-3	1-3a	2	sandstone bedrock and boulders	Hermit crab 1 biolayer 85 white flecks (barnacles?) (o) breadcrumb sponge (10%)	46.1	hermit crab in whelk shell. Bedrock
AUG08	1-3	1-3b	2	sandstone	hermit crab 2 white flecks (barnacles/snails) (c) sponge, breadcrumb 15% biolayer (85%) edge community	46.1	close up of sandstone boulder, covered with find gray brown tubes.
AUG08	1-3	1-3c	2	sandstone, level with cobble.	Boltenia 1 white flecks (Hermit crab/snail) (o) white flecks (barnacles) (c) sponge, breadcrumb 10% edge filaments red anemone 1	46.1	level, fractured bedrock table; biolayer; Boltenia in rock crevice see next frame;
AUG08	1-3	1-3d	2	sandstone	Boltenia 1 White flecks (hermit crab/snail) (o) White flecks (barnacles) (c) Biolayer (95%)	46.1	Rock type similar to previous image
AUG08	1-3	1-3e	2	sandstone	Henricia 1	46.1	Partial overlap with previous

Table A1. Biological communities on seabed at proposed site of tidal power demonstration facility, Minas Passage, from survey conducted August & September 2009. Geological regions: 1=volcanic bedrock; 2=sedimentary ridges and troughs; 3=deep unconsolidated boulder/cobble; 4= shallow unconsolidated shelf and slope. Depth in metres below MLW. Abundance codes: (c) common; (a) abundant; (o) occasional; (r) rare.

Cruise	Station	Image Number	Geological Region	Description	Biological Community	Depth (m)	Comment
					Red anemone 1 White flecks (Hermit crab/Snail) (o) Biolayer (95%) Edge community Boltenia 3		
AUG08	1-3	1-3h	2	sandstone bedrock sandstone cobble	Boltenia 1 biolayer 50% red anemone? 1 breadcrumb sponge 1%	46.1	large sandstone outcrop, rough surface, pocked surface etc. Smaller smooth large cobble; edge crevice fauna present. Patchiness of biolayer
AUG08	1-3	1-3i	2		Boltenia 1 Crevice filaments biolayer (95%)	46.1	close up of previous crevice communtity, crevice tubes biolayer with irregular coating. Irregular white patches, scuffing
AUG08	1-repeat-2	1-repeat 2b	2	smooth sandstone	Boltenia 1 White Fleck (Hermit crab/snail) white patches on rocks (o) sponge, yellow 1%	45.8	closer view of previous photo dim and distant view of boulders occasional flecks
AUG08	1-repeat-2	1-repeat 2d	2	rounded to subangular large cobble of mixed types; mixed gravel types.	white patches (sponge?) edge fauna (small amt) filaments white fleck (Hermit crab/snail)	45.8	closer view of previous photo next one in sequence as well white patches on smooth boulders, some edge fauna smooth boulders possible 3 hermit crabs
AUG08	1-repeat-3	1-repeat 3a	2	packed large cobble sandstone and other types.	yellow sponge patches (1%) white patches (o)	46.1	smooth boulders, occasional yellow patches
AUG08	1-repeat-3	1-repeat 3b	2	bedrock siltstone, mudstone cobble of mixed types.	hermit crab 1 Boltenia 1 yellow sponges (1%)	46.1	smooth surfaces, occasional yellow patches; hermit crab. Current strong. possibly 3 extra 3 hermit crabs
AUG08	2-1	2-1a	2	sandston, rounded cobble of other	hermit crab 1 sea star juv 2 white flecks (barnacle,snail) (o)	44.5	smooth rounded surface with biolayer. White flecks? Snails? Henricia? In lower right. Small bumps which could be snails
AUG08	2-1	2-1b	2	sandstone/siltstone	sea star juv 2 biolayer (100%) edge fauna filaments	44.5	close up of previous photo; smooth rounded surface with biolayer. Some edge fauna White flecks? Snails? Henricia? In lower right. Small bumps which could be snails
AUG08	2-2	2-2a	2	sandstone, siltstone	Boltenia 1 drift? Finger sponge 1 Henricia 2 bioflayer 100 %	44.5	Elongate bedrock with depression. Drift Finger? Sponge in rock depression Henricia in 2 depressions (video). Red anemone?

Table A1. Biological communities on seabed at proposed site of tidal power demonstration facility, Minas Passage, from survey conducted August & September 2009. Geological regions: 1=volcanic bedrock; 2=sedimentary ridges and troughs; 3=deep unconsolidated boulder/cobble; 4= shallow unconsolidated shelf and slope. Depth in metres below MLW. Abundance codes: (c) common; (a) abundant; (o) occasional; (r) rare.

Cruise	Station	Image Number	Geological Region	Description	Biological Community	Depth (m)	Comment
AUG08	2-3	2-3a	2	mixed, stly smooth surfaces.	establishing biolayer & linear biolayer edge fauna minimal juv sea stars 2	44.5	biolayer tracks smooth large cobbles some edge fauna strong currents visible in DVD hermit crab in video upper left
AUG08	2-4	2-4a	2	sandstone	biolayer 'colonies' white flecks (barnacles,snails) (a)	44.5	mottled biolayer patches, 1-3 cm dia. porous sandstone bedrock
AUG08	2-4	2-4c	2	sandstone	biolayer patches white flecks (Hermit crab/gastropod)(o) small white flecks (barnacles) (c)	44.5	jagged sandstone bedrock biolayer patches
AUG08	3-1	3-1a	2	sandstone & other	white flecks (barnacles) (a) seastar? 1 white flecks (Hermit crab/gastropod) (o) edge fauna	46.6	chasm between bedrock & boulders. Possible Mudstone minimal edge community
AUG08	3-1	3-1b	2	sandstone & other	white flecks (barnacles) (a) seastar? 1 white flecks (Hermit crab/gastropod) (o) edge fauna white patches (sponge) <1%	45.7	overlaps 3-1a chasm between bedrock & boulders. Possible Mudstone minimal edge community
AUG08	3-2	3-2b	2	sandstone & other, mostly smooth non sedimentary orcks	Hermit crab 1 bivalve shell (Pandora) 5 cm. edge fauna incl Flustra (o) yellow sponge hydroids on rocks (c)	44.9	part of previous image, sponge and edge community on elevated projecting large cobble
AUG08	3-3	3-3a	2	sandstone & other, mostly smooth non sedimentary orcks	hermit crab 1 yellow sponge <1% white patches (sponge)	45.9	largely bare smooth surfaces of cobble, elongate rough cobble (sandstone?) orange seastar seastar-like structure engulfing snail with hermit crab sponge and edge community on elevated projecting large cobble
AUG08	4-1	4-1a	2	sandstone	white patches (sponge) Henricia 1 hermit crab 1 seastar juv? 1	47.6	upper surface of bedrock outcrop (sandstone?)
AUG08	4-2	4-2b	2	sandstone	white flecks (barnacles) (c) no biolayer	45.9	upper surface of bedrock outcrop (sandstone crag)
AUG08	4-2	4-2c	2	sandstone	biolayer 50% biolayer patches (o) white flecks (barnacles) (c) edge fauna Boltenia 1	45.9	flat sandstone surface outcrop (sandstone crag)
AUG08	4-2	4-2d	2	sandstone bedrock, pitted	biolayer 50% continuous biolayer patches (o) (correspond to pits in sandstone bedrock)	45.9	sandstone outcrop (sandstone crag) patches of biolayer corresponding to pits in bedrock

Table A1. Biological communities on seabed at proposed site of tidal power demonstration facility, Minas Passage, from survey conducted August & September 2009. Geological regions: 1=volcanic bedrock; 2=sedimentary ridges and troughs; 3=deep unconsolidated boulder/cobble; 4= shallow unconsolidated shelf and slope. Depth in metres below MLW. Abundance codes: (c) common; (a) abundant; (o) occasional; (r) rare.

Cruise	Station	Image Number	Geological Region	Description	Biological Community	Depth (m)	Comment
					white flecks (barnacles) (o) white fleck (Hermit crab/snail) 1 sea star juv 2		
AUG08	4-3	4-3a	2	sandstone	biolayer 80 white flecks (barnacles) ©	45.9	upper surface of bedrock outcrop (sandstone crag) poor visibility
AUG08	5-1	5-1a	2	sandstone bedrock	biolayer 50% continuous white flecks (barnacles) (a) Hermit crab 1 Boltenia 1 sea star juv 5 Henricia 1 edge community	46.2	sandstone outcrop (sandstone crag) closeup of previous frame continuous biolayer and occasional small patches texturing that could be dense barnacles
AUG08	5-1	5-1b	2	sandstone bedrock, pitted	biolayer 50% continuous biolayer patches (o) white flecks (barnacles) (o) Hermit crab 1 sea star juv 5 Henricia 1 edge fauna	46.2	sandstone outcrop (sandstone crag) continuous biolayer and occasional small patches
AUG08	5-2	5-2b	2	siltstone bedrock table	white patches (sponge) <1 % boring clams (c) (~25)	47.2	red mudstone with pits (either fossil roots or boring clams)
AUG08	5-3	5-3b	2	sandstone and other	Henricia 3	46.5	sandstone and other cobble and boulder field. Quite clean
AUG08	5-3	5-3c	2	sandstone and other boulder and cobbles	Henricia 1 White flecks (barnacles) © Sponge unid (1%) pink	46.5	sandstone and other cobble and boulder field. Quite clean except for one boulder. Example of abrasion. Lower portion of boulder not colonized.
AUG08	5-3	5-3d	2	mudstone and other boulder and cobbles	White flecks (barnacles)(o)	46.5	Quite clean except for one boulder. Example of abrasion. Lower portion of boulder not colonized.
AUG08	6-1	6-1b	2	sandstone outcrop, pitted	yellow breadrumb sponge 25% biolayer patches 20% barnacle bases 2 white flecks (barnacles) (c)	44.9	dark biolayer patches 2 cm dia.
AUG08	6-1	6-1c	2	sandstone outcrop, pitted	yellow breadrumb sponge 20% biolayer 50% and patches white patches 2% white flecks (barnacles) (c)	44.9	sl out of focus. Rough pitted sandstone surface.
AUG08	6-1	6-1f	2	sandstone outcrop, pitted	yellow breadrumb sponge 20% biolayer 50% and patches white patches 2% white flecks (barnacles) (c) Henricia 1	44.9	sl out of focus. Rough pitted sandstone surface.
AUG08	6-	6-	2	cobble over bedrock,	Boltenia 2	48.1	

Table A1. Biological communities on seabed at proposed site of tidal power demonstration facility, Minas Passage, from survey conducted August & September 2009. Geological regions: 1=volcanic bedrock; 2=sedimentary ridges and troughs; 3=deep unconsolidated boulder/cobble; 4= shallow unconsolidated shelf and slope. Depth in metres below MLW. Abundance codes: (c) common; (a) abundant; (o) occasional; (r) rare.

Cruise	Station	Image Number	Geological Region	Description	Biological Community	Depth (m)	Comment
	repeat-2	repeat 2a		mixed types			
AUG08	6-repeat-2	6-repeat 2b	2	cobble over bedrock, mixed types	white fleck (Hermit crab/snail)	48.1	Clean
AUG08	6-repeat-3	6-repeat 3b	2	cobble over bedrock, mixed types	white fleck (Hermit crab/snail)	45.8	
AUG08	6-repeat-3	6-repeat 3c	2	cobble over bedrock, mixed types	white fleck (Hermit crab/snail) Henricia 1 white patches	45.8	
AUG08	7-1	7-1b	2	sandstone, routh and pitted	white patches sponge (<1%) yellow sponge patches Drift finger sponge in hole 1 biolayer 50% white flecks (barnacles) (c)	41.9	
AUG08	7-1	7-1c	2	sandstone, rough and pitted	yellow sponge patches Drift finger sponge in hole 1 biolayer 50% white flecks barnacles (a) Henricia 1	41.9	
AUG08	7-1	7-1e	2	sandstone, rough and pitted	white flecks barnacles (a) hermit crab 1 biolayer present (50%?)	41.9	
AUG08	7-2	7-2b	2	mixed rock types, including mudstone cobble.	white patches (<1%) boring clams mudstone cobble Henricia 1 White flecks (barnacles) minor edge fauna.	43.3	clean bottom, surfaces smooth
AUG08	7-3	7-3b	2	mixed rock types	white patches (<1%) Henricia 1 biolayer 30%	46.8	poor visibility surfaces smooth
AUG08	8-1	8-1a	2		yellow ridged encrusting sponge 20%	45.0	lower rock free of sponge
AUG08	8-2	8-2a	2	sandstone, rough pitted	yellow encrusting sponge 20% edge fauna	46.4	out of focus, poor visibility
AUG08	8-2	8-2b	2	sandstone, rough pitted	yellow sponge 15% white flecks (barnacles) (c)	46.4	out of focus (condensation) , poor visibility
AUG08	10-1	10-1b	2	sandstone	white flecks (barnacles/snails) (c) white flecks (hermit crab,gastropod) 1 biolayer (30%) biolayer patches (c) seastar juv 3 Henricia 1 hermit crab 1	45.0	typical sandstone outcrop community

Table A1. Biological communities on seabed at proposed site of tidal power demonstration facility, Minas Passage, from survey conducted August & September 2009. Geological regions: 1=volcanic bedrock; 2=sedimentary ridges and troughs; 3=deep unconsolidated boulder/cobble; 4= shallow unconsolidated shelf and slope. Depth in metres below MLW. Abundance codes: (c) common; (a) abundant; (o) occasional; (r) rare.

Cruise	Station	Image Number	Geological Region	Description	Biological Community	Depth (m)	Comment
					white patches sponges on cobbles		
AUG08	10-2	10-2b	2	sandstone crags	white flecks (barnacles/snails) (c) white flecks (hermit crab,gastropod) (o) biolayer (30%) White patches <1% Hermit crab 1	44.8	sandstone crags curious white ganglion on rock??
AUG08	10-2	10-2c	2	sandstone crags	white flecks (barnacles/snails) (c) white flecks (hermit crab,gastropod) (o) biolayer (20%) yellow breadcrumb sponge White patches <1% mussel (in crevice) 1 Henricia 1	44.8	sandstone crags curious white ganglia good community photo
AUG08	10-3	10-3a	2	sandstone bedrock	white flecks (barnacles/snails) (c) white flecks (hermit crab,gastropod) (o) biolayer 40%) White patches <1% edge fauna, filaments	46.1	sandstone outcrops
AUG08	10-3	10-3b	2	sandstone bedrock	white flecks (barnacles/snails) (c) white flecks (hermit crab,gastropod) (o) biolayer 60%) seastar juv. 1 White patches <1% edge fauna, filaments	46.1	sandstone outcrops closer view of previous
AUG08	15-1	15-1a	2	sandstone bedrock outcrop	white patch (sponge) 1	12.8	poor image
AUG08	16-2	16-2a	2	sandstone bedrock	white flecks (hermit crab/snail)	25.1	poor image
AUG08	16-3	16-3a	2	sandstone bedrock	yellow sponge breadcrumb (80%) hermit crab 1 white flecks (barnacles) (c)	23.0	poor image
AUG08	16-repeat 2	16-repeat 2a	2	boulders and cobble mixed type.		25.1	poor image. good motion view of bedload.
AUG08	16-repeat 2	16-repeat 2b	2	boulders and cobble mixed type.		25.1	poor image. good motion view of bedload. flecks and shells in motion obscurd bottom.
AUG08	16-repeat 3	16-repeat 3b	2	boulders and cobble mixed type.	red anemone? 1 white patch (sponge) 1	23.0	poor image. good motion view of bedload. flecks and shells in motion obscure bottom. Area covered same as previous image.
AUG08	16-repeat 3	16-repeat 3c	2	boulders and cobble mixed type.	red anemone? 1 white patch (sponge) 1	23.0	poor image. good motion view of bedload. flecks and shells in motion obscure bottom. Area covered same as previous image.

Table A1. Biological communities on seabed at proposed site of tidal power demonstration facility, Minas Passage, from survey conducted August & September 2009. Geological regions: 1=volcanic bedrock; 2=sedimentary ridges and troughs; 3=deep unconsolidated boulder/cobble; 4= shallow unconsolidated shelf and slope. Depth in metres below MLW. Abundance codes: (c) common; (a) abundant; (o) occasional; (r) rare.

Cruise	Station	Image Number	Geological Region	Description	Biological Community	Depth (m)	Comment
AUG08	20-1	20-1b	2	sandstone outcrop	yellow sponge 10% white flecks barnacles(c) biolayer 60%	44.2	poor image. condensation but typical of sandstone crags.
AUG08	20-1	20-1c	2	sandstone outcrop	white flecks barnacles(c) biolayer 80%	44.2	poor image. condensation but typical of sandstone crags.
AUG08	20-repeat-2	20-repeat-2b	2	mixed types	edge fauna seastar 1 biolayer 100% on sandstone outcrop white flecks (hermit crab/gastropod)	42.7	poor image. condensation clean rocks. same area as previous image
AUG08	20-repeat-2	20-repeat-2c	2	mixed types	edge fauna long tube seastar 2 biolayer on sandstone boulder white flecks (hermit crab/gastropod) hermit crab 1	42.7	
AUG08	20-repeat-2	20-repeat-2d	2	mixed types	edge fauna long tube seastar 1 biolayer on sandstone boulder white flecks (hermit crab/gastropod) hermit crab 1	42.7	poor image. condensation clean rocks. same area as previous image but closer.
AUG08	21-2	21-2b	2	rounded rocks, mixed types	white fleck (hermit crab/gastropod) 2 edge fauna <1% yellow sponge 1% breadcrumb	43.8	
AUG08	21-2	21-3b	2	sandstone	white fleck (hermit crab/gastropod) (o) biolayer (70%) white flecks (barnacles) (c)	43.8	
SEP08	21-1	21-1b	2	smooth non sandstone cobble & boulder	hermit crab/gastropod 5 barnacles (o)	47.8	
SEP08	21-2	21-2c	2	smooth non sandstone boulder	biolayer 100% flecks barnacles (o)	43.8	
SEP08	21-3	21-3b	2	sandstone	biolayer 50% flecks barnacles (a yellow encrusting sponge 1-5%	43.8	
SEP08	3-1	3-1	2	Mixed c/w occas sandstone and mudstone.	White fleck hermit crab 2 white patch sponge rare	46.6	
SEP08	3-2	3-2	2	Mixed c/w occas sandstone and mudstone. Large mudstone rock with boreholes and barnacles	White patch sponge (o) Barnacles (C) on mudstone Biolayer (10%) Seastar small 1 White flecks hermit crab (c)	44.9	
SEP08	3-3	3-3	2	Mixed mostly smooth without mudstone/sandstone.	Hermit crab 1 Hermit crab/whelk 3 Barnacles (C) on mudstone	45.9	

Table A1. Biological communities on seabed at proposed site of tidal power demonstration facility, Minas Passage, from survey conducted August & September 2009. Geological regions: 1=volcanic bedrock; 2=sedimentary ridges and troughs; 3=deep unconsolidated boulder/cobble; 4= shallow unconsolidated shelf and slope. Depth in metres below MLW. Abundance codes: (c) common; (a) abundant; (o) occasional; (r) rare.

Cruise	Station	Image Number	Geological Region	Description	Biological Community	Depth (m)	Comment
					Seastar small 8		
SEP08	3-4	3-4	2	Mixed mostly smooth without mudstone/sandstone.	Hermit crab 2 Seastar small 11 Asterias 2 edge layer white patches <1%	43.7	
SEP08	3-5A	3-5A	2	Bedrock (sandstone/siltstone table) with occasional boulder/cobble mixed type.	Hermit crab 3 Henricia 2 Asterias 3 edge fauna white patches <1% biolayer 80%	42.6	unlike most areas of its type this trough has extensive coating of biolayer
SEP08	3-5B	3-5B	2	Mixed mainly non-sandstone.	Hermit crab 3 Henricia 4 Asterias 1 edge fauna incl worm tubes hermit crab/gastropod ~5 biolayer 75% white patches <1%	42.6	unusual occurence of biolayer on smoother non-sandstone rocks
SEP08	3-5C	3-5C	2	Siltstone/mudstone table with mixed mainly non-sandstone boulder and cobble.	Henricia 4 Linear biolayer <1% white patches <1%	42.6	
SEP08	3-5D	3-5D	2	Smooth non-sandstone boulder.	Henricia 1 biolayer 10% white patches <1%	42.6	dislodged material
SEP08	3-5E	3-5E	2	Sandstone bedrock ridges.	Henricia 2 Seastar juv 1 biolayer 100% Edge fauna Boltenia 1	42.6	side view
SEP08	3-6	3-6	2	Sandstone bedrock ridge	hermit crab? 1 biolayer 5% Edge fauna,tubes Boltenia 1 White patches <1% Red anemone? 1 barnacles (a) red encrusting sponge (<1%)	42.2	side view
SEP08	7-1	7-1	2	Mixed smooth non-sandstone boulder and cobble embedded in gravel.	Henricia 1 Hermit crab 2 Hermit crab/gastropod 1 red anemone 1 Linear biolayer <1%	41.9*	sponge on top of boulder; scour zone

Table A1. Biological communities on seabed at proposed site of tidal power demonstration facility, Minas Passage, from survey conducted August & September 2009. Geological regions: 1=volcanic bedrock; 2=sedimentary ridges and troughs; 3=deep unconsolidated boulder/cobble; 4= shallow unconsolidated shelf and slope. Depth in metres below MLW. Abundance codes: (c) common; (a) abundant; (o) occasional; (r) rare.

Cruise	Station	Image Number	Geological Region	Description	Biological Community	Depth (m)	Comment
					biolayer <1% yellow encrusting sponge 5% white patches <1%		
SEP08	7-2	7-2	2	Smooth non-sandstone boulder and cobble embedded in gravel.	Henricia 1 Hermit crab 1 Hermit crab/gastropod 1 red anemone 1 Linear biolayer <1% biolayer <1% yellow encrusting sponge <1% white patches <1%	43.3	
SEP08	7-3	7-3	2	Mixed sandstone and other boulder and cobble with gravel.	Biolayer 50% hermit crab/gastropod 1 edge fauna (o) barnacles(c)	46.8	polychaete tubes occasional
SEP08	7-4	7-4	2	Mixed smooth non-sandstone boulder and cobble embedded in gravel.	biolayer <1% yellow encrusting sponge <1% hermit crab/gastropod 1	46.3	
SEP08	7-5A	7-5A	2	Smooth sandstone? outcrop and boulder	biolayer 95% hermit crab 1 edge fauna c/w tubes barnacles (C)	46.7	includes a smooth boulder with partial biolayer.
SEP08	7-5B	7-5B	2	smooth non-sandstone boulder/cobble	biolayer <1% hermit crab/ gastropod 2 edge fauna c/w tubes <1% barnacles (C)	46.7	
SEP08	7-5C	7-5C	2	flat angular sandstone steps	biolayer 30% yellow encrusting sponge 10% edge fauna <1% barnacles (C) hermit crab 3	46.7	
SEP08	7-5D	7-5D	2	sandstone ridge	biolayer 20% yellow breadcrumb sponge 40% edge fauna <1% barnacles (C)	46.7	
SEP08	7-5E	7-5E	2	sandstone ridge	biolayer 40% yellow breadcrumb sponge 15% Asterias/Henricia 1 Fourhorn sculpin 1 red anemone 4 hermit crab 1 barnacles (C)	46.7	
SEP08	7-5F	7-5F	2	sandstone mudstone	white flecks (barnacles) (c)	46.7	holes bored in some rocks

Table A1. Biological communities on seabed at proposed site of tidal power demonstration facility, Minas Passage, from survey conducted August & September 2009. Geological regions: 1=volcanic bedrock; 2=sedimentary ridges and troughs; 3=deep unconsolidated boulder/cobble; 4= shallow unconsolidated shelf and slope. Depth in metres below MLW. Abundance codes: (c) common; (a) abundant; (o) occasional; (r) rare.

Cruise	Station	Image Number	Geological Region	Description	Biological Community	Depth (m)	Comment
				table			
SEP08	7-5G	7-5G	2	sandstone boulders and other cobble	white flecks (barnacles) (c) edge fauna tubes biolayer (50%) yellow encrusting sponge 5% hermit crab? 2	46.7	
SEP08	7-6	7-6	2	piece of sandstone outcrop	white flecks (barnacles) (c) yellow encrusting sponge 10%	35.2	partial view
SEP08	7A-1	7A-1	2	level sandstone bedrock slab, strata visible	white flecks (barnacles) (c) yellow encrusting sponge <1% biolayer (100%) seastar juv 3	38.0	
SEP08	7A-2	7A-2	2	sandstone bedrock	yellow encrusting sponge <1% biolayer (100%) red anemone 1 edge fauna tubes hermit crab/gastropod 2 hermit crab 2	39.7	
SEP08	7A-3	7A-3	2	level bedrock slab	yellow encrusting sponge 5% pale encrusting sponge 5% Henricia 1 biolayer (800%) red anemone 1 edge fauna tubes Boltenia 2 hermit crab/gastropod 1 barnacles (c) finger sponge white patches <1%	39.8	partial frame good barnacle images
SEP08	8-1	8-1A	2	non-sandstone		45.0	poor image out of focus
SEP08	8-1	8-1B	2	non-sandstone	seastar 2 hermit crab/gastropod? 1 yellow sponge <1% edge fauna.	45.0	
SEP08	8-1	8-1C	2	non-sandstone, smooth	seastar 2 hermit crab/gastropod? 1 yellow sponge <1% edge fauna.	45.0	overlaps last photo condensation
SEP08	8-2	8-2A	2	non-sandstone, smooth		46.4	image obscured, condensation
SEP08	8-2	8-2B	2	non-sandstone, smooth cobble	hermit crab crab/gastropod 1	46.4	image obscured, condensation
SEP08	8-3	8-3A	2	non-sandstone, smooth cobble	edge fauna	45.2	image obscured, condensation

Table A1. Biological communities on seabed at proposed site of tidal power demonstration facility, Minas Passage, from survey conducted August & September 2009. Geological regions: 1=volcanic bedrock; 2=sedimentary ridges and troughs; 3=deep unconsolidated boulder/cobble; 4= shallow unconsolidated shelf and slope. Depth in metres below MLW. Abundance codes: (c) common; (a) abundant; (o) occasional; (r) rare.

Cruise	Station	Image Number	Geological Region	Description	Biological Community	Depth (m)	Comment
SEP08	8-3	8-3B	2	non-sandstone, smooth cobble & mudstone boulder, boulder slightly bored	edge fauna tubes (o)	45.2	image obscured, condensation
AUG08	17-1	17-1a	Deep Water Unconsolidated Bottoms	mixed types	White fleck (hermit crab/gastropod)	32.0	smooth clean surfaces.
AUG08	17-2	17-2b	3	mixed types	white fleck (hermit crab/snail) 2	33.0	smooth clean surfaces.
AUG08	17-3	17-3a	3	mixed types	white fleck (hermit crab/gastropod)	33.7	smooth clean surfaces.
AUG08	17-3	17-3b	3	mixed types	white fleck (hermit crab/gastropod) 4 hermit crab 1	33.7	smooth clean surfaces.
AUG08	18-1	18-1a	3	mixed types		40.6	poor image. smooth clean surfaces.
AUG08	18-2	18-2a	3	mixed types	yellow sponge white fleck (hermit crab/snail)	28.0	poor image. smooth clean surfaces.
AUG08	19-1	19-1a	3	mixed types		43.7	poor image. smooth clean surfaces.
AUG08	19-2	19-2a	3	mixed types?		43.5	poor image. bottom only partially in view.
AUG08	19-2	19-2b	3	mixed types?		43.5	poor image.
AUG08	23-1	23-1a	3	non-sandstone, smooth cobble		24.6	
AUG08	23-2	23-2a	3	non-sandstone, smooth cobble		24.2	
AUG08	23-2	23-2c	3	non-sandstone, smooth cobble		24.2	better view of previous image
SEP08	18-1	18-1	3	non sandstone boulder and cobble, embedded	Henricia 3 edge fauna <1%white patches (sponge?)<1% hermit crab/gastropod 1 red anemone 1 bioilm 10%	40.6	smooth surfaces, biolayer on one boulder
SEP08	18-2	18-2	3	non sandstone boulder and cobble, embedded	smooth yellow encrusting sponge <1% hermit crab/gastropod 7	41.4	smooth surfaces, bedload effect
SEP08	18-3	18-3	3	non sandstone boulder and cobble, embedded	ridged yellow encrusting sponge 20% hermit crab/gastropod Seastar juv 2	28.2	smooth surfaces, bedload effect for sponges, rock with sponge broken loose
SEP08	18-4	18-4	3	Non sandstoneboulder and cobble, smooth, embedded	ridged yellow encrusting sponge 20% red anemone 1 hermit crab 1 edge fauna seastar juv 2	42.4	smooth surfaces, bedload effect for sponges.
SEP08	18-5	18-5	3	non-sandstone boulder and cobble, smooth, embedded	ridged yellow encrusting sponge 15% seastar juv 1 barnacle scars red anemone 1	44.5	smooth surfaces, bedload effect for sponges.
SEP08	18-6	18-6	3	non sandstone boulder	ridged yellow encrusting sponge 10%	46.6	smooth surfaces, bedload effect for

Table A1. Biological communities on seabed at proposed site of tidal power demonstration facility, Minas Passage, from survey conducted August & September 2009. Geological regions: 1=volcanic bedrock; 2=sedimentary ridges and troughs; 3=deep unconsolidated boulder/cobble; 4= shallow unconsolidated shelf and slope. Depth in metres below MLW. Abundance codes: (c) common; (a) abundant; (o) occasional; (r) rare.

Cruise	Station	Image Number	Geological Region	Description	Biological Community	Depth (m)	Comment
				and cobble, smooth, embedded	seastar 1 red sponge 1		sponges.
SEP08	18-7	18-7a	3	boulder & cobble	ridged yellow sponge on boulder 30%	35.9	
SEP08	18-7	18-7b	3	boulder & cobble	breadcrumb sponge on boulder 50% biolayer 20% flecks (barnacles) (o)	35.9	
SEP08	18-9	18-9b	3	boulder & cobble	ridged yellow sponge on boulder 25% biolayer 20% flecks (barnacles) (o hermit crab 1 edge fauna Flustra? <1%	37.0	
SEP08	19-1	19-1b	3	boulder & cobble, smooth, mudstone with pits at edge of image	breadcrumb sponge on boulder 15% hermit crab 2 edge fauna Flustra? <1%	43.7	
SEP08	19-2	19-2c	3	cobble, gravel occasional mudstone, smooth	white patch sponge? hermit crab?1	43.5	
SEP08	19-3	19-3b	3	boulder & cobble, smooth	white patch hermit crab?1	43.5	
SEP08	20-1	20-1a	3	mudstone outcrop	hermit crab?2 seastar 1	46.5	
SEP08	20-2	20-2c	3	mudstone/sandstone/other	edge fauna Flustra	42.7	
SEP08	20-3	20-3c	3	sandstone/other	white patchy sponge <1% seastar 2	39.8	
SEP08	20-4	20-4c	3	boulder unid.	seastar 1 hermit crab/gastropod 3 biolayer 70% edge fauna tubes. yellow ridged encrusting sponge	38.2	yellow ridged sponge on another part of boulder.
AUG08	23-1	23-1a	3	Cobble/ small boulder, mixed types	No organisms visible	24.6	
AUG08	23-2	23-2b	3	Well sorted cobble in wave.	Hermit crabs? occasional	24.2	
SEP08	29-1	29-1	3	Non-sandstone boulder and cobble, smooth, embedded	seastar juv 2 white patch < 1%	27.1	smooth surfaces,
SEP08	29-2	29-2	3	non sandstone cobble, smooth, embedded	spots of biolayer (tube building orgaNisms) (r)	27.4	smooth surfaces,
SEP08	29-3	29-3	3	mixed type cobble, smooth, embedded	Flustra (o) biolayer <5% seastar juv 4 Henricia 2	28.1	smooth surfaces,
SEP08	29-4	29-4	3	mixed type cobble,	white patches < 1%	28.0	smooth surfaces,

Table A1. Biological communities on seabed at proposed site of tidal power demonstration facility, Minas Passage, from survey conducted August & September 2009. Geological regions: 1=volcanic bedrock; 2=sedimentary ridges and troughs; 3=deep unconsolidated boulder/cobble; 4= shallow unconsolidated shelf and slope. Depth in metres below MLW. Abundance codes: (c) common; (a) abundant; (o) occasional; (r) rare.

Cruise	Station	Image Number	Geological Region	Description	Biological Community	Depth (m)	Comment
				smooth, embedded	hermit crab 2 seastar juv 3 red anemone 1 biolayer small patches <1% yellow sponge <1%		
SEP08	29-5A	29-5A	3	mixed type cobble, smooth,	white patches < 1% biolayer 25% edge fauna (Flustra <1%), invertebrate tubes. Boltenia 2 Henrcia 1 seastar juv 1 red anemone 1	29.1	one large colonized boulder withoug bedload effect. Henricia moderately large, 5-10 cm across
SEP08	29-5B	29-5B	3	mixed type boulder & cobble, smooth,	white patches < 1% biolayer 25% edge fauna (Flustra <1%), invertebrate tubes. Boltenia 1 seastar juv 1 red anemone 7	29.1	Overlaps previous image. one large colonized boulder without bedload effect.
SEP08	29-5C	29-5C	3	mixed type boulder & cobble, smooth,	biolayer 5% patches of biolayer (o) seastar juv 2 hermit crab 2 red anemone 1 barnacle?	29.1	
SEP08	29-6	29-6	3	mixed type boulder & cobble, smooth,	hermit crab 1 seastar juv 1 biolayer <1% edge fauna with tubes <1% hermit crab/gastropod 4	31.3	
SEP08	30-1	30-1	3	non sandstone boulder & cobble, smooth,	hermit crab 2 yellow ridged encrusting sponge10% hermit crab/gastropod 1	38.3	
SEP08	30-1	30-1	3	non sandstone boulder & cobble, smooth.	hermit crab 2 ridged encrusting yellow sponge 5% barnacle ? 2	38.3	sponge without bedload effect. On boulder and several smaller patches.
SEP08	30-2	30-2	3	non sandstone boulder & cobble, smooth.	red anemone 2 hermit crab 2?	39.3	
SEP08	30-3	30-3	3	non sandstone boulder & cobble, smooth.	yellow ridged encrusting sponge 5% hermit crab? 1	39.5	bedload effect on sponge
SEP08	30-4	30-4	3	non sandstone cobble, smooth.	yellow ridged encrusting sponge 5% hermit crab/gastropod 4 seastar? 1	39.2	bored cobble. seastar appropriately coloured object on rock.

Table A1. Biological communities on seabed at proposed site of tidal power demonstration facility, Minas Passage, from survey conducted August & September 2009. Geological regions: 1=volcanic bedrock; 2=sedimentary ridges and troughs; 3=deep unconsolidated boulder/cobble; 4= shallow unconsolidated shelf and slope. Depth in metres below MLW. Abundance codes: (c) common; (a) abundant; (o) occasional; (r) rare.

Cruise	Station	Image Number	Geological Region	Description	Biological Community	Depth (m)	Comment
SEP08	30-5A	30-5A	3	non sandstone cobble, smooth.	yellow ridged encrusting sponge 5% white patch sponge <1%	38.2	
SEP08	30-5B	30-5B	3	non sandstone boulder & cobble, smooth.	yellow ridged encrusting sponge <5% white patch <1% white fleck hermit crab/gastropod/barnacle 1	38.2	
SEP08	30-5C	30-5C	3	non sandstone cobble, smooth.	yellow ridged encrusting sponge 1% linear biolayer	38.2	
SEP08	30-5D	30-5D	3	non sandstone cobble & boulder, smooth.	yellow encrusting sponge <1% hermit crab 1 barnacle? 2 boltena? 1	38.2	Bottom at Stn 30 seems uniform between stations.
SEP08	30-6	30-6	3	non sandstone cobble & boulder, smooth.	hermit crab 1	38.5	
AUG08	11-1	11-1a	Nearshore, Shallow Water Unconsolidated bottoms	subtidal flat, gravel shingle, occasional shell	50%	3.4	
AUG08	11-3	11-3a	4	subtidal flat, gravel shingle, occasional shell, sand wave	50% corallines (Lithothamnium) on gravel drift kelp	3.5	
AUG08	11-3	11-3b	4	subtidal flat, gravel shingle, occasional shell	50% corallines (Lithothamnium) on gravel drift kelp	3.5	
AUG08	12-1	12-1a	4	subtidal flat, gravel shingle, occasional shell	50% corallines (lithothamnium) on rocks and possibly corallina.	3.0	Essentially similar to 11-1
AUG08	13-1	13-1a	4	subtidal flat, gravel shingle, occasional shell	50%	5.0	Essentially similar to 11-1
AUG08	13-1	13-1d	4	subtidal flat, gravel shingle, occasional shell, mini sand/gravel waves, pile of tiny shell on sand.	20% Flustra 10% ined up along sand/gravel waves	5.0	
AUG08	13-1	13-1e	4	subtidal flat, gravel shingle, occasional shell, mini sand/gravel waves, pile of tiny shell on sand.	20% Flustra 10% ined up along sand/gravel waves Lithothamnium on gravel.	5.0	
AUG08	13-2	13-2a	4	subtidal flat, gravel shingle, occasional shell, mini sand/gravel waves, pile of tiny shell on sand.	10 %	4.7	

Table A1. Biological communities on seabed at proposed site of tidal power demonstration facility, Minas Passage, from survey conducted August & September 2009. Geological regions: 1=volcanic bedrock; 2=sedimentary ridges and troughs; 3=deep unconsolidated boulder/cobble; 4= shallow unconsolidated shelf and slope. Depth in metres below MLW. Abundance codes: (c) common; (a) abundant; (o) occasional; (r) rare.

Cruise	Station	Image Number	Geological Region	Description	Biological Community	Depth (m)	Comment
AUG08	13-3	13-3b	4	subtidal flat, gravel shingle, occasional shell.	5% coralline algae (lithothamnium on cobble)	5.1	
AUG08	14-1	14-1b	4	subtidal flat, gravel shingle, shell common.	5%	6.3*	poor visibility
AUG08	14-2	14-2a	4	subtidal flat, gravel shingle, shell common.	Present	8.7	poor visibility.
SEP08	14-1	14-1A	4	homogeneous gravel	rockweed patches	6.3*	image obscured, condensation
SEP08	14-1	14-1B	4	homogeneous cobble	Flustra 60% Hermit crab 2	6.3*	
SEP08	14-1	14-1C	4	homogeneous cobble	Flustra 10% Hermit crab 1 Coralline algae? on cobble (10%) Palmaria?	6.3*	
SEP08	14-1	14-1D	4	homogeneous cobble	Flustra 10% Hermit crab 1 Barnacles (o) Coralline algae? on cobble (10%) Palmaria?	6.3*	overlaps previous image
SEP08	14-2	14-2A	4	homogeneous cobble	Flustra 10% Hermit crab 1 Barnacles (o) Coralline algae? on cobble (10%) Palmaria?	8.7*	poor image
SEP08	14-2	14-2B	4	homogeneous cobble	Coralline algae on cobble (20%) Palmaria? Flustra 5% Hermit crab? 1	8.7*	poor image
SEP08	15-1	15-1b	4	image of top surface of boulder	red algae (Palmaria ?) fucus 20% corallines on cobble red algae (Palmaria ?) barnacles (a) Flustra 20%	12.7	
SEP08	15-2	15-2c	4	mixed cobble, gravel a	fucus 15% corallines on cobble	12.7	
SEP08	15-3	15-3b	4	mixed cobble, gravel	fucus 15% corallines on cobble white patches (sponge) 5% seastar 1	12.7	
SEP08	S 1-1	S 1-1	4	level gravel shingle 'flat' similar to lower	Fucus clumps (10-15 cm dia) 15%	1.9	

Table A1. Biological communities on seabed at proposed site of tidal power demonstration facility, Minas Passage, from survey conducted August & September 2009. Geological regions: 1=volcanic bedrock; 2=sedimentary ridges and troughs; 3=deep unconsolidated boulder/cobble; 4= shallow unconsolidated shelf and slope. Depth in metres below MLW. Abundance codes: (c) common; (a) abundant; (o) occasional; (r) rare.

Cruise	Station	Image Number	Geological Region	Description	Biological Community	Depth (m)	Comment
				intertidal zone			
SEP08	S 2-1	S 2-1	4	level gravel shingle 'flat' similar to lower intertidal zone	Fucus clumps (10-15cm dia) 15% Drift kelp (o) Hermit Crab (o)	1.5	
SEP08	S 3-1	S 3-1	4	level gravel shingle 'flat' similar to lower intertidal zone	Fucus clumps (10-15cm dia) 15% Drift kelp (o) Hermit Crab 1	1.1	
SEP08	S 4-1	S 4-1	4	level gravel shingle 'flat' similar to lower intertidal zone	Fucus clumps (10-15cm dia) 15% Hermit Crab 3	0.5	
SEP08	S 5-1	S 5-1	4	level gravel shingle 'flat' similar to lower intertidal zone	Coralline algae (Lithothamnium) 30% Fucus clumps 30% Palmaria 10% Hermit crab 4	6.8	
SEP08	S 6-1	S 6-1	4	level gravel shingle 'flat' similar to lower intertidal zone	Coralline algae (Lithothamnium) Drift kelp frond Palmaria 10% Flustra 10% encrusting bryozoan <1%	5.9	Flustra on one large cobble
SEP08	S 7-1	S 7-1	4	level cobble flat like lower intertidal zone	Coralline algae (Lithothamnium) Fucus clumps 30% Palmaria present drift kelp	4.9	
SEP08	S 8-1	S 8-1	4	level gravel flat.	Fucus clumps 10% Drift kelp (o)	2	
SEP08	S 9-1	S 9-1	4	level gravel flat.	Fucus clumps <1% Hermit crab 2	1.2	
SEP08	S10-1	S10-1	4	level cobble with occasional boulders	Coralline patches Palmaria juv plants 30% Yellow encrusting sponge Seastar juv 1 Hermit crab 3	7.9	Boulder common, 10% of bottom, interspersed with cobbles. Dominates area between S10 and S11.
SEP08	S10-1	S10-Aa	4	area of mixed cobble and boulders, boulde common, perhaps 5% civer	Coralline algae (p) Palmaria (young plants) 30% Yellow encrusting sponge <1% Seastar juv 1 Hermit crab 3	7.9	productive area in terms of marine plants.
SEP08	S11-1	S11-1	4	boulder field, sedimentary	Biolayer 100% Boltenia? 2 Barnacles (c)	11.4	
SEP08	S12-1	S12-1	4	boulder field, sedimentary	Henricia 1 Biolayer 100% Boltenia Edge fauna tubes	10	

Table A1. Biological communities on seabed at proposed site of tidal power demonstration facility, Minas Passage, from survey conducted August & September 2009. Geological regions: 1=volcanic bedrock; 2=sedimentary ridges and troughs; 3=deep unconsolidated boulder/cobble; 4= shallow unconsolidated shelf and slope. Depth in metres below MLW. Abundance codes: (c) common; (a) abundant; (o) occasional; (r) rare.

Cruise	Station	Image Number	Geological Region	Description	Biological Community	Depth (m)	Comment
SEP08	S13-1	S13-1	4	level cobble with boulder	Flustra 100%	9	
SEP08	S14-1	S14-1	4	level cobble with boulder	Yellow encrusting sponge 15% Flustra 10% Biolayer 30% Barnacles? (o) Seastar 1	14.5	
SEP08	S15-1	S15-1	4	level cobble with occasional boulder, mixed rock types	Yellow encrusting sponge 5% Flustra 5% Biolayer 20% Hermit crab 1	13.5	