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Recommended citation
Kostylev, V.E., Parrott, D.R., and Rumbolt, S., 2024. Seafloor flora, fauna, and texture in photographs from CCGS *J.L. Hart* survey 2004010 in the Strait of Canso, offshore Nova Scotia; Geological Survey of Canada, Open File 9211, 26 p. https://doi.org/10.4095/p3mh7yw3ee

Publications in this series have not been edited; they are released as submitted by the author.

ISSN 2816-7155
ISBN 978-0-660-73356-2
Catalogue No. M183-2/9211E-PDF
https://doi.org/10.4095/p3mh7yw3ee

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1. Executive Summary

The Strait of Canso separates Cape Breton Island from mainland Nova Scotia. Prior to completion of the Canso Causeway in 1955, a tidal difference of about 1 m between the northern and southern portions of the Strait gave rise to strong currents with a strong net water flow southward. High current velocities of 2.67 m/sec (9.6 km/h) south-going and 2.1 m/sec (7.6 km/h) north-going, within the Strait of Canso resulted in erosion of seafloor sediments and generally maintained a coarse substrate by preventing deposition of fine-grained marine sediments on the seafloor. After completion of the causeway, the Strait of Canso exhibited conditions more closely related to a tidal inlet or fjord. The quieter current regime is now prone to deposition of fine-grained sediments resulting in a change from an erosional environment which saw the development of sand waves and erosional flutes, to a depositional environment with the accumulation of fine-grained sediments at rates in the range of 1 to 2 mm per year.

During a recent survey by the Geological Survey of Canada – Atlantic, multibeam bathymetry, sub-bottom profiler, and sidescan sonar data, as well as seafloor samples, video and photographs were collected. This suite of data provides an insight into the present conditions on the seafloor of the Strait. The causeway presence resulted in present accumulation of sediments, with a veneer of fine-grained material covering most of the deeper portions of the Strait. The source of the most recent sediments south of the causeway is mainly local, with material derived from natural (e.g., eroding shorelines, small drainage systems) as well as anthropogenic (e.g., urban and industrial wastes) sources.

Southeast of the Canso Causeway, seafloor photographs and samples confirm that much of the seafloor is covered by a thin veneer of fine sediments with a dense population of the deposit-feeding brittle star *Ophiura sarsi*. Sea anemone *Hormathia nodosa*, which generally anchor on a hard substrate, are visible in many images, indicating the presence of coarser material under the fine surface veneer. Richness of benthic epifauna varies with the substrate type and increases with distance from the causeway. The higher accumulation of deposit feeders, seaweed debris and detritus on the surface of seabed in the inner part of the strait, indicates that the strait is effectively capturing and accumulating organic material.

2. Introduction

Survey Hart 2004010 was conducted as a joint project between the Geological Survey of Canada - Atlantic (GSC-A) and Environment Canada from 27 April to 14 May, 2004, to provide information on the character and distribution of seafloor sediments in the Strait of Canso, concentrating on conditions in and near the Strait of Canso Common User Offshore Disposal Site. The common offshore disposal site was established in 1983 for dredging activities within the Strait of Canso based on a disposal site selection survey (Martec, 1984; Tay, 1988). The site is in a 650 m long, 200 m wide trough with depth of about 55 to 64 m, shown by the yellow rectangle in Figure 1. The site has a capacity for holding 500,000 to 600,000 m^3 of dredged material or sediment. About 178,000 m^3 of material from near the docks of Port Hawkesbury and Mulgrave has been placed in the disposal site since 1993 (Parrott, 2010).

Descriptions of benthic habitats and fauna were determined from 867 seafloor photographs and several hours of underwater video transects collected during Hart 2004010 in the Strait of Canso, NS. This report expands on the analysis performed by Rumbolt (2005) and presents the results of a statistical classification of the seafloor photographs from the Strait of Canso.

2.1 Survey location: Strait of Canso

2.1.1 Physiography

The Strait of Canso is a NW-SE oriented, 27 km long body of water that separates Cape Breton Island from mainland Nova Scotia (Figure 1). The Strait generally has a "U"-shaped cross section, with a depth in the centre of the Strait of 38 to 65 m, an average depth of approximately 45 m, and a width that varies from about 0.8 to 2.0 km.

Prior to completion of the Canso Causeway in 1955, the Strait of Canso provided a zone of mixing between the waters of the Atlantic and the Gulf of St. Lawrence (Vilks et al. 1975). A tidal difference of about 1 m between the northern and southern portions of the Strait gave rise to currents of 2.67 m/sec (9.6 km/h) south-going and 2.1 m/sec (7.6 km/h) north-going (Fothergill 1954). This resulted in a net water flow southward of 4250 m^3/sec ($3.68 * 10^8$ m^3/day); about the equivalent of one-half of the daily discharge of the St. Lawrence River (Buckley et al., 1974). After completion of the causeway, the Strait of Canso exhibited conditions more closely related to a tidal inlet, or fjord, with an average current velocity of 0.18 km/h reported near Wright Point (Lawrence et al. 1973).

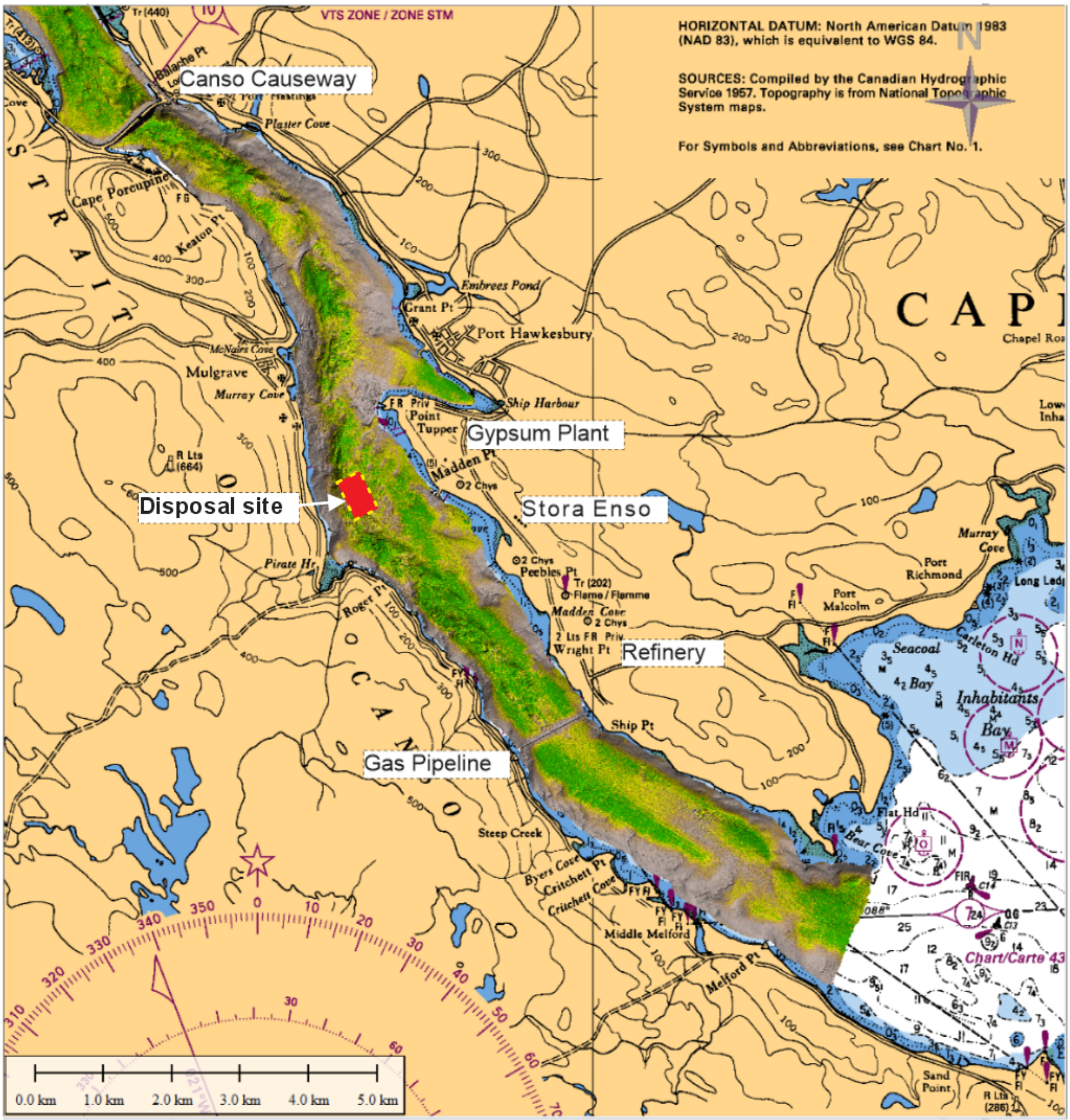

Figure 1. Strait of Canso from the causeway to Eddy Point, showing place names referred to in the text. An image of the acoustic backscatter from the Simrad EM3000 multibeam bathymetry survey is shown draped over a shaded relief image of bathymetry. Green color indicates low backscatter (muddy), grey color indicates higher backscatter. The disposal site is indicated by red rectangle.

2.1.2 Marine Surficial Geology

The marine surficial geology of the Canso Strait (Figure 2) has been described in studies by the Geological Survey of Canada (Buckley *et al*., 1974; MacLean *et al*., 1977). A summary of the marine surficial geology of the Strait of Canso was prepared as part of environmental assessment documents for proposed development along the shores of the Strait and submitted as part of the

Registration Document by Nova Scotia Power Incorporated in support of Registration of Point Tupper Marine Coal Terminal (NSPI 2003). A full consideration of the glacial and post-glacial setting of the Strait is presently underway, based on the multibeam and sub-bottom profiler data from Hart 2004010. It includes a more detailed map of the seabed texture based on these samples and acoustic backscatter strength.

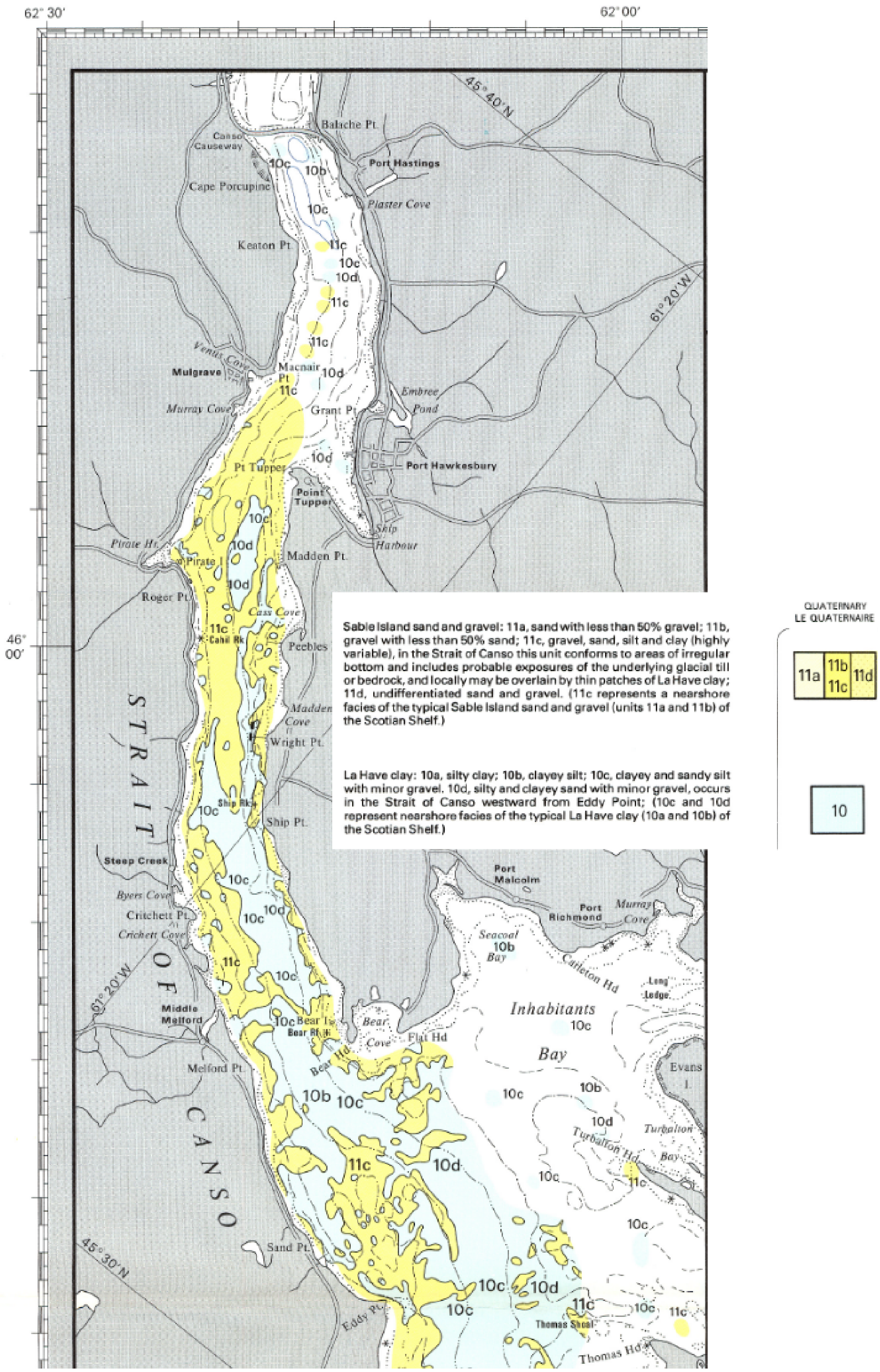

Figure 2. Marine surficial geology of the Strait of Canso showing the distribution of LaHave Clay overlying Sable Island Sand and Gravel. After MacLean *et al*., 1977.

Buckley *et al*. (1974) report that clayey silt was found in 35% of all samples, while silty sand and a mixture of sand, silt, and clay were found in 44% of the bottom surface samples. Silty sand was common on the shallow banks of the eastern half of the Strait adjacent to Peebles Point, Ship Point, and Bear Head. Sand existed in only one relatively deep part of the mid-channel northwest of Point Tupper. A unique pattern in the distribution of clayey silt occurs adjacent to Point Tupper and Peebles Point. The distribution of these fine-grained sediments suggests some correlation with the outfall areas of the industrial sites (AMEC 2003).

The surficial geological units within the marine environment of the Strait of Canso were mapped by MacLean *et al*., (1977) based on the character of echo soundings supplemented with bottom grab samples (Figure 2). High resolution sub-bottom profiler data were not available for the study. MacLean *et al*. (1977) identified nearshore facies of the Sable Island Sand and Gravel and the LaHave Clay. The Sable Island Sand and Gravel represents a transgressive basal deposit, formed as post-glacial sea-level rose and subjected the area to coastal processes. These sediments were subjected to continued (pre-causeway) reworking and deposition in both some deep and shallow areas within the Strait, subject to the strong currents that then developed as the Strait opened on both ends. The multibeam bathymetric survey shows large bedform fields comprising dunes (sand waves) up to meters high and fields of much smaller scale. They were not targeted in the sampling program. The Sable Island Sand and Gravel unit primarily consists of a highly spatially variable mixture fine- to coarse-grained sand, which grades to gravel. In the Strait of Canso, the gravel fraction consists principally of sandstone pebbles, granite, and quartzite. At one locality midway along the Strait, wood fibers comprised virtually all of the gravel-sized material. Their presence must be related to the activity of the old pulp mill near Port Hawkesbury. The LaHave Clay within the study area consists of clayey and sandy silt. The LaHave Clay laps upon and partly covers deposits of the Sable Island Sand and Gravel.

The more recent (2004) Geological Survey of Canada data included sub-bottom profiler transects which allowed a more detailed interpretation of the surficial geology (Parrott 2010). These present a clearer distribution of the mud-rich deposits overlying till and bedrock comprising both glacial (Emerald Silt Formation) and post glacial mud (LaHave Clay Formation), not differentiated in the MacLean et al. (1977) surficial geology map. The glacial deposits locally developed gravelly surfaces as fines were current-winnowed, leaving the rock clasts in place. Accordingly, the glacimarine mud has a gravel component at the seabed as opposed to the post-glacial mud. Also not depicted in the Figure 2 map are strait-flanking exposures of transgression-modified glacial till (gravel and cobble surface lag) and limited bedrock outcrop.

As the 2004 survey samples and photography clearly indicate the deep water gravel components, the shortcomings of the map are not considered to degrade findings in this study with respect to relating seabed texture and flora/fauna.

Prior to completion of the Canso Causeway in 1955, high current velocities within the Strait of Canso resulted in the erosion of seafloor sediments and generally maintained a coarse substrate by preventing the deposition of fine-grained marine sediments on the seafloor. After construction of the causeway, the Strait of Canso exhibited conditions more closely related to a tidal inlet, or fjord, which is much more prone to deposition of fine-grained sediments. The reduced current flow regime, which developed after construction of the causeway, has resulted in more quiescent conditions allowing the deposition of fine-grained sediments and preserving seafloor features such as anchor furrows and marks from spud cans. The quieter current regime has allowed fine-grained sediments to accumulate at rates in the range of 1 to 2 mm per year (Buckley et al., 1974; Lewis and Keen, 1990). Recent seafloor images and samples show the presence of a veneer of fine mud overlaying most of the seafloor within the Strait of Canso (Parrott 2010, Envirosphere 2004). The source of the most recent sediments south of the causeway is likely to be local with material derived from natural (e.g., eroding shorelines, small drainage systems) as well as anthropogenic sources (e.g., urban and industrial wastes).

2.1.3 Previous Ecological studies in the Canso Strait

Numerous studies have been conducted in the Strait of Canso to understand the environmental impacts of past and proposed industrial developments. The Geological Survey of Canada has performed several studies there. Buckley *et al*. (1974) carried a major multidisciplinary study of the Strait of Canso to determine the effects of the causeway on the marine environment. The Strait was determined to exhibit features like those of a bisected fjord. Water quality and geochemical and biological anomalies were discovered in the recent sediments. The marine surficial geology of the Strait of Canso has been also described by MacLean *et al*. (1977).

Studies carried out by Martech (1984) show that, after construction of the causeway, benthic communities in the strait were not diverse (with approximately 6 species per grab sample), were dominated by polychaetes and nemerteans; no mollusks were noticed, and echinoderms were represented only by the brittlestar species *Ophiura sarsi*. The southeastern part of the strait and Chedabucto Bay appeared more diverse and abundant than the rest of the area (with up to 12 taxa per grab). Seatech (1986) studies showed that only live organisms in grab samples were polychaetes, sipunculids and nemerteans, with samples oily-smelling and containing tar droplets. This is presumed, but not demonstrated, to be remnants from the infamous *SS Arrow* tanker spill of 1970 in the approaches to the Strait. The most abundant species were polychaetes *Pectinaria* sp. followed by *Prionospio steenstrupi* and *Ninoe nigripes* (Seatech 1986).

Several researchers noticed gradual development of a “molluscan barren zone” in the deeper waters of the Strait. Wagner (1975) documented a zone along the eastern side of the Strait south of the causeway in which no living mollusca were collected. Shaeffer et al (1975) report that in 1973 the barren zone was stretching approximately from Mulgrave to Middle Melford. Bivalves, such as *Modiolus modiolus* and *Cerastoderma pinnulatum* were present only in shallow waters (Envirosphere 2004). Martech (1984) reports that in 1983 the zone extended to the centre of the Strait, where earlier (in 1970’s) up to 5 molluscan species were recorded, suggesting expansion of the zone in 10 years. 1986 samples revealed mostly disarticulated bivalve shells in the central Strait, as well as empty and eroded gastropod shells (Seatech 1986). The reason for the appearance and gradual extension of the dead zone could be increased effects of anoxia and organic enrichment or displacement of the molluscan species due to changed habitat conditions. Vilks et al (1975) report on the drastic reduction of currents and water mixing in post-construction period, leading to the extensive stratification of waters in the Strait and the reduction of bottom summer water temperatures from 15ºC to 2ºC. Another possible cause of the molluscan dead zone could be industrial contamination (Buckley et al. 1974) caused by e.g. Stora paper mill.

Scarratt (1994) used shoreline observations and diver transects (to depth of about 20 m) to group seafloor conditions into 3 categories. The seafloor was classified into an unaffected sublittoral zone; sites with industrial degradation in deeper water, but with a more natural biota in shallow water; and sites with clear evidence at all depths of environmental degradation attributable to industrialization of the area. A layer of wood fiber with a thickness of 4 m was measured off the outfall from the Stora Forest Products mill at Madden Point. A depth of soft sediment (which included "reddish clayey mud" and wood fiber) was reported, reaching up to 4.0 meters thickness. A 1-3 m thick dark brown turbid surface layer of water, with cleaner water below that, and extending to the bottom, was reported adjacent to the Stora mill. The decapod crustacean *Axius serratus* was found distributed extensively throughout the Strait, in areas from which other species were eliminated (Pemberton *et al*., 1976). This deeply burrowing species can bioturbate sediments to depths of 2 m or more.

Similarly to the degradation of molluscan habitat, a temporal change in benthic fauna was observed in the Strait since 1984. At the common-user disposal site in the Strait the benthic fauna has decreased in species richness since 1984 and previously dominant species of polychaetes (*Nereimyra punctata* and *Spiophanes kroyeri*) became absent (Envirosphere 2004). In 1987, the species composition of benthic fauna indicated the second stage of succession of soft-bottom community (Pocklington 1987), likely after recolonization of initially disturbed habitats. This was indicated by the dominance of *Prionospio steenstrupi* with a mean density of 1556.2 individuals/m^2. Most of the biomass was attributed to larger polychaetes (e.g. *Lumbrinereis* sp.) in samples dominated by wood chips and fiber. After the construction of the causeway the lobster catches in Chedabucto Bay declined by 95% (Petroski 1997).

An assessment of the benthic zone was performed for a proposed coal terminal at Point Tupper by AMEC Earth and Environmental Limited. This assessment consisted of onshore visual inspection and interpretation of the terrestrial environment, underwater benthic video survey, sampling and interpretation of marine sediment, and identification and interpretation of benthic invertebrates (AMEC 2003). Most of the shoreline in this region is described as largely beach-weathered rock with limited vegetation. Field observations of the sediment and invertebrate samples were used to classify this portion of the Strait of Canso as mainly (80%) fine-grained sediment with a high organic matter and limited occurrences of benthic invertebrates. Gravel and cobble materials dominated the immediate nearshore areas. However, the substrate was dominated by mud with a high organic content a short distance from shore. The vegetation was generally very sparse and dominated by eel grass (*Zostera marina*) and rockweed (*Fucus spp*.), with some isolated kelp (*Laminaria spp*.), Irish moss (*Chondrus crispus*), and sour weed (*Desmarestia spp*.). The eel grass communities were the most varied as they tended to occur both as isolated plants or small groups, and also as thick patches over larger areas of the transects (AMEC 2003). These results are supported by Scarratt (1994), who stated that the area "located between the Refinery and the Generating Station cooling water intake had impoverished habitat on the deeper sections, but in shallow water the flora and fauna were more normal".

Based largely on the Hart 2004010 survey, chemical and biological monitoring was conducted for Environment Canada (Tay et al. 2010), including results of biodiversity, and sediment toxicity at the disposal site (TOC, PCBs and PAHs, NH3, S, heavy metals and Redox).

2.2 Equipment

2.2.1 Seafloor Photographs

Seafloor photographs were taken with the “Icehole camera” developed by GSCA (Figure 3, Figure 4). Images were obtained on transects through the disposal site and surrounding area using 200 ASA color print film. Scanned, digital images were incorporated into an ArcView GIS project as a series of “hotlinks” to enable viewing of the images in a geographically referenced context. For further information on methods used to collect photographs and video, and their locations, refer to Hart 2004010 expedition report (Parrott 2010).

Figure 3. “Icehole camera” used to collect seafloor photographs during Hart 2004010 expedition. Photograph by D.R. Parrott. NRCan photo 2023-684.

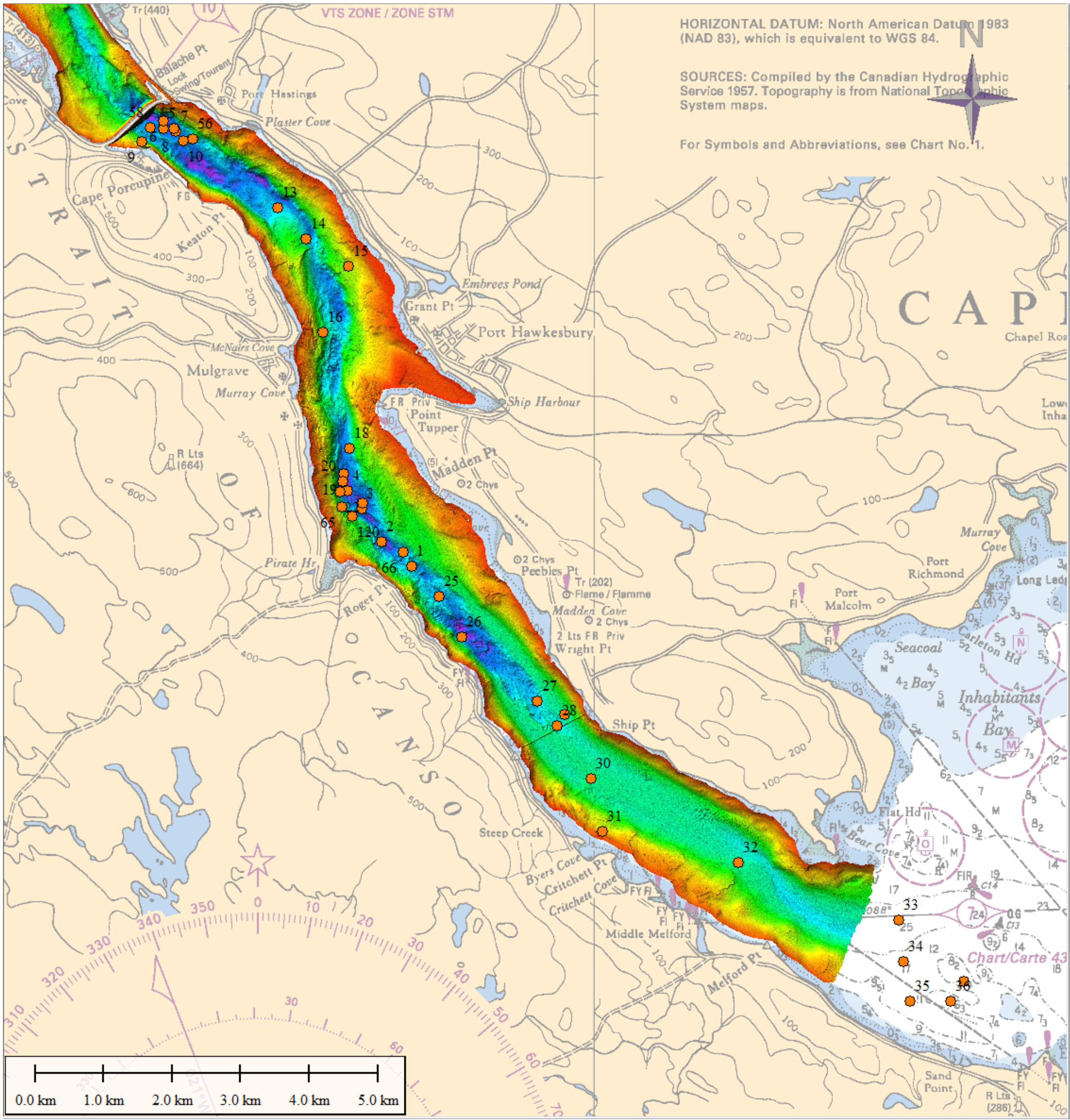

Figure 4. Location of seafloor photographs, shown by the orange circles, taken during Hart 2004010 survey in April 2004. Background – multibeam bathymetry.

2.2.2 Digital Video and Still Photographs

Digital video and still images of the seafloor photographs were obtained with an Insite Tritech Scorpio model 6kM digital still camera. The system consists of a Nikon E995 model camera (3.34 megapixel) in a pressure housing rated for 6000 meters water depth. In Figure 5, the Scorpio camera is shown on the left of the frame, with the flash and flood light on the right of the frame. The digital images were incorporated into an ArcView GIS project as a series of "hotlinks" to enable viewing of the images in a geographically referenced context. Photograph locations are shown in Figure 6. A list of video transects, and thumbnails of the photographs are provided in Parrott (2010).

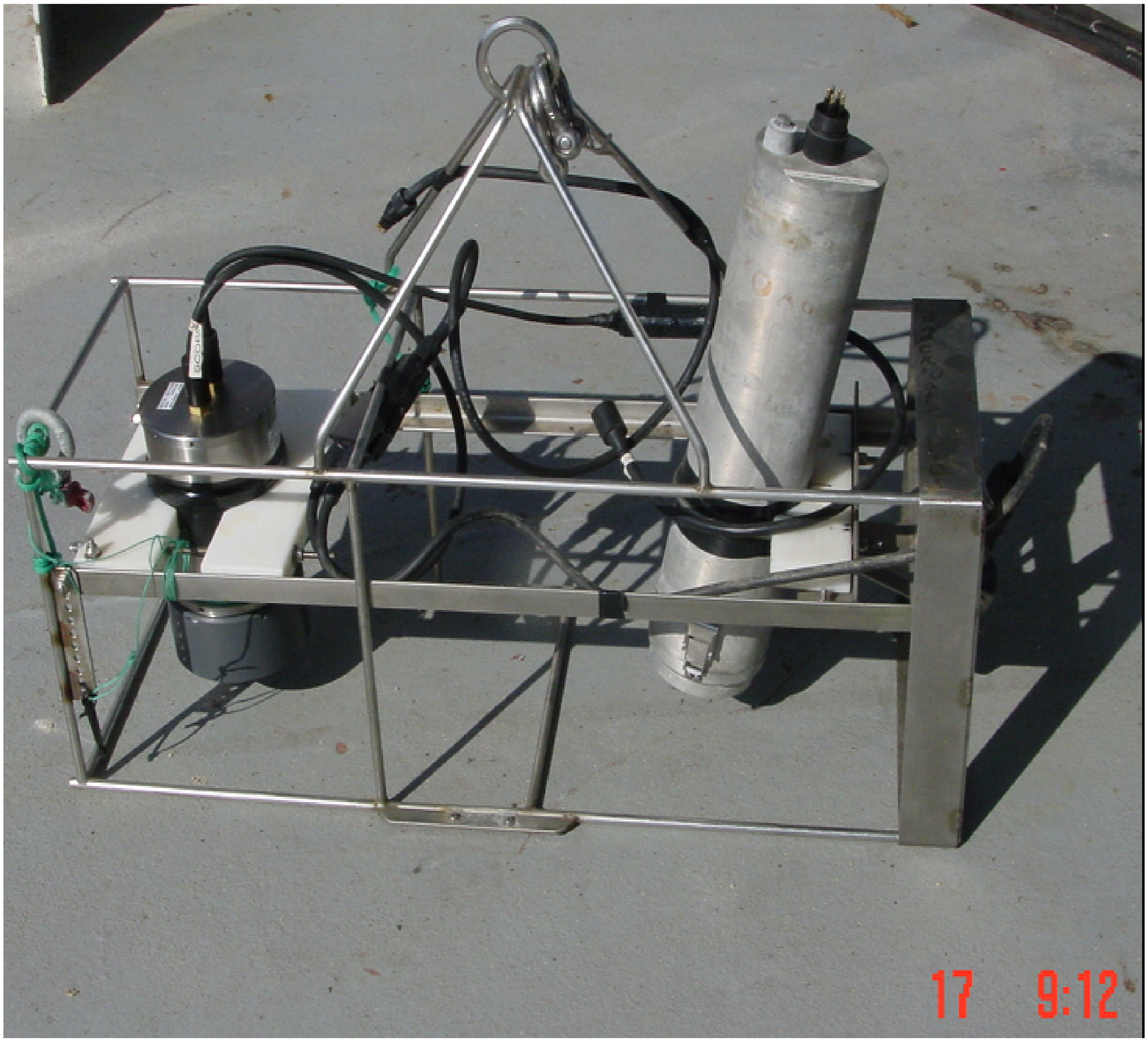

Figure 5. Digital video system used to collect video and digital still images during Hart 2004010. Photograph by D.R. Parrott. NRCan photo 2024-685.

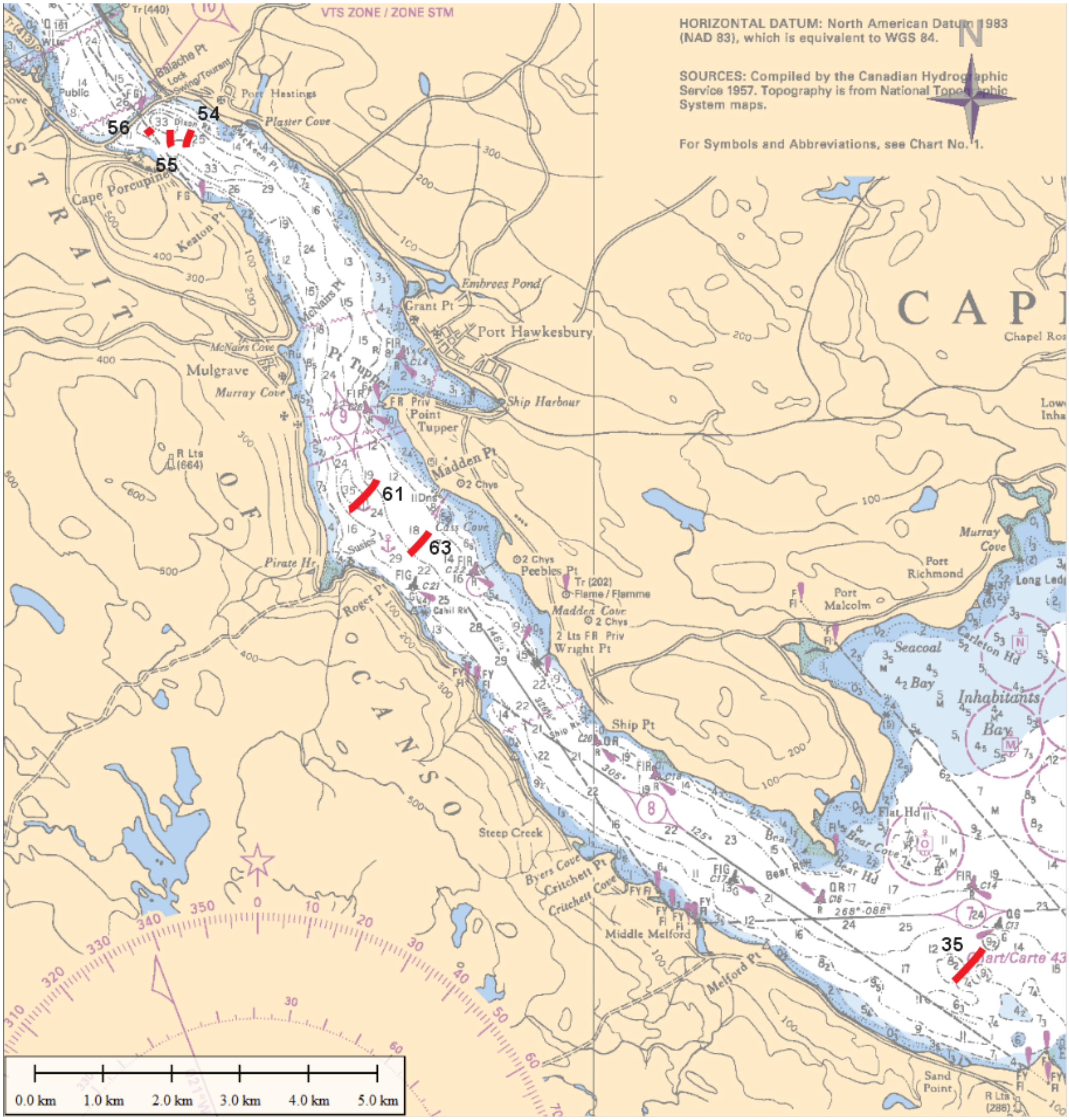

Figure 6. Location of digital video transects taken during survey Hart 2004010 in April 2004 using the Scorpio camera.

2.2.3 TOWCAM

TOWCAM (Gordon et al. 2004) was used to collect color video imagery and digital images of the seabed (Figure 7). The cameras provide a field of view about 1-2 m wide when towed at a constant altitude (generally about 2-4 m above the seabed). High-resolution digital still images were burned to CD and analyzed on a computer using Paint Shop Pro. Manipulating the contrast, brightness, color and grain of the image further enhanced the resolution and allowed resolving features on the order of a few millimeters.

The photograph locations are shown in Figure 8. Many of the digital images were incorporated as ‘hotlinks’ in an ArcView GIS data base to provide geographically referenced access to the images.

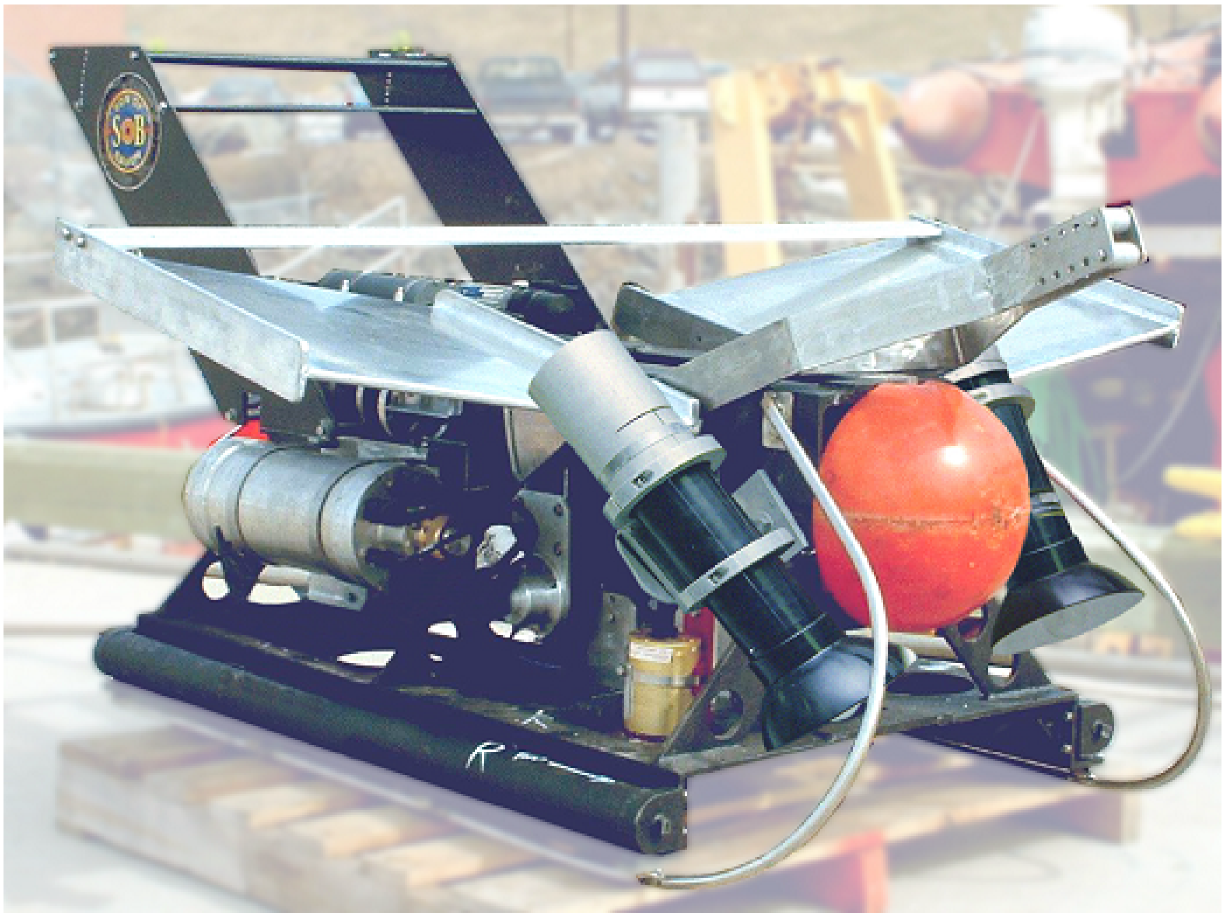

Figure 7. The TOWCAM system. The lights are located on the front of the tow body. Photograph by D.R. Parrott NRCan photo 2023-686.

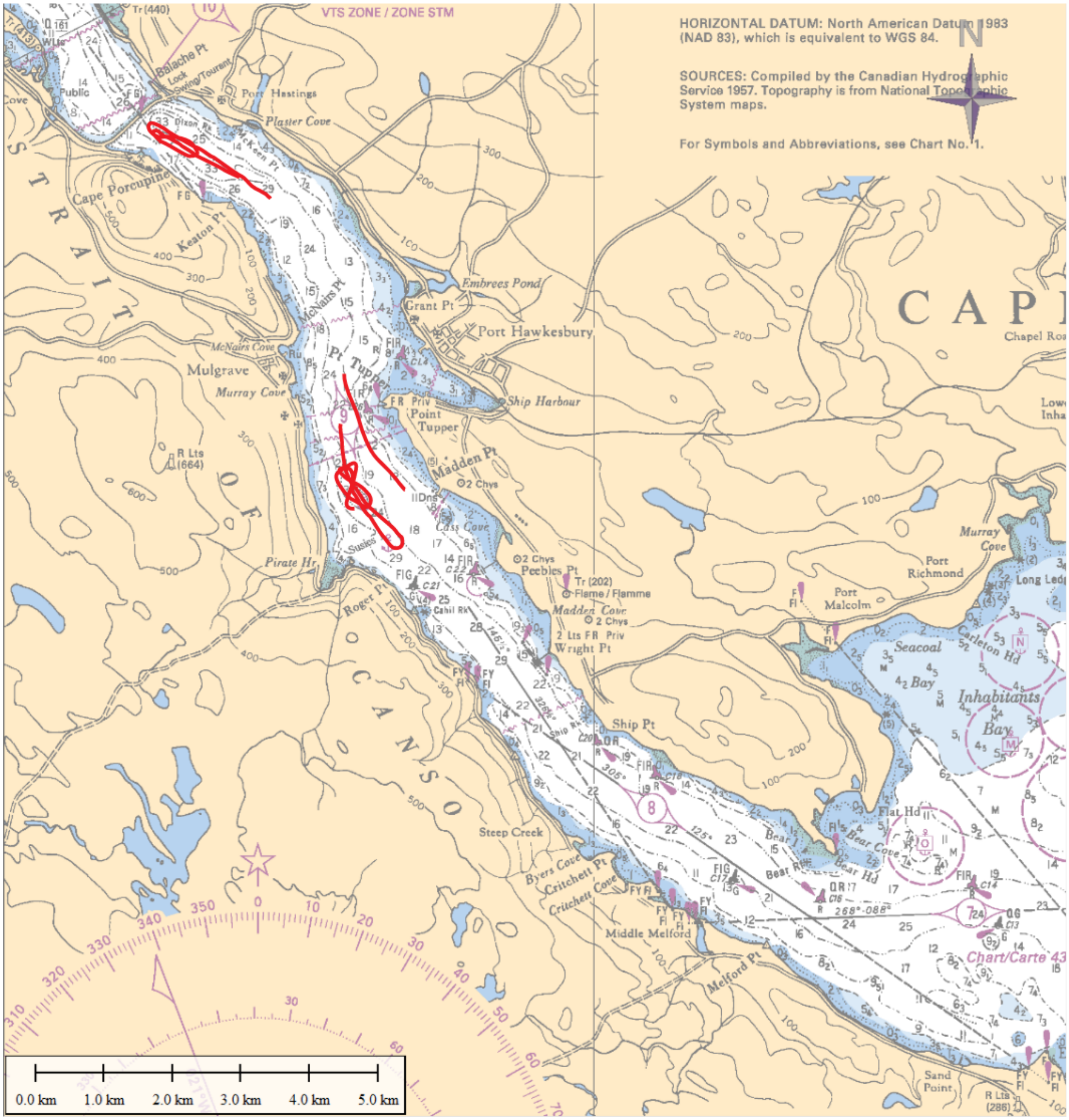

Figure 8. Location of TOWCAM transects, shown by the red lines, taken during survey Hart 2004010 in April 2004.

3. Analysis of Benthic Fauna

A detailed analysis was performed on 867 seafloor photographs and on several hours of underwater video transects collected by GSC(A) in the Strait of Canso during Hart 2004010 survey (Rumbolt 2005). Images from a total of 38 stations were analyzed. Physical habitat characteristics and the type and relative abundance of benthic fauna were interpreted from the seafloor photographs. Physical habitat was described in terms of relative surface cover of boulders, cobbles, pebbles, granules, sand and silt and perceived topographic complexity. Other habitat descriptors were surface complexity and water turbidity, as well as abundance of shell hash, large and small burrows, and siphons of infaunal invertebrates. All visible species of megabenthos were identified to the highest possible taxonomic resolution. Average abundance ranks for benthos and habitat characteristics were calculated for each seafloor photograph, ranging from 0 (very low) to 5 (very high). The observed surficial sediments were classified into 7 categories: bedrock, cobbles/boulders, pebbles/granules, sand, fine sand, muddy sand, and mud, following the Wentworth Scale (Wentworth 1922).

Presence of visible benthic fauna were identified to the lowest taxonomic level possible and a representative photo of each representative taxon was saved in a database. The presence of burrows, trails and tracks of motile fauna were described as references to the possibility of infauna or other species present but not observed on the photographs. The presence of each taxon from each photograph was then averaged to arrive at an occurrence frequency for each taxa at each photo station for a total of 38 stations. Average percent cover of each sediment type within a station was calculated by finding its proportion in each photograph and averaging all photographs at a given station.

This detailed analysis of the seafloor photographs provided information on the physical habitat in terms of relative abundance of boulders, cobbles, pebbles, granules, sand and silt. The images confirm the presence of fine-grained sediments over the deeper portions of the Strait, with coarse grained sediments present near the disposal site. Figure 9 shows sediment texture (Percent cover for different grain sizes) based on optical classification of bottom photographs. There is a general correspondence between occurrence of coarser sediments with zones of higher backscatter.

Most benthic species could be easily identified from these photos although it is difficult to identify some taxa to species level without further laboratory work. Some photos were of poor clarity due to the height of the camera above the seafloor or bad camera focus making positive identification of some benthic organisms difficult. When identifying benthic invertebrates from photos it is not possible to accurately describe the infauna community that burrow into the substrate. In this case the presence of burrows, trails and tracks of fauna are described as references to the possibly of an infaunal community.

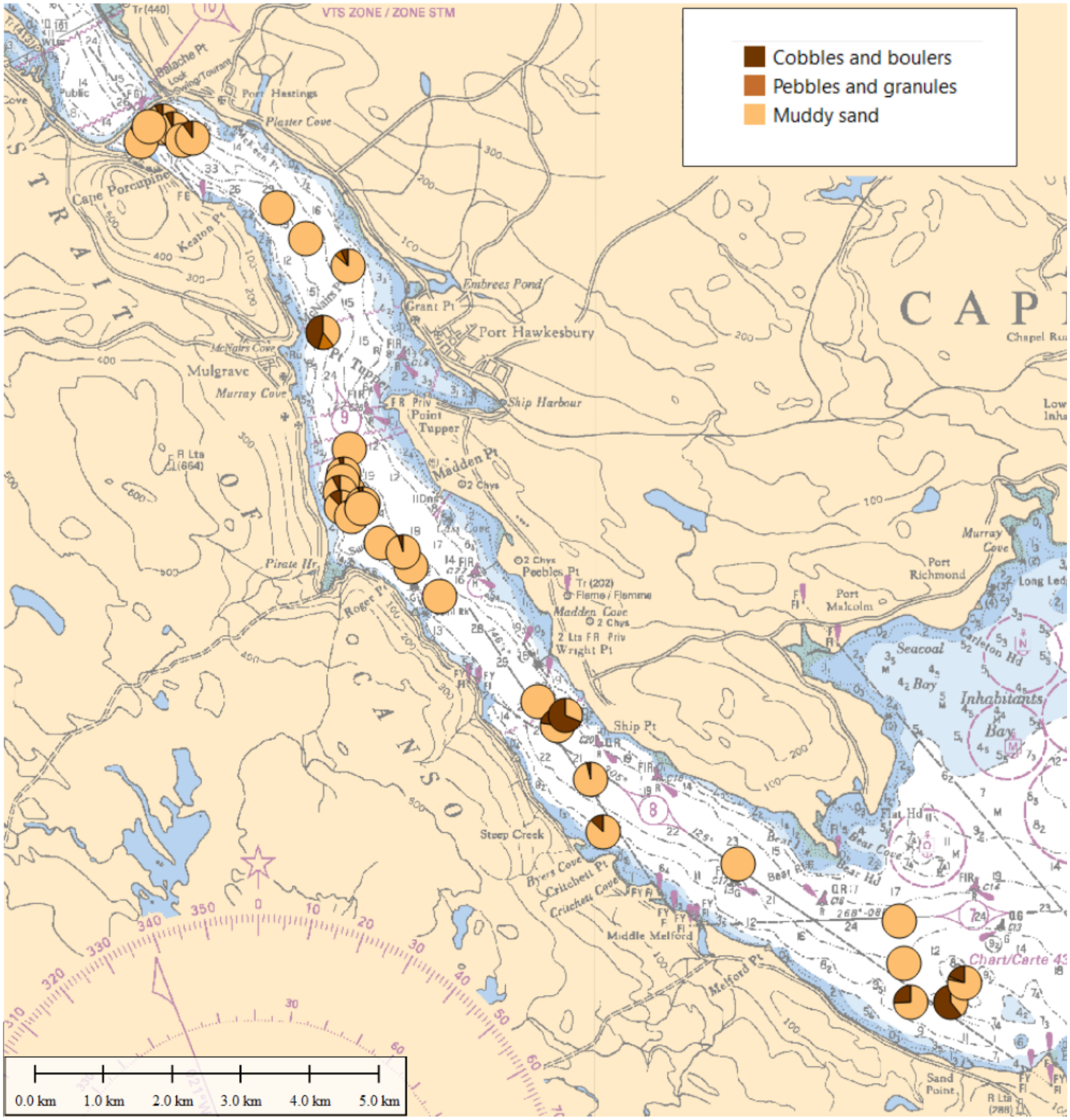

Figure 9. Sediment texture (Percent cover for different grain sizes) based on optical classification of bottom photographs.

Seafloor photographs from within the deeper portion of the Strait, including the disposal site (Figure 10), show seafloor with a covering of fine-grained sediment which sometimes overlies coarser material. This mud was apparent on bottom photographs because the trigger weight for the camera, as it impacted seafloor sediments, generally caused suspension of the fine material. Large quantities of the brittle star *Ophiura sarsi* and borrows of unknown origin were present throughout the area. Analysis of seabed texture revealed that, within the disposal site and in its vicinity, surficial cover of gravel is higher than elsewhere in the strait. Photographic transects through the disposal site also showed the presence of boulders, cobbles and gravel, along with assorted debris including tires, trees, wood and a trailer.

Seafloor photographs southeast of the Canso Causeway, confirm that much of the seafloor is covered by a thin veneer of fine sediments and densely populated with the brittle star *Ophiura sarsi* and sea anemones *Hormathia nodosa*, which generally anchor themselves on a hard substrate (Figure 11). Their occurrence indicates the presence of coarser material under the fine surface veneer. Note how the range marker for the digital camera disturbed the seafloor sediments and caused suspension of the fine material.

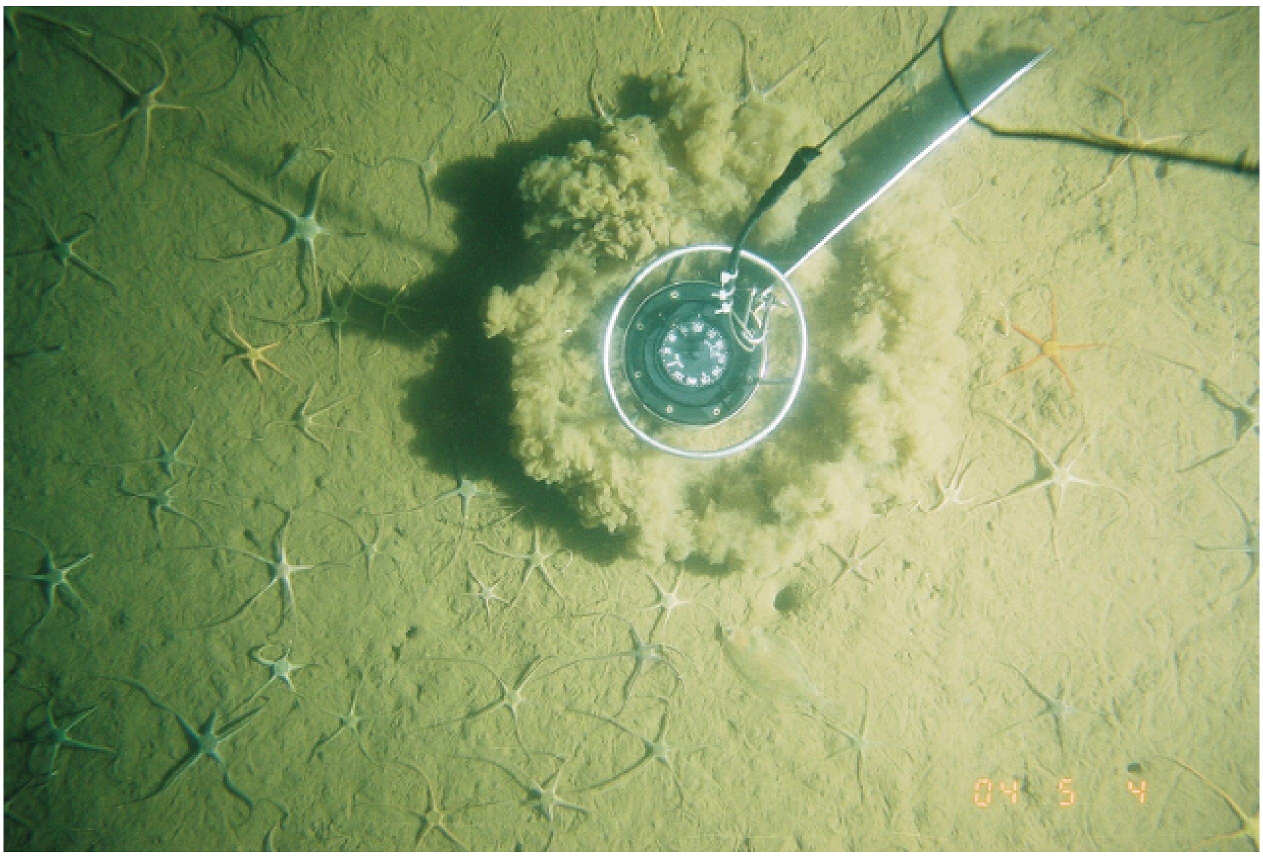

Figure 10. Seafloor photograph from within the disposal site from Hart 2004010 Station 3.
Photograph by D.R. Parrott NRCan photo 2023-687.

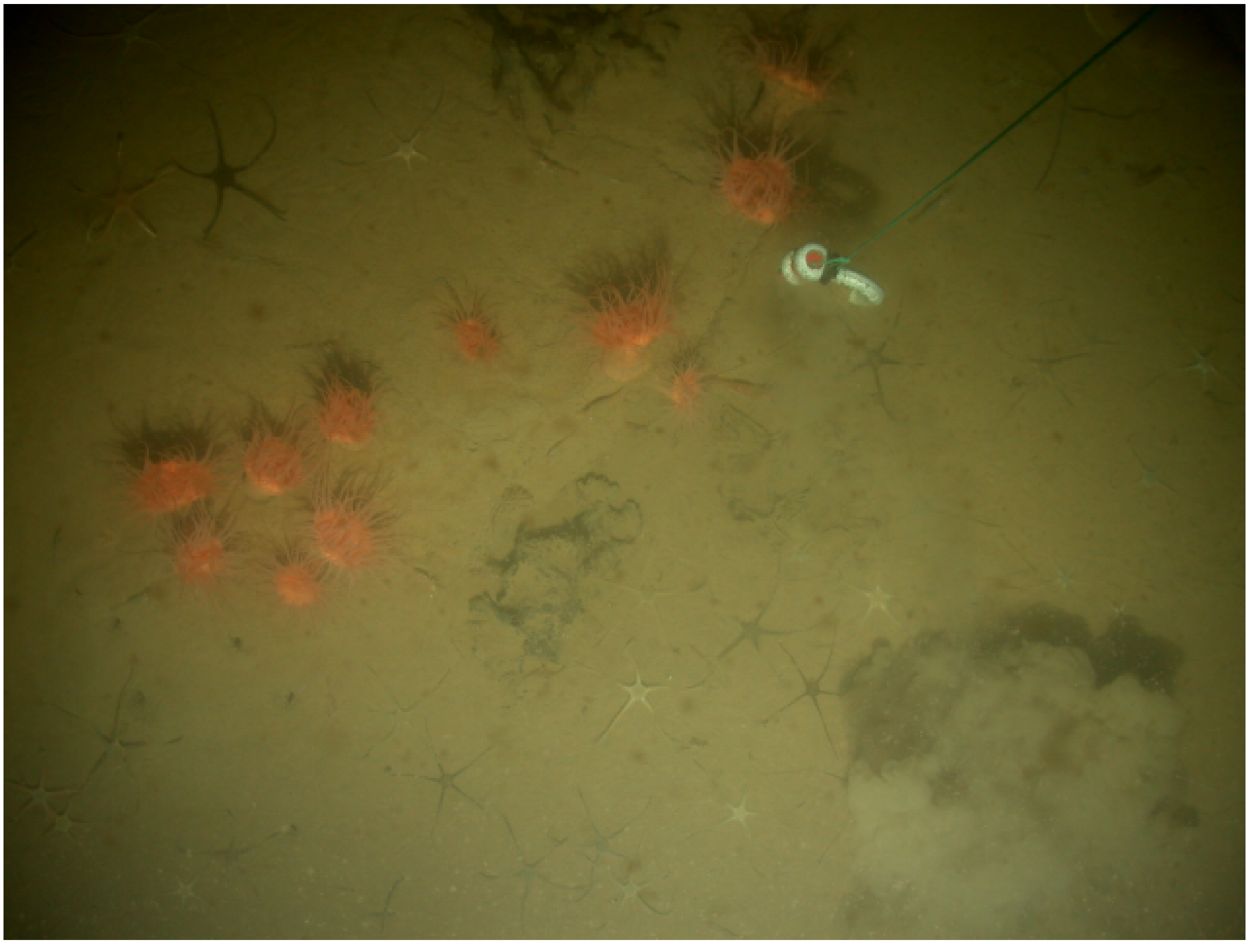

Figure 11. Seafloor photographs from Canso Strait showing soft sediments with high density of brittle stars. Sea anemones were present in many areas, indicating the presence of hard substrate under the fine sediments. Photograph by D.R. Parrott NRCan photo 2023-688.

Pandalid shrimps were common. The seabed was bioturbated, with multiple tracks and trails of mobile fauna, polychaete burrows, siphon openings of infaunal mollusks, tubes and fecal casts of other invertebrates. Jonah crab (*Cancer* sp.) and flatfish also occur in this habitat. This assemblage dominated water depths 30 meters and deeper, with surficial sediment cover generally containing less than 20% gravel.

Cluster analysis and Nonmetric Multidimensional Scaling plots were generated from the interpretation of benthic organisms seen on the bottom photographs. Five distinct clusters were distinguished based on the co-occurrence of benthic organisms on seabed photographs as shown in Figure 12. Two community types were determined to be the most common and widespread in the study area – a soft bottom community (assemblage C) dominated by brittle star *Ophiura sarsi* and a hard bottom community (assemblage A) mainly comprising brown algae and sometimes horse mussels (*Modiolus modiolus*). Figure 12 shows the composition and association diagrams of the assemblages.

Richness and composition of benthic epifauna was found to vary with the substrate type and distance from the causeway. Assemblage A is common on hard substrates, assemblage C is common on soft, muddy sand as shown in Figure 13. Other assemblages do not exhibit a distinct pattern and are less represented through the area. Note the increase in assemblage A with the increase in gravel content and the corresponding decrease in assemblage C.

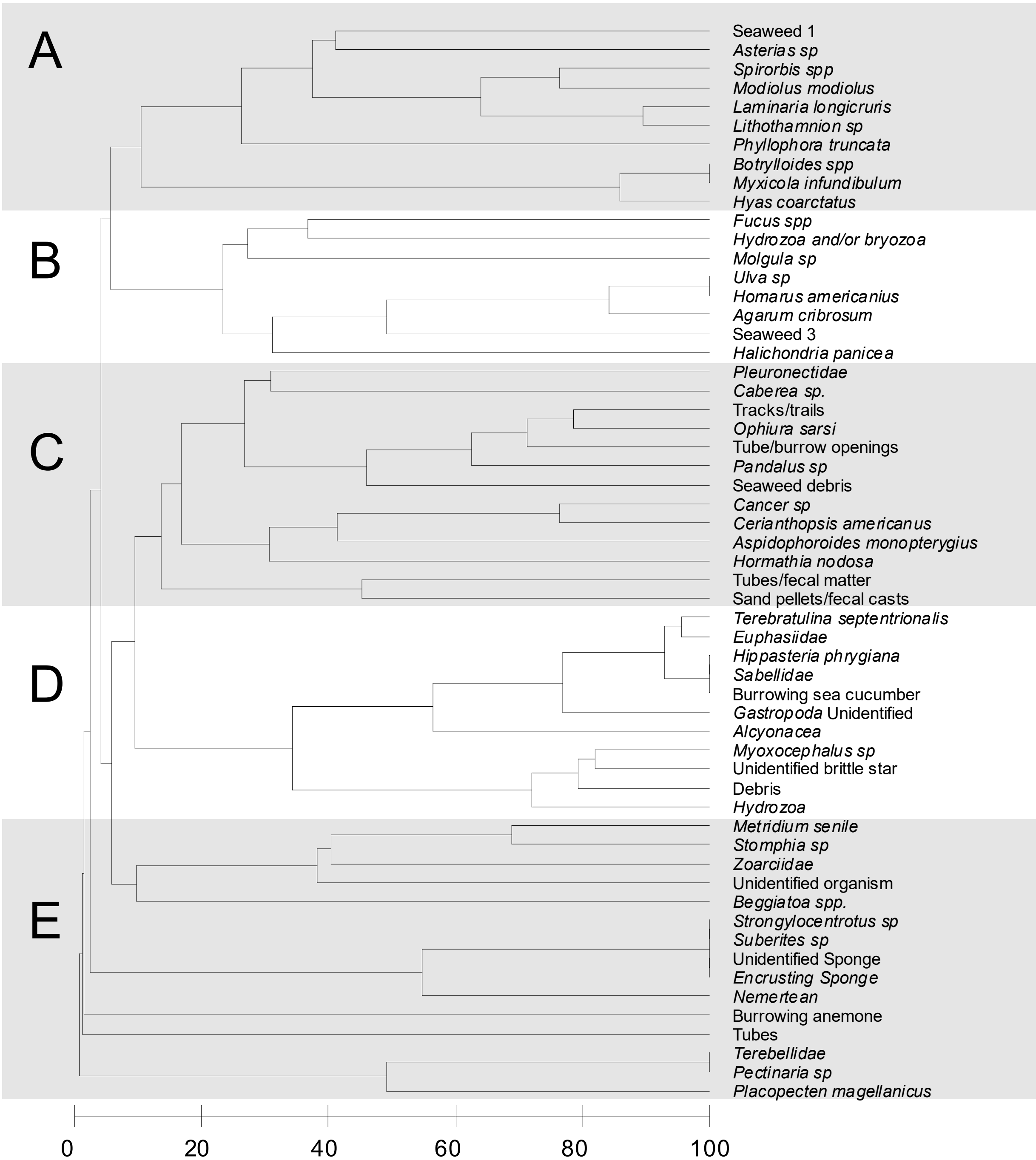

Figure 12. Cluster analysis of co-occurrence of benthic organisms distinguished on seabed photographs, determined using Bray-Curtis similarity with group average linking.

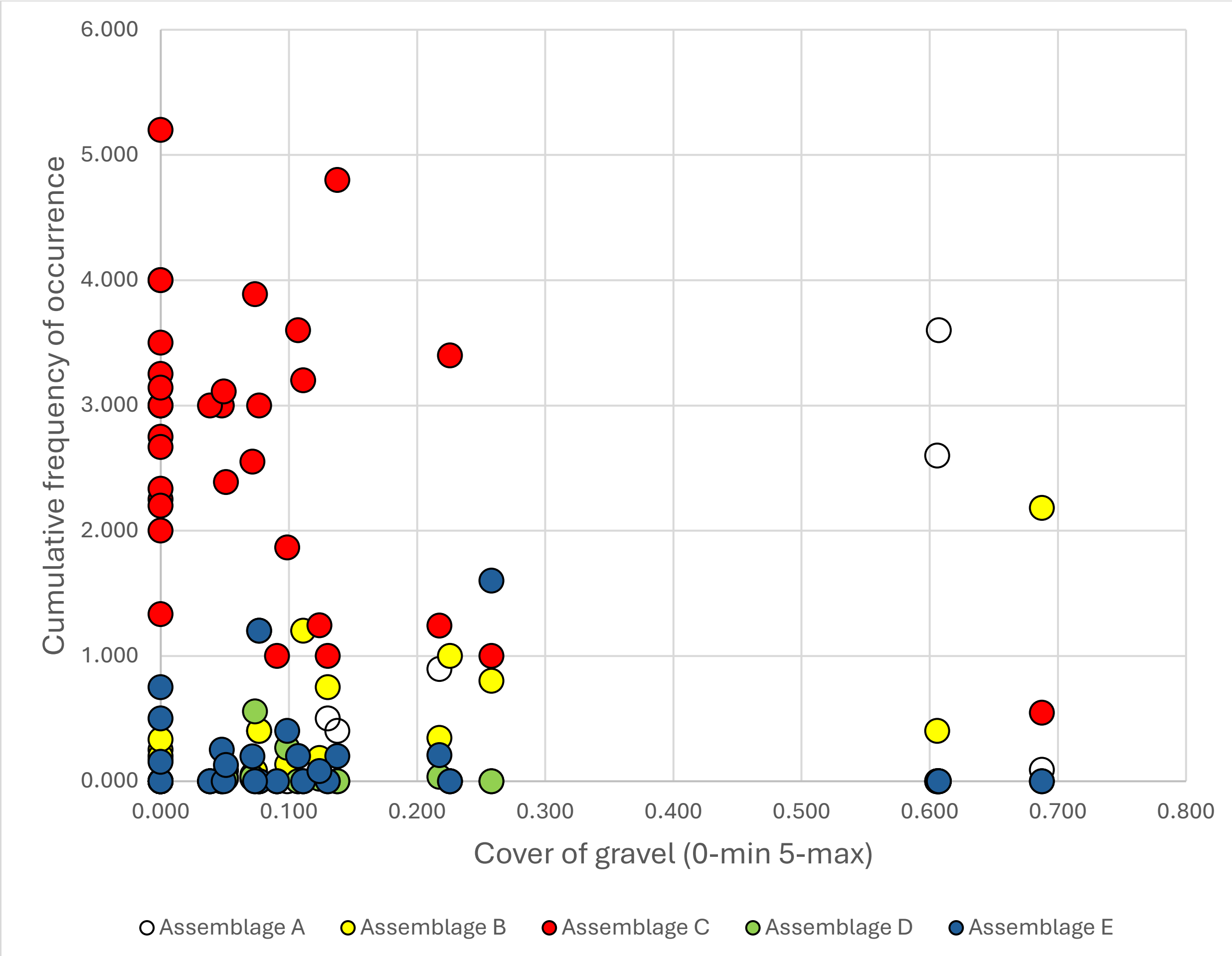

Figure 13. Cumulative frequency of assemblages' occurrence versus cover of gravel, cobbles and boulders throughout the Strait of Canso. Assemblage A is common on hard substrates, assemblage C is common on soft, muddy sand. Other assemblages do not exhibit a distinct pattern and are less represented through the area.

Figure 14 shows the distribution of the clusters overlain on the acoustic backscatter intensity. Assemblage C which contains the *Ophiura* is the most common assemblage and is found throughout the Strait in much of the deeper water, with a soft substrate (indicated by lighter colors on the acoustic backscatter data). Near the disposal site, assemblage C dominates, with some occurrence of species from other groups. Hydrozoans and bryozoans are commonly found on gravel particles here and may be related to gravel occurrences due to disposal activities. Near the disposal site there were fewer indications of bioturbation (such as infaunal burrows) than in other soft-bottom sites in the strait, suggesting possible effects by disposal activities. Assemblage A occurs near areas with high backscatter (dark grey color on Figure 14) indicating the presence of coarser sediments such as gravel.

On the images analyzed, biodiversity was the highest in areas immediately outside of Strait, where a maximum of 21 macro benthic species were observed per station (Figure 15). These data confirm the observation by Martech (1984) that biodiversity was decreased within the Strait. The amount of seabed covered by bryozoans and hydroids, and other epibenthic species, also increased with proximity to open water. Within the Strait and approaches, epifauna was directly related to sediment texture and became more diverse with the increase in seabed surface cover by cobbles and boulders.

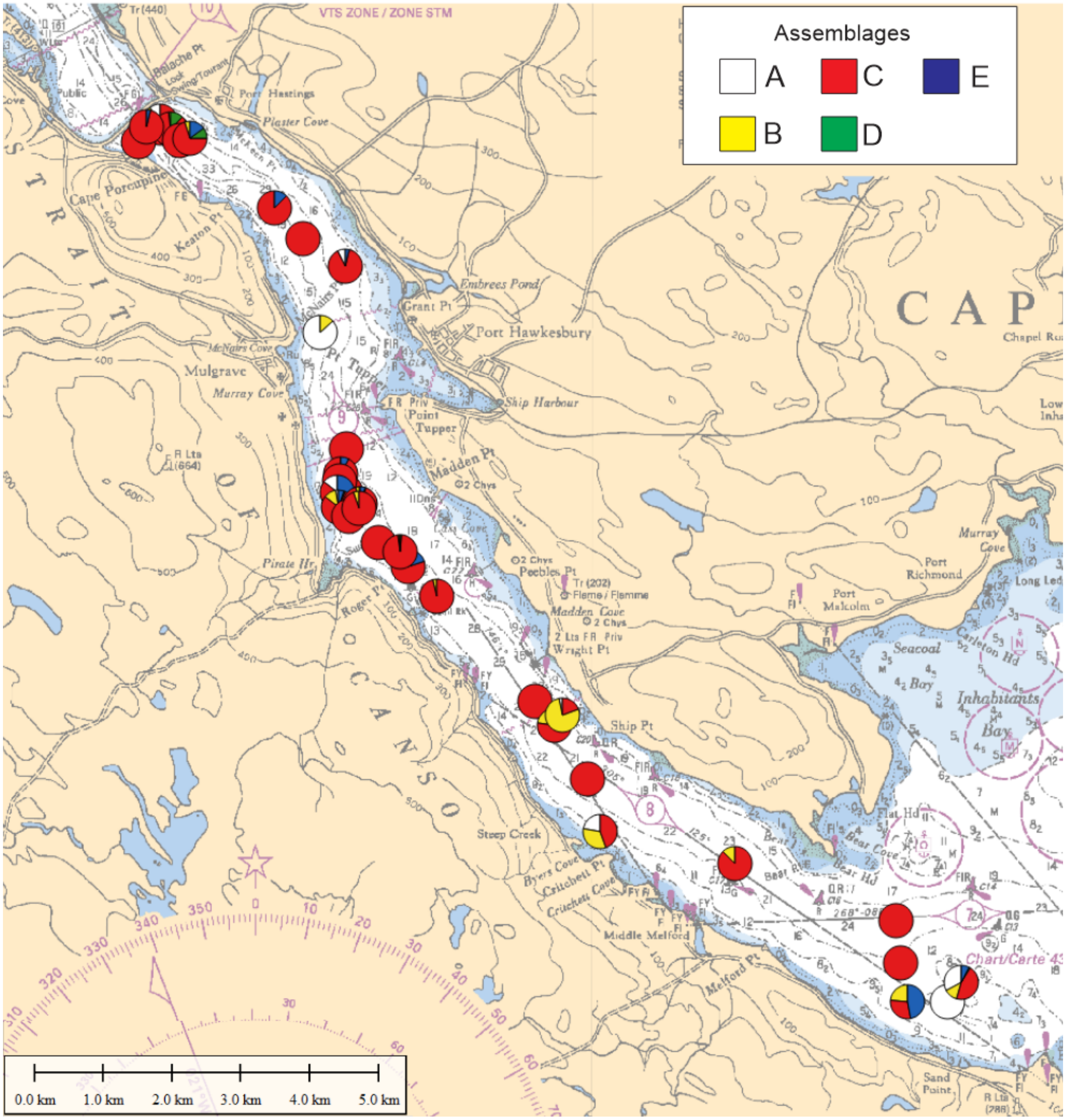

Figure 14. Relative frequency distribution of assemblage types in the Strait of Canso. Assemblage C is common in areas of low acoustic backscatter, indicating muddy substrate. Assemblage A is found in areas with higher backscatter indicating coarse sediments.

The number of taxa observed at each station in the Strait increases with water depth (Figure 16), and with the fraction of sediment cover by muddy sand where the relative abundance of taxa as well as variability of it is the highest. Generally, the number of taxa in the study area is highest on muddy sand, relating to higher diversity of *Ophiura* assemblage. The disposal site did not show a distinct difference from other stations in taxonomic diversity.

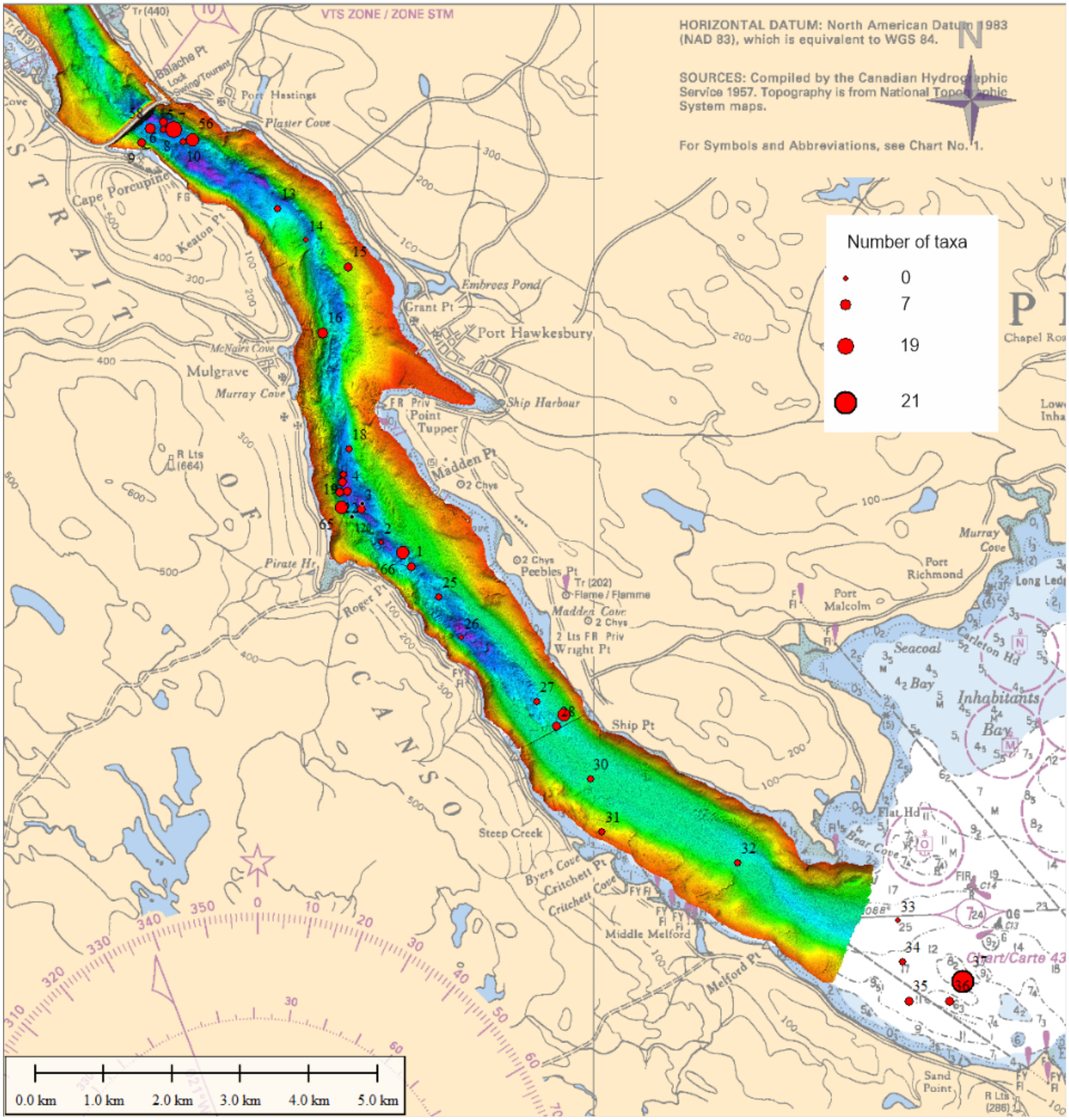

Figure 15. Number of benthic taxa observed on the seabed in the study area overlain on depth.

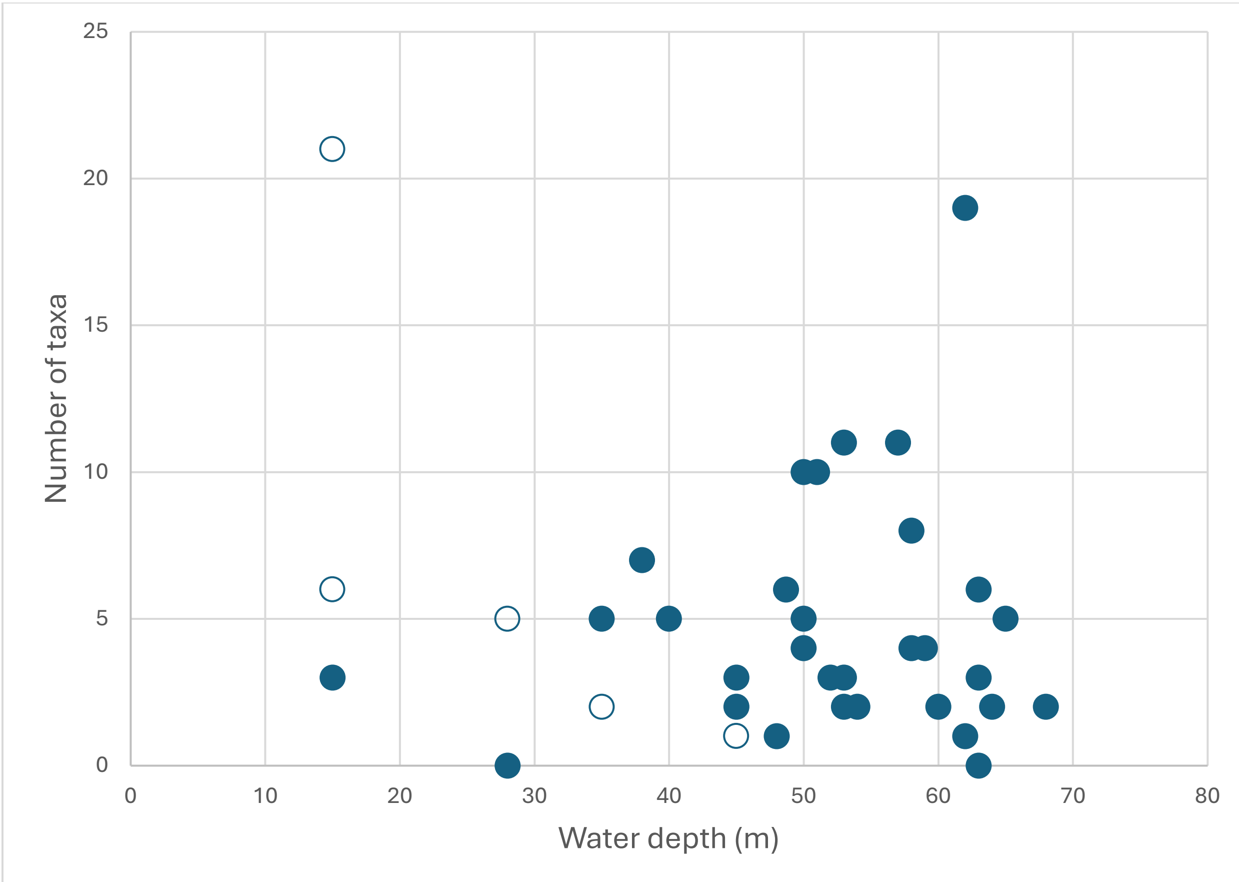

Figure 16. Number of taxa vs water depth. Filled circles – stations within the Strait. Open circles – stations outside the Strait (Chedabucto Bay). Species richness within the Strait generally increases with water depth.

4. Conclusions

The data presented here provide an interpretation of seafloor sediments and macrofauna observed from underwater photographs and video transects only. The area of seafloor surveyed during Hart 2004010 cruise is predominantly a muddy sand substrate. No sand ripples are visible though the bathymetric imagery confirms a variety of such bedforms outside the sample sites. Occasional patches of angular cobbles and boulders occur but otherwise the seafloor is homogenous. In some cases, the bottom type is described as muddy sand, there is probably a hard substrate underneath, covered by a thin layer of soft sediment. This is evident by the presence of the anemone *Hormathia nodosa*, which attaches itself to a hard substrate and is very abundant in certain areas. The predatory brittle star, *Ophiura sarsi* is very abundant throughout the survey and frequently occurs in "muddy" substrate communities. Numerous burrow openings, trails and tracks of other invertebrates are also seen, indicating the presence of an infauna community. Other fauna is generally scarce.

Bivalve mollusks were observed mostly in the outer part of the Strait, connecting with Chedabucto Bay, and the only occurrence of horse mussels in the inner Strait was next to the dumping site. These may have been transported with the dumped material, or occurred there because of presence of dumped gravel, suitable for attachment.

The reduced current flow regime, which developed after construction of the causeway, has resulted in more quiescent conditions allowing the deposition of fine-grained sediments and preserving seafloor features. Seafloor images and samples show the presence of a veneer of fine mud overlying most of the seafloor within the Strait of Canso, including the bedforms on the seafloor (Parrott 2010, Envirosphere 2004).

This study further substantiates numerous earlier examinations that demonstrate decreased biodiversity within the Strait compared to the surveyed part of Chedabucto Bay. Further, the diversity is temporally linked to the diminished circulation and possibly the increased mud deposition that developed after causeway construction. The amount of seabed covered by bryozoans and hydroids, and other epibenthic species, also increased with proximity to open water. Within the Strait and approaches, epifauna was directly related to sediment texture and became more diverse with the increase in seabed surface cover by cobbles and boulders. The number of taxa observed at each station in the strait increases with water depth, and the variability of it is the highest on muddy sand.

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