

Near-seafloor optical imagery surveys (2022 to 2024) in proposed Scotian Shelf-Bay of Fundy marine bioregion conservation network sites in Southwest New Brunswick, Canada: benthic habitat characterization and occurrence of select taxa

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ABSTRACT

Teed, L. L. and Lawton, P. 2026. Near-seafloor optical imagery surveys (2022 to 2024) in proposed Scotian Shelf-Bay of Fundy marine bioregion conservation network sites in Southwest New Brunswick, Canada: benthic habitat characterization and occurrence of select taxa. *Can. Tech. Rep. Fish. Aquat. Sci.* 3785: viii + 94 p. <https://doi.org/10.60825/fvqd-qh71>

A near-seafloor optical imagery survey was conducted from 2022 to 2024 at 73 locations within Ecologically and Biologically Significant Areas (EBSAs) and proposed Marine Conservation Network (MCN) sites in Southwest New Brunswick (SWNB). Here we document occurrence and abundance of select taxa and/or species of interest, characterize benthic habitats and unique bathymetric features (e.g., Wolves Bank), and update information on benthic taxa and habitats since prior surveys in 2016 and 2017. Updated camera system specifications allowed for an expanded depth coverage (to 200-m depth compared to prior ~85-m deployment capability). The new survey explored 11 of 20 areas included in the MCN plan for SWNB, gained information to guide ocean managers and stakeholders on commercially important taxa, and provided new ground-truthing information for habitat suitability models for two conservation priority species. Over 47 km of the seafloor was surveyed (15 to 188-m depths), with an estimated area coverage of 27080 m², resulting in over 30 hours of high-definition video and over 5800 digital still images. Full video sequences were used to qualitatively describe each transect and evaluate substrate characteristics, while a subset of 1699 images (spaced ~20 m apart along transects) were analyzed to document occurrence of select taxa and abundance of commercially important and conservation priority species. Image analysis included 68 taxa across 11 phyla, 43 of which were identified to species level. A total of 8524 occurrences were recorded, with the most common taxa including encrusting sponges, common sea stars, and knotted wrack algae. The Head Harbour/West Isles/Passages EBSA was particularly diverse, containing 59 of the 68 taxa on a highly heterogeneous seafloor. Horse mussel beds were common in this EBSA, while sea urchins were notably absent, when compared to 2017 imagery surveys. This survey supports the development of the MCN plan, highlighting uniquely diverse habitats across SWNB.

RÉSUMÉ

Teed, L. L. and Lawton, P. 2026. Near-seafloor optical imagery surveys (2022 to 2024) in proposed Scotian Shelf-Bay of Fundy marine bioregion conservation network sites in Southwest New Brunswick, Canada: benthic habitat characterization and occurrence of select taxa. Can. Tech. Rep. Fish. Aquat. Sci. 3785: viii + 94 p. <https://doi.org/10.60825/fvqd-qh71>

Un relevé par imagerie optique près du fond marin a été réalisé de 2022 à 2024 à 73 endroits situés dans des zones d'importance écologique et biologique (ZIEB) et des sites proposés pour le réseau de conservation marine dans le sud-ouest du Nouveau-Brunswick. Nous documentons ici la présence et l'abondance de certains taxons et espèces d'intérêt, caractérisons les habitats benthiques et les éléments bathymétriques uniques (p. ex. le banc Wolves) et mettons à jour l'information sur les taxons et les habitats benthiques depuis les relevés antérieurs de 2016 et 2017. Avec l'actualisation des spécifications du système de caméra, la couverture des profondeurs a été augmentée (jusqu'à 200 m de profondeur par rapport à une capacité de déploiement antérieure d'environ 85 m). Le nouveau relevé a permis d'explorer 11 des 20 zones incluses dans le plan du réseau de conservation marine dans le sud-ouest du Nouveau-Brunswick, d'obtenir de l'information pour guider les gestionnaires des océans et les intervenants sur les taxons d'importance commerciale et de faire une validation des données sur le terrain pour la modélisation du caractère convenable de l'habitat pour deux espèces prioritaires en matière de conservation. Plus de 47 km de fond marin ont été relevés (de 15 à 188 m de profondeur), avec une couverture estimée à 27 080 m², ce qui a donné plus de 30 heures de vidéo haute définition et plus de 5 800 images numériques fixes. Des séquences vidéo complètes ont été utilisées pour décrire qualitativement chaque transect et évaluer les caractéristiques du substrat, tandis qu'un sous-ensemble de 1 699 images (espacées d'environ 20 m le long des transects) a été analysé pour consigner la présence de certains taxons et l'abondance d'espèces d'importance commerciale et prioritaires pour la conservation. L'analyse des images a porté sur 68 taxons répartis dans 11 phylums, dont 43 ont été identifiés au niveau de l'espèce. Au total, 8 524 présences ont été enregistrées, les taxons les plus courants étant les éponges incrustantes, les étoiles de mer communes et les ascophylles noueuses. La ZIEB de Head Harbour/West Isles/Les Passages (comportant cinq sites du réseau de conservation marine) était particulièrement diversifiée, contenant 59 des 68 taxons sur un fond marin hétérogène. Les gisements de modioles étaient courants dans cette ZIEB, mais l'absence des oursins a été notée par rapport aux relevés par imagerie de 2017. Ce relevé contribue à l'élaboration du plan du réseau de conservation marine en mettant en évidence la diversité unique des habitats dans le sud-ouest du Nouveau-Brunswick.

1 INTRODUCTION

The Canadian Government set a new goal in 2019 to protect 30% of Canada's oceans by 2030, following achievement of protecting 10% of coastal areas (DFO 2023a), aligning with the Convention on Biological Diversity (2022) Kunming-Montral Global Biodiversity Framework that was adopted in December 2022. The Department of Fisheries and Oceans Canada (DFO) has worked with affiliated partners (other federal and provincial government departments, Indigenous communities, and fisheries and other stakeholders) to advance a marine conservation network plan for the Scotian Shelf-Bay of Fundy (SS-BoF) bioregion (Figure 1). When formally in place, this Marine Conservation Network (MCN) will amplify the contributions of individual Marine Protected Areas (MPAs), Marine Refuges, and Other Effective Area-based Conservation Measures to achieve significant ecological benefits leading to cultural, social, and economic advantages (DFO 2018, 2023a, 2025). While the proposed MCN is still under discussion with stakeholders, further baseline characterization of proposed conservation sites is required, along with consideration of potential ecological monitoring approaches (e.g., T.J. Kenchington 2014; King et al. 2021), both at the site and at the regional scale.

The southwestern portion of the bioregion, within the lower Bay of Fundy (off the coast of Southwest New Brunswick – hereafter SWNB) contains numerous islands that form, at least in part, broader Ecologically and Biologically Significant Areas (EBSAs; Figure 1). This includes areas off of the three largest islands in SWNB: Deer Island, Campobello Island, and Grand Manan. Generally, SWNB has depths extending from the intertidal down to ~220 m (off Southern Grand Manan), and is characterized by strong tidal currents, persistent upwelling, heterogenous substrates, and complex seafloor topography surrounding numerous smaller islands and passages (Buzeta 2014). Various benthic habitat types exist here, supporting a high biodiversity of organisms, including areas of dense kelp and algae (dulse) beds, biogenic habitat-forming horse mussel reefs and stalked tunicate fields, bryozoan turf, cerianthid fields, and sponge communities (Thomas 1983; Buzeta 2014; E. Kenchington 2014; DFO 2015). In addition to their conservation significance domestically, several of these biogenic habitat-forming species hold international conservation priority designations (Murillo et al. 2011; DFO 2018; Kenchington et al. 2019; NAFO 2024).

The horse mussel, *Modiolus modiolus*, is a semi-infaunal bivalve that can form dense aggregations termed “biogenic reefs” or “beds” (Wildish et al. 1998; Morris 2015). These beds or reefs are considered a priority marine habitat (OSPAR Commission 2009), with significant

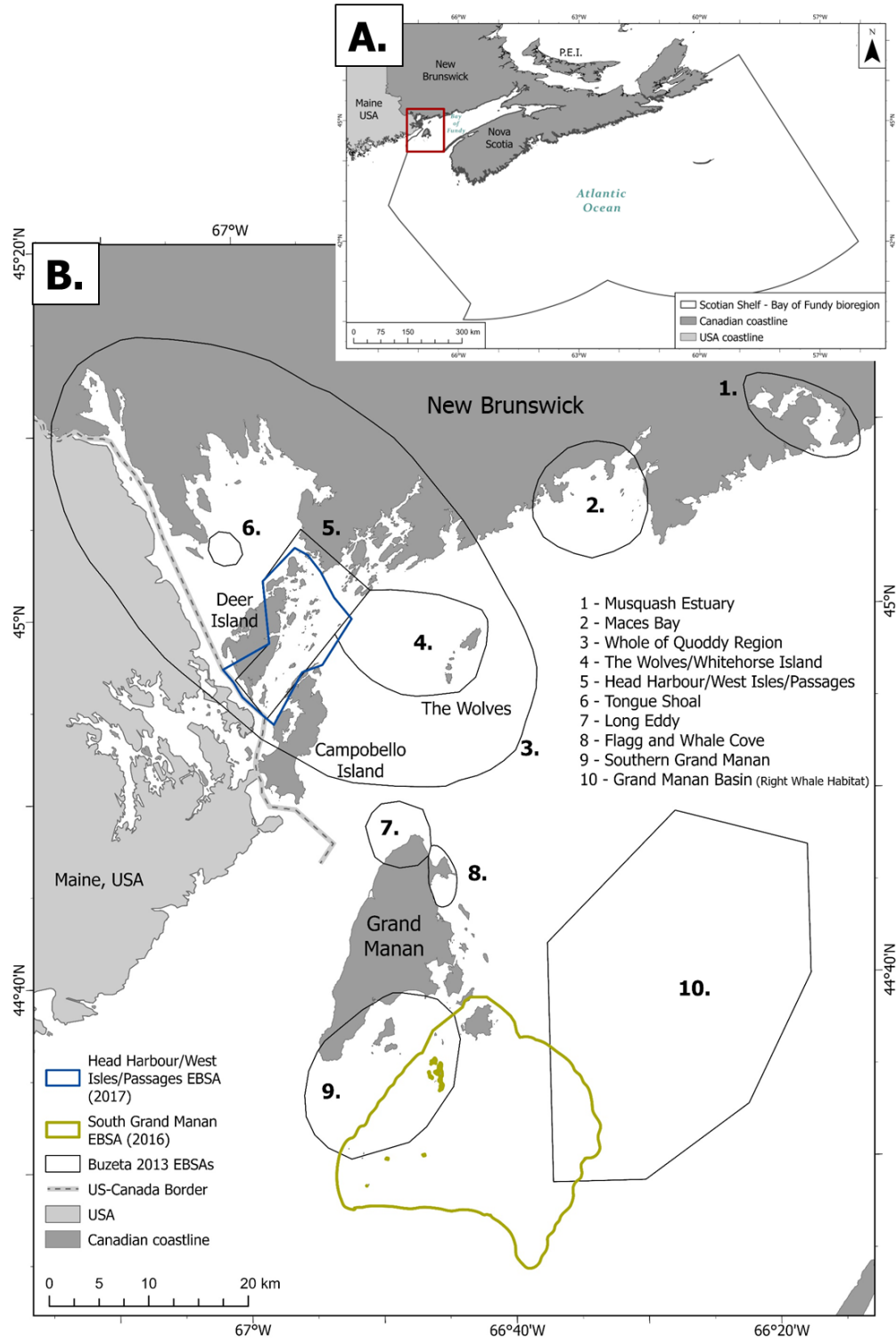


Figure 1. (A) Southwest New Brunswick coastline in the Scotian Shelf-Bay of Fundy marine bioregion with the (B) original proposed Ecologically and Biologically Significant Areas (EBSAs) from the 2014 inventory (black), and 2016/2017 iterations of two particular EBSAs: the Head Harbour/West Isles/Passages (HH/WI/P) EBSA (blue) and the Southern Grand Manan EBSA (green).

aggregations documented in the central portion of the Bay of Fundy (Sameoto et al. 2021; Wilson et al. 2021), and also within the SWNB region between Deer Island and Campobello Island (Mireault et al. 2025). Stalked tunicate fields (*Boltenia ovifera*) may occur broadly within the Bay of Fundy, increasing habitat complexity, and generating shelter for mobile epifauna and attachment sites for epibionts (Francis et al. 2014). However, the only quantitatively documented fields (i.e., geo-located along with density information) are within the passages surrounding Deer Island and northwest Campobello Island (Mireault et al. 2025). Bryozoan turf (comprised in the region mainly of *Flustra foliacea* that host other bryozoans, hydroids, polychaetes, and other cryptic epifauna) is also a conservation priority, as this turf is susceptible to disturbance, yet houses numerous epibionts and provides refuge for mobile epifauna (Murillo et al. 2011; E. Kenchington 2014). Tube-dwelling anemones (i.e., cerianthids – *Pachycerianthus borealis*) are also vulnerable to disturbance, yet they can form dense aggregations, providing complexity and structure for taxa such as fishes on otherwise featureless sandy and muddy seafloor (Fuller et al. 2008; E. Kenchington 2014). Sponge habitats in the region are known to enhance local biodiversity, creating a distinct habitat with their complex structures along with their spicules, likely providing settlement grounds for invertebrates and feeding grounds for juvenile fish (E. Kenchington 2014; Hawkes et al 2019). Additionally, the SWNB region also accommodates extensive settling and feeding grounds for many commercially important species including lobster, scallop, groundfish, sea cucumber, and green sea urchin, making this area economically formidable for commercial fisheries and finfish aquaculture (Lawton et al. 2001; Robichaud 2010; Rozalska and Coffen-Smout 2020; DFO 2021, 2023b, c; Martin et al. 2023; Murphy et al. 2024; White et al. 2024; Government of New Brunswick 2026). This report documents benthic ecosystem characteristics in SWNB based on sessile fauna and the abovementioned biogenic habitats in the context of marine conservation planning considerations.

In 2008, a subset of areas within the SWNB region were selected as priority EBSAs for consideration within regional conservation network planning, including the “Head Harbour/West Isles/Passages” (HH/WI/P), The Wolves, and the Southern Grand Manan EBSAs (Buzeta and Singh 2008) (Figure 1b). The inclusion of these areas resulted from a review of prior research (e.g., diving surveys by MacKay et al. 1978a, b, c, 1979; MacKay and Bosien 1979; Lawton 1992; Lawton et al. 2001) and regional scientific expert contributions. Following these EBSA designations, in 2016 to 2017, DFO undertook the development of a formal draft conservation network plan which included refinement of EBSAs and other proposed areas, resulting in slight shifts of SWNB network sites (DFO 2018, 2025; see <https://www.dfo-mpo.gc.ca/oceans/networks-reseaux/scotian-shelf->

plateau-neo-ecossais-bay-baie-fundy/development-developpement-eng.html for more details) (Figure 1b). Similar to the 2008 subset, such refinement in 2016 and 2017 was driven by on-going oceanographic and targeted ecosystem surveys (e.g., Lawton 2022; Mireault et al. 2023). Benthic imagery surveys in 2016 and 2017 completed 150 near-seafloor transects primarily in the HH/WI/P, The Wolves, and Southern Grand Manan EBSAs, with analysis of continuous video and digital still imagery for 41 select taxa and underlying substrate characteristics (Lawton et al. 2026). While the 2016 to 2017 imagery surveys provided extensive spatial coverage, there was a significant gap in coverage at depths >85 m (beyond camera system operational limit; Lawton et al. 2026).

More recently, significant engagement with local researchers, Indigenous communities, and fisheries and aquaculture stakeholders in SWNB has further refined the network plan to its current iteration (outlined in DFO 2023a, *in prep*; Figure 2). The revised MCN plan still aims to protect representative marine habitat, but has responded to stakeholder concerns to limit impacts on commercial and recreational activities. Baseline characterization is required to validate and support inclusion of the newly proposed network sites. Certain sites are underrepresented with respect to available scientific information, as prior SWNB sampling focused primarily on coastal fringe, easy-to-access sites (*i.e.*, dive surveys; MacKay et al. 1978a, b, c, 1979; MacKay and Bosien 1979; Lawton et al. 2024). Given ongoing fishery pressures (Rozalska and Coffen-Smout 2020) and limited depth coverage of the prior surveys (Lawton et al. 2026), additional benthic survey effort is warranted, both to attempt to capture temporal changes in species assemblages and to characterize underrepresented areas towards overall assessment of the regional MCN plan.

A DFO Maritimes Region science project funded under the DFO Science Marine Conservation Targets (MCT) program from 2021 to 2025, has generated renewed focus on using both SCUBA diving approaches and near-seafloor imaging tools to survey coastal and inner-shelf benthic habitats in support of MCN planning and for ecological monitoring (Teed et al. 2025a). This project implemented a new regional near-seafloor optical imaging system capable in its initial configuration of surveying to depths of 200 m. The camera system (hereafter FOBIS survey package, for Fibre Optic-Based Imaging System; further details in Section 2.2) comprises underwater components (cameras, lighting, frame, etc.), a fibre optical cable-based deck winch system, and surface operations consoles, and is transportable for installation on different coastal and inner-shelf survey vessels (e.g., as in Teed et al. 2025a).

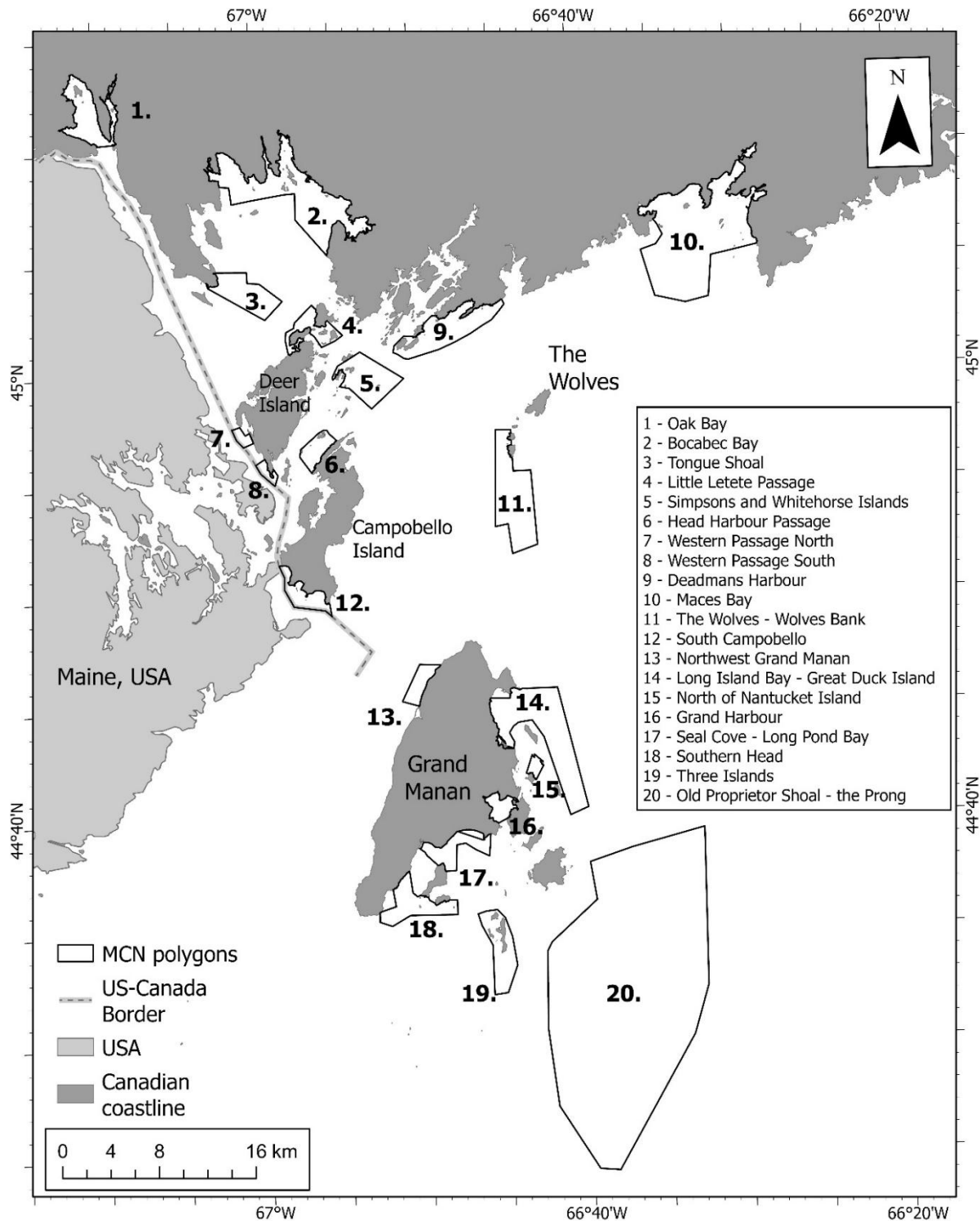


Figure 2. Southwest New Brunswick coastline with the 2025 iteration of the proposed regional Marine Conservation Network (MCN) plan, covering areas extending from Passamaquoddy Bay to southern Grand Manan.

This report outlines the first major benthic survey efforts from 2022 to 2024 with the FOBIS survey package within proposed MCN sites in SWNB. Five objectives were developed for this report:

- 1) Summarize benthic imagery survey coverage within and adjacent to proposed SWNB MCN sites based on 2022 to 2024 field studies;
- 2) Document the occurrence of taxa of interest, along with abundance estimates for a subset of species such as biogenic habitat-forming and commercially important species;
- 3) Provide qualitative benthic habitat descriptions, with associated biological observations, for SWNB benthic habitats for which there is no prior description with associated imagery;
- 4) Conduct a proximity analysis evaluating proximity of new benthic survey imagery to prior imagery locations, and comment on observed temporal changes in specified taxa;
- 5) Consider relevance of benthic imagery survey results to MCN plan development, and recommend future applications of this benthic survey approach for ecological monitoring.

Our approach, following Lawton et al. (2026), focusses on documenting occurrence of a restricted set of taxa, with abundance recorded for a subset of taxa, in contrast to other benthic diversity assessment approaches based on full taxonomic assemblage analyses (e.g., Paulin et al. 2025; Teed et al. 2025b). A complete suite of taxa prevalence could potentially better inform on regional species assemblages; however, searching for select species or taxa saves significant time in image annotation. Additionally, the *a priori* selection of taxa ensures annotator confidence in taxon identification and, for the current study, meets the requirements for timely collection of scientific information to inform the SS-BoF MCN plan.

2 MATERIALS AND METHODS

2.1 SITE SELECTION AND SURVEY PLANNING

We conducted benthic imagery surveys in September and October each year from 2022 to 2024 using the FOBIS survey package (section 2.2) operating off the Canadian Coast Guard Ship (CCGS) *Viola M. Davidson*. Seven preliminary sites sampled in 2022 formed part of field-engineering trials of FOBIS. Survey targets were selected using high-resolution (1 to 100-m horizontal resolution) multibeam echosounder and LiDAR (Light Detection and Ranging) bathymetry data acquired from the Canadian Hydrographic Service (CHS) and the Ocean Mapping Group (OMG 2007, University of New Brunswick), visualized in ArcGIS pro v.2.8 (Figure 3).

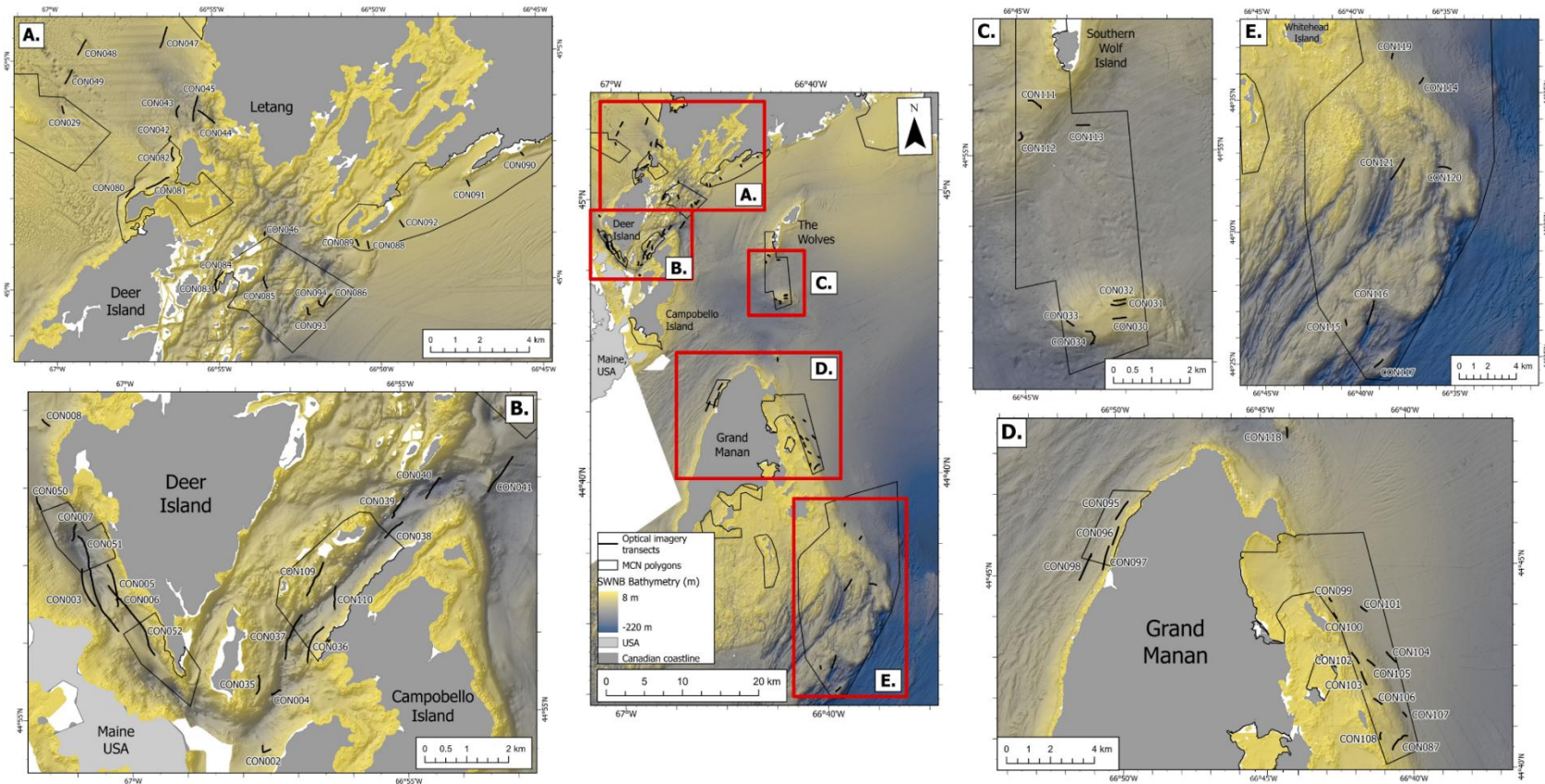


Figure 3. Optical imagery survey transect locations (indicated by a CON#) with proposed conservation network polygons, and 1 to 100-m resolution bathymetry data with hillshade. (A) transects conducted in the upper passages region, including areas of Passamaquoddy Bay out to Deadmans Harbour; (B) transects in the lower passages, between Deer Island and Campobello Island; (C) transects around The Wolves and on Wolves Bank; (D) transects off northern and eastern Grand Manan; and (E) transects off the southern coast of Grand Manan.

High-resolution bathymetry enabled identification of unique features on the seafloor, such as steep slopes and shallow banks. Site selection considered several objectives: 1) to extend survey coverage beyond ~85-m depths, leveraging the 200-m depth capability of FOBIS; 2) to survey unexplored areas within the latest iteration of the MCN plan; 3) to help inform coastal management and stakeholder consultations (e.g., on commercially important taxa such as sea cucumbers); and 4) to ground-truth prior presence probability models of two biogenic habitat-forming species of interest (*Modiolus modiolus* and *Boltenia ovifera* – from Mireault et al. 2025).

While 20 proposed MCN sites occur in the SWNB region, only 11 sites with benthic survey coverage from 2022 to 2024 (Figure 3) are described here (general description of all sites are being prepared; DFO *in prep*). One such area is the proposed Tongue Shoal MCN site, ~12 km² (DFO *in prep*), contiguous to the pockmarks (cone-shaped depressions in muddy sediments; Wildish et al. 2008) of Passamaquoddy Bay. Adjacent to this site is the ~114 km² “Head Harbour/West Isles/Passages” (HH/WI/P) EBSA (Figure 1) that reaches depths of ~149 m and contains several smaller proposed MCN sites. These include the Little Letete Passage site surrounding Pendleton Island that is ~6 km², the Simpsons Island-White horse Island MCN site (~13 km² in size), the Head Harbour Passage MCN site (which is ~5 km² and runs along the coast of Campobello Island, out to Casco Bay and Popes Islands), and the North and South Western Passage MCN sites, both just 2 km² in size (Figure 2). Similar EBSA criteria surrounding The Wolves (Figure 1), has led to the proposal of a 23 km² MCN site off Flat and Southern Wolf Islands, extending to the unique shallow bank feature, Wolves Bank (Figure 2). North of The Wolves is Deadmans Harbour, a proposed MCN site ~17 km² in size (Figure 2), containing lobster settlement areas along the rocky coastline. Grand Manan also has several, smaller, proposed MCN sites in attempt to limit economic impacts (DFO *in prep*). In part, these sites include the Northwest Grand Manan MCN site (~5 km² in size), adjacent to Long Eddy, the Long Island Bay – Great Duck Island MCN site, which is 32 km² in size, and the largest proposed SWNB MCN site, the Old Proprietor Shoal/The Prong MCN site, ~266 km² in size (Figure 2). The Old Proprietor Shoal/The Prong area extends from shallow regions near White Head Island, out towards Grand Manan Basin, overlapping much of the prior 2016 Southern Grand Manan EBSA (Figure 1). However, due to strong rip currents, little prior benthic sampling has been conducted in this area.

2.2 NEAR-SEAFLOOR OPTICAL IMAGERY SURVEY APPROACHES

At each target location surveyed, a drift transect protocol was employed using the FOBIS survey package (see Teed et al. 2025a – their Figure 5) maintaining the system ~1 m above the seafloor, with a maximum allowable depth deployment of 200 m (a formal technical report detailing FOBIS set-up, protocols, and analyses is currently being prepared). A full frame digital camera (D850, Nikon, Mississauga, ON, Canada), oriented downwards, captured individual digital still images (generally ~25 MB, but up to 45 MP; 8256 x 5504 pixels) at periodic intervals. Target image acquisition rate was typically every 30 s; though dependent on speed over ground (SOG), in order not to generate either multiple closely-spaced images (at very low SOG), or only a few widely-spaced images (very high SOG). Primary image settings (ISO speed, aperture, focusing mode – stored in each image file’s metadata; Table 1) were generally set at the start of each annual survey period. A downward-facing high-definition video camera (1Cam Mk6, SubC Imaging, Clarenville, NL, Canada) provided continuous video imagery of the seafloor. In 2023 and 2024 (unavailable in 2022), a forward-facing high-definition video camera (HD Multi SeaCam, Deep Sea Power & Light, San Diego, CA, USA) provided additional video imagery. The forward-facing video imagery allowed the FOBIS operator to make real-time adjustment of the camera height above the seafloor; however, the forward-facing camera only transmitted composite (standard-definition) video to the surface.

Table 1. Overview of still camera settings for the Nikon D850 camera deployed as part of the FOBIS survey package in Southwest New Brunswick optical imagery transects from 2022 to 2024.

Survey year	Transects	Focal length	Focus	ISO speed	Shutter speed	Aperture
2022	CON002-008	24 mm	Auto	800	1/100 s	f16
2023	CON029-052	24 mm	Auto	500 to 800	1/200 to 1/250 s	f13 to f16
2024	CON080-121	24 mm	Auto	500 to 800	1/200 s	f14

Both video and still image files were recorded and automatically named according to transect number (CON###), date and UTC time (e.g., CON002-20220921T124202). A VA500 altimeter (Teledyne Valeport Ltd, Totnes, UK) provided records of the height of the survey package off-bottom (once every second), and a pair of lasers (10-cm spacing) provided a means to evaluate the field of view (FOV) in both the downward video and still imagery (estimated using ImageJ2 –

Rueden et al. 2017). The FOV was estimated using a subset of images and video frames for each year to account for minor system adjustments. For downward-facing video, the 10-cm lasers were in view for altitude off-bottom ranging from 0.5 to 2.7 m, while for digital stills, FOV calculations were only possible when altitudes were 0.7 to 1.7 m. To generate an estimate of area covered (m^2) for each transect, the average FOV from the downward-facing video across each transect was multiplied by the estimated distance travelled (m). These estimates were then summed across transects to generate overall seafloor area coverage.

For the first two years (2022 and 2023) of the survey, an available underwater ultra-short baseline acoustic positioning system was used (Tracklink 1500HA transceiver with Tracklink 1505B transponder; Linkquest Inc., San Diego, USA). This system proved to be unreliable, and so year one and two survey vessel geographic positions were recorded using a SeaNav 300 Global Navigation Satellite System receiver at the surface (Kongsberg Gruppen ASA, Kirkegårdsveien, Norway). The track line of each transect can be expected to correspond to the actual distance travelled by the camera package over the seafloor, although the offset of the camera system from the vessel was not defined. In year three (2024) a new underwater acoustic positioning system was implemented (uPAP 201-H transceiver/transducer, along with cNODE Micro transponders/beacons, Kongsberg Gruppen ASA, Kirkegårdsveien, Norway). The upgraded positioning system allowed for transects to be mapped according to the FOBIS position (<5-m horizontal accuracy). Year three also allowed for direct comparison of the camera system position in relation to the vessel's position, where it was found that spatial offsets from the survey vessel ranged up to 50 m astern and 1 to 10 m port or starboard depending on depth and tidal influences (akin to observations from Teed et al. 2025a).

Reported depths (in m Below Chart Datum, BCD) corresponding to the location of the camera track were extracted from the 1 to 10-m multibeam echosounder and LiDAR bathymetry data (OMG 2007; Figure 3). Depths of video transect observations were categorized into the following depth classes for depth distribution visualization purposes: 10 to 35 m, 35 to 100 m, and 100 to 200 m, selected to reflect survey classification approaches outlined in Lawton and Teed (2026). Drift camera tracks for all transects were plotted in ArcGIS Pro (v. 2.8) corresponding to the date and time when the camera package was in a near-seafloor survey mode. The actual distance traveled (m) by the camera package over the seafloor was calculated using the z-field geometry tool in ArcGIS Pro (ESRI 2021), calculated at the transect level. The distance between still images along a transect was calculated using the "Split Line at Point" tool in ArcMap (v.10.8, Advanced licensing).

2.2.1 DIGITAL STILL IMAGE ANALYSIS

A sub-set of digital still images was selected from each FOBIS drift transect, at ~20-m spacing, using buffer tools in ArcGIS Pro v.2.8 (ESRI 2021). This approach aimed to reduce the annotation workload by focussing on the presence of organisms of interest (selected *a priori*), as well as anthropogenic debris such as fishing gear and garbage. Still images were deemed unusable and removed from the dataset if there were insufficient light levels, too much turbidity, or if the altitude off-bottom exceeded 1.9 m. This yielded 1699 still images for analysis (of the 5081 collected).

Organism occurrences in selected still images were analyzed using the image annotation software BIIGLE 2.0 (Langenkamper et al. 2017; Zuroweitz and Nattkemper 2021). Annotations corresponded to a designated label of a taxa (species or higher level: genus, family, order, etc.) or a morphotype. Identifications were limited by the bottom conditions (light penetration, water, turbidity) and the image resolution, focus, and blurriness. As such, only taxa and morphotypes of interest (*i.e.*, organisms that are easily identifiable and distinguishable in imaging surveys; often ≥ 2 cm in size) were annotated, mostly to the species or genus level. We report ‘taxa count’ as the number of taxa present, of the taxa selected for analysis, within analysed images. For morphotypes, labels were based on visual assessment of morphological traits, for example ‘encrusting sponges’. Taxa and morphotypes of interest were limited to sessile and mobile benthic taxa, with a few burrowing organisms (*i.e.*, cerianthids, sandfan worms). Taxonomic names were obtained from the World Register of Marine Species (WoRMS 2025).

Annotations were organized as a label tree in BIIGLE (named SWNB2024), comprising a hierarchical set of groupings of taxa and morphotypes, using the 41 taxa of interest from the 2016 to 2017 SWNB imagery survey as a starting basis (Lawton 2022; Lawton et al. 2026). Additional species and general taxa labels (where species could not be confirmed) were added to the label tree as they were encountered, including labels for fishes and commonly observed sponges for which the annotator was confident in identifying. In the prior survey, fishes were only classified as sculpins and allies (Cottoidei) or unidentified fish, whereas the current survey aimed to identify all fishes to the lowest possible taxonomic classification (e.g., *Pholis gunnellus*). As of this report, some taxa remain unconfirmed and may be verified in the future by taxonomic experts, including through feedback on image examples posted on the iNaturalist.org community site (iNaturalist 2025). Selected images of organisms were uploaded to iNaturalist

(<https://www.inaturalist.org/projects/southwest-new-brunswick-imaging-surveys-dfo-science>).

Feedback from community members resulted in some suggested changes to identifications (namely fishes), which were then applied in BIIGLE.

Overall, images were analyzed for occurrences of 68 taxa of interest (Table 2) and scored as '0' (absent) or '1' (present). Taxa counts per image were binned into the following categories for visualization purposes as in Lawton et al. (2026): 0, 1, 2–5, 6–10, and >10 taxa. For the current survey, these bins correspond to 0%, 1.5%, 3–7%, 8–15%, and >15% of all taxa analyzed ($n = 68$). Occurrence was then reported as the number and proportion (%) of still images where a taxa or morphotype was present across a transect (Table 2). Abundance was estimated for select taxa of specific conservation priority (stalked tunicate [*Boltenia ovifera*], horse mussel [*Modiolus modiolus*], sea strawberry [*Gersemia rubiformis*], and northern cerianthid [*Pachycerianthus borealis*]) and commercial interest (American lobster [*Homarus americanus*], orange-footed sea cucumber [*Cucumaria frondosa*], green sea urchin [*Strongylocentrotus droebachiensis*], Atlantic sea scallop [*Placopecten magellanicus*]). Abundance (number of individuals visible in each image) was also converted to density by dividing the count by the still image FOV (number of individuals – ind. m⁻²). We compare our density estimates with other data sources for some species; however, in general we report abundance, binned into categories for visualization: 1 = 1 ind. image⁻¹, 2 = 2–5 ind. image⁻¹, 3 = 6–10 ind. image⁻¹, 4 = 11–20 ind. image⁻¹, 5 = 21–50 ind. image⁻¹, 6 = 51–100 ind. image⁻¹, 7 = 101–200 ind. image⁻¹, and 8 = >200 ind. image⁻¹.

Substrate categories were defined by first viewing both the video and still imagery, and recording common substrate types, then later refined based on similar benthic survey operations and/or substrate descriptions (Lacharité et al. 2018; Greenlaw and Harvey 2022; Lawton 2022). Resulting substrate categories included: 1) Mud, 2) Mixed fine sediments (silt/sand/gravel/pebbles) covering >50% of the field of view, 3) Mixed sediments with <50% cover of cobbles/boulders, 4) Mixed sediments with >50% cover of cobbles/boulders, 5) Horse mussel (*Modiolus modiolus*) reef, and 6) Bedrock (Figure 4). Sub-categories were generated to identify variation within each category often caused by biota or varying geology. For example, the invasive tunicate *Didemnum vexillum* can generate large homogenous tunicate mats over a variety of mixed sediments (from gravel to bedrock) often smothering fauna (Teed et al. 2024), and was used to further delineate substrate categories. Other sub-categories included prevalence of algae, cerianthids, uniquely high densities of the bryozoan *Flustra foliacea*, along with distinct bedrock formations (Figure 4). Bedrock sub-

categories include bedrock with *D. vexillum* cover, bedrock overlain with a thin silt layer/veneer, pitted bedrock (hollow depressions along surface – as reported in SCUBA surveys [e.g., Goodwin et al. 2025]), and smooth/glacially sculpted bedrock likely composed of a different, non-fissured rock type (Philibert et al. 2024). Sub-categories were used to highlight heterogeneous habitats at the transect level, but were binned into the original six substrate categories for general survey results. To determine the primary substrate in each image or video frame, the field of view was divided into four quadrants, with each quadrant receiving a substrate category. Once substrate categories were scored within four quadrants of each of the 1699 images, then a primary substrate was allocated for the category appearing in two or more quadrants.

2.2.2 CONTINUOUS VIDEO ANALYSIS

Qualitative observations (*i.e.*, general habitat descriptions along with commonly observed macrobenthos) were reported for all transects based on a combined review of still images, and forward- and downward-facing video (Appendix Table 1). The downward-facing video was analyzed in more detail, documenting all significant substrate changes when the seafloor was in view. Specifically, each downward-facing video was viewed at a maximum 0.5 speed (or less depending on SOG) in VLC Media Player (VideoLan 2025), and associated substrate was recorded every second (*i.e.*, one video frame per second) according to the day/time and location stamp. Substrate and associated sub-categories used for video analysis followed the same classification and analyses used for the digital still images (Figure 4).

2.3 PROXIMITY ANALYSIS

Once transect and affiliated still image positions were obtained and imported into ArcGIS Pro v.2.8, an image proximity analysis was performed using the Near (Analysis) tool (ESRI 2021) to determine the shortest distance (in m) that analyzed still images from the current survey were away from prior 2016 to 2017 imagery survey locations. This assessed the spatial relationship between data sources, allowing for qualitative assessment of changes in general community assemblages according to various sampled areas and habitats. However, it should be noted that we did not attempt to replicate specific 2016 and 2017 transects throughout the 2022 to 2024 survey, instead a *post-hoc* proximity analysis was completed.

Table 2. Occurrence and proportion present (%) of taxa and morphotypes of interest as well as marine debris across analyzed still images ($n = 1699$), listed according to phylum, from SWNB imaging surveys (2022 to 2024). Notes on common names as well as suggested likely taxa are included. Taxa with an asterisk (*) are unsure or may be confirmed later.

Phylum	Taxa of interest	Notes/Suggested taxa	Number of occurrences	Proportion (%) present
Annelida	<i>Myxicola</i> spp.*	Sand fan worms, part of a species complex	80	4.7
Arthropoda	Barnacles	<i>Balanus</i> or <i>Chirona</i>	454	26.7
	<i>Cancer</i> spp.	Mix of <i>C. borealis</i> (Jonah crab) and <i>C. irroratus</i> (Rock crab)	231	13.6
	<i>Carcinus maenas</i>	Green crab, invasive	3	0.2
	<i>Homarus americanus</i>	American lobster	64	3.8
	<i>Hyas coarctatus</i>	Toad crab	0	0
	<i>Pagurus</i> spp.	Hermit crabs (<i>P. acadianus</i> , <i>P. arcuatus</i>)	87	5.1
	Pandalidae	Shrimp	334	19.7
	Euphausiacea	Krill	50	2.9
Bryozoa	<i>Flustra foliacea</i>	Lemon weed, forming bryozoan turf	175	10.3
Chlorophyta	<i>Ulva</i> spp.	Sea lettuce, likely <i>U. lactuca</i>	114	6.7
Chordata	<i>Boltenia ovifera</i>	Stalked tunicate	214	12.6
	<i>Dendrodoa carnea</i>	Blood drop sea squirt	273	16.1
	<i>Didemnum albidum</i>	Northern white crust	434	25.5
	<i>Didemnum vexillum</i>	Invasive tunicate, sea vomit/carpet	166	9.8
	<i>Aspidophoroides monopterygius</i>	Alligatorfish	5	0.3
	<i>Myoxocephalus</i> spp.*	Likely mix of <i>M. octodecemspinosus</i> and <i>M. scorpius</i>	54	3.2
	<i>Pholis gunnellus</i>	Rock gunnel	13	0.8
	<i>Hemitripterus americanus</i>	Sea raven	2	0.1
	<i>Sebastes</i> spp.	Redfish, likely mix of <i>S. fasciatus</i> , <i>S. mentella</i> (but most likely <i>S. fasciatus</i>)	36	2.1
	<i>Zoarces americanus</i>	Ocean pout	8	0.5
	<i>Tautoglabrus adspersus</i>	Cunner	13	0.8
	<i>Melanogrammus aeglefinus</i>	Haddock	2	0.1
	<i>Gadus</i> spp.	Cod	10	0.6
	<i>Urophycis</i> spp.	Hake	23	1.4
	<i>Clupea harengus</i>	Atlantic herring	5	0.3
	<i>Scomber scombrus</i>	Atlantic mackerel	2	0.1
	<i>Lophius americanus</i>	American monkfish	1	0.06
	Pleuronectiformes*	Groundfish, likely mix of <i>G. cynoglossus</i> , <i>H. platessoides</i> , <i>P. americanus</i>	65	3.8
	<i>Leucoraja</i> spp.	Skates, likely mix of <i>L. erinaceus</i> , <i>L. ocellata</i>	3	0.2
Cnidaria	<i>Urticina felina</i> / <i>Cribrinopsis similis</i> *	Dahlia anemone or <i>C. similis</i>	556	32.7
	<i>Metridium senile</i>	Frilled anemone	12	0.7

Phylum	Taxa of interest	Notes/Suggested taxa	Number of occurrences	Proportion (%) present
	<i>Pachycerianthus borealis</i>	Northern cerianthid	250	14.7
	<i>Gersemia rubiformis</i>	Soft coral – sea strawberry	4	0.2
Echinodermata	<i>Asterias/Leptasterias</i> spp.*	Common sea stars, likely mix of <i>A. rubens</i> , <i>L. groenlandica</i>	732	43.0
	<i>Henricia</i> spp.	Blood stars	426	25.1
	<i>Porania pulvillus</i>	Red cushion star	4	0.2
	<i>Pteraster militaris</i>	Wrinkled star	1	0.06
	<i>Crossaster papposus</i>	Rose sun star	6	0.4
	<i>Solaster endeca</i>	Purple sun star	0	0
	Ophiuroidea	Brittle stars, likely mix of <i>O. aculeata</i> , <i>Ophiacantha</i> spp.	17	1.0
	<i>Echinarachnius parma</i>	Sand dollar	0	0
	<i>Strongylocentrotus droebachiensis</i>	Green sea urchin	3	0.2
	<i>Cucumaria frondosa</i>	Orange-footed sea cucumber	183	10.9
Mollusca	<i>Mytilus edulis</i>	Blue mussel	0	0
	<i>Modiolus modiolus</i>	Horse mussel	359	21.1
	<i>Placopecten magellanicus</i>	Atlantic sea scallop	192	11.3
Orchophyta	<i>Ascophyllum nodosum</i>	Knotted wrack	654	38.5
	<i>Fucus</i> spp.	Likely mix of rockweed (<i>F. distichus</i>) and bladder wrack (<i>F. vesiculosus</i>)	135	7.9
	<i>Chorda filum</i>	Mermaid's tresses	20	1.2
	<i>Desmarestia</i> spp.	Likely mix of <i>D. aculeata</i> , <i>D. viridis</i>	52	3.1
	<i>Laminaria</i> spp.	Likely mix of oarweed (<i>L. digitata</i>) and sugar kelp (<i>S. latissima</i>)	122	7.2
Porifera	<i>Aplysilla sulfurea</i>	Sulphur sponge	38	2.2
	<i>Haliclona/Isodictya</i> spp.*	Likely mix of <i>H. oculata</i> , <i>Isodictya</i> spp.	146	8.6
	<i>Hymedesmia canadensis</i>		104	6.1
	<i>Hymedesmia paupertas</i>		22	1.3
	<i>Iophon</i> spp.*		26	1.5
	<i>Iophon</i> spp. type*	Mat-forming <i>Iophon</i> type	182	10.7
	<i>Mycale lingua</i>		129	7.6
	<i>Myxilla fimbriata</i>		22	1.3
	<i>Polymastia bartletti</i>		60	3.5
	<i>Polymastia uberrima</i>		91	5.4
	<i>Sphaerotylus capitatus</i>		26	1.5
	<i>Halichondria panicea</i>	Breadcrumb sponge	159	9.4
	<i>Halichondria sitiens</i>		25	1.5
	<i>Suberites ficus</i>	Fig sponge	30	1.8
	Encrusting species		800	47.1
Rhodophyta	Encrusting calcareous algae	Corallinales	12	0.7
Fishing gear		Rope, traps, etc.	1	0.06
Garbage			6	0.4

Table 2 cont.

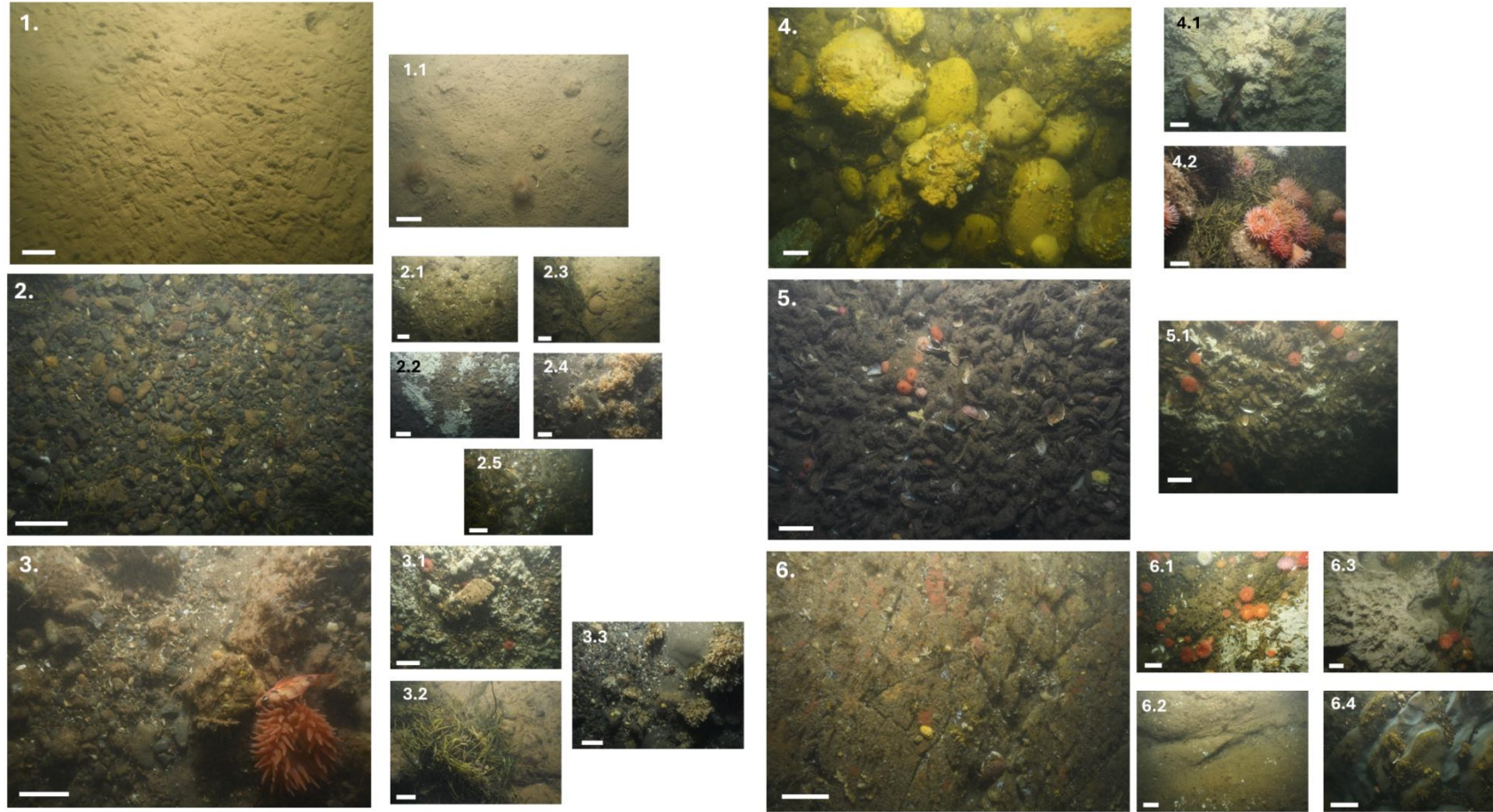


Figure 4. Substrate classification (with modifiers for key biota) applied to SWNB 2022 to 2024 digital still imagery and continuous video: 1. Mud (subcategory 1.1 - Mud with cerianthids); 2. Fine sediments >50% cover. Subcategories : 2.1 - with cerianthids; 2.2 - with *D. vexillum* cover >50%; 2.3 - with algae; 2.4 - with *F. foliacea*; and 2.5. with densely compacted empty shells; 3. Mixed sediments with <50% cobbles/boulders cover (subcategories 3.1 - with *D. vexillum* cover >50%; 3.2 - with algae; and 3.3 - with *F. foliacea*); 4. Mixed sediments with >50% cobbles/boulders cover (subcategories 4.1 - with *D. vexillum* cover >50%; and 4.2 - with algae); 5. Horse mussel reef (subcategory 5.1 – with *D. vexillum* cover); and 6. Bedrock (subcategories 6.1 - with *D. vexillum* cover; 6.2 - with thin silt layer; 6.3 - pitted; and 6.4 - smooth/glacially sculpted). White scale bars indicate 10-cm scale.

3 RESULTS

Seventy-three drift transects were completed across 15 days in September and October, 2022 to 2024 (2 days in 2022, 5 days in 2023 and 8 days in 2024) with continuous seafloor coverage varying from periods of three minutes to over one hour and twenty minutes (Table 3, Figure 3). The drift SOG, influenced by strong tidal currents, ranged from 0.01 to 4.52 knots (average: 0.94 knots). This resulted in variable distance travelled, with transect lengths ranging from 133 m to 2.6 km. Overall, the survey covered a total estimated distance over the seafloor of ~47.7 km. Estimated area of individual transects ranged from 59 to 1689 m², with a total estimated area coverage of ~27080.5 m² (~2.7 hectares). Altitude off the seafloor ranged from 0.1 to 3.3 m (average: 0.9 m) at depths from 15 to 188 m BCD. These drift transects generated over 30 hours of downward-facing continuous video, along with associated forward-facing video (no forward-facing video in 2022), and 1 to 232 still images per transect, capturing 5081 images in total (Table 3). Due to strong tidal currents, no usable still images were taken in CON046 (east of Adam Island in the HH/WI/P sub-area), and only three minutes of video were recorded before the transect was aborted. Images were collected at intervals ranging from 0.5 to 320 seconds (average = ~21 s), representing distances apart from 0.2 to 449 m (average = 9.1 m). After applying the 20-m buffer and assessing quality of retained images, a subset of 1699 still images were available for analysis of occurrence of 68 listed taxa (Table 2), along with abundance for eight species. The resulting number of still images per transect ranged from 0 to 95 (average = 23 stills), with average altitudes ranging from 0.5 to 1.3 m (average = 0.9 m) above the seafloor, and average depths ranging from 22 to 132 m (average = 49 m) (Appendix Table 2).

The dominant substrate and associated sub-categories were determined from 1699 still images and 27 hours and 58 mins of continuous video. All substrate categories occurred across the survey depth range, with the exception of mud, which was predominantly restricted to shallower depths (<100 m; Figure 5a, 6a). For continuous video, 47% of video observations (one observation per second: $n = 100705$) contained predominately fine sediments (Figure 5; estimated area of 12728 m²). This was followed by 18% of video observations (~4874 m²) dominated by mixed sediments with <50% cobbles and boulders, and 14% (~3791 m²) dominated by mud. Mussel reefs (3%, ~812 m²) and bedrock (8%, ~2166 m²) were the least represented substrate categories. Only 18% of video observations could be further classified into sub-categories below the six general categories (Figure 5b). Analyzed digital still imagery showed similar findings, with 47% of stills

Table 3. Transect summary for the optical imagery survey in Southwest New Brunswick from 2022 to 2024 ($n = 73$). Consecutive numbers (CON#) were assigned to each camera deployment as the survey proceeded; however, transects are ordered here based on geographic location (*i.e.*, sub-area). Date, transect length (in time and distance travelled), start location, minimum and maximum depths, number of still images taken, number of still images analyzed for occurrence ($n = 1699$) of 68 taxa and morphotypes of interest, and the number of taxa observed. Sub-area refers to the general area the transect occurred including: PB = Passamaquoddy Bay, HHWIP = the Head Harbour/West Isles/Passages, W/DH = The Wolves and Deadmans Harbour, and GM = Grand Manan. Primary substrate refers to the dominant substrate category observed in the continuous seafloor video of each transect: 1 = Mud, 2 = Fine sediments (>50% cover), 3 = Mixed sediments with <50% cobbles/boulders, 4 = Mixed sediments with >50% cobbles/boulders, 5 = Horse mussel reef, or 6 = Bedrock. Additional imagery metadata and full transect track lines are available on Canada's open data portal including transect drift direction, speed over ground, and imagery data volume (see Lawton and Teed 2025; <https://open.canada.ca/data/en/dataset/f9098f77-b2e1-423d-8950-eeabd7bba85b>).

Transect	Date (DD-MM-YYYY)	Sub-area	Transect time (H:MM:SS)	Distance travelled (m)	Estimated area covered (m ²)	Start latitude (DD)	Start longitude (DD)	Minimum depth (m)	Maximum depth (m)	Number of still images	Number of still images analyzed	Number of taxa observed	Primary substrate
CON029	22-09-2023	PB	15:01	299	103	45.0640	-66.9939	48.6	52.0	36	12	3	1
CON047	25-09-2023	PB	20:08	902	388	45.0946	-66.9400	29.0	57.2	82	35	7	1
CON048	25-09-2023	PB	20:14	689	309	45.0905	-66.9817	28.2	44.7	90	28	15	1
CON049	25-09-2023	PB	19:56	627	310	45.0797	-66.9892	29.7	66.2	90	25	6	1
CON042	25-09-2023	HHWIP	20:38	215	90	45.0549	-66.9391	39.8	41.8	55	9	18	2
CON043	25-09-2023	HHWIP	30:09	511	212	45.0658	-66.9345	66.7	75.8	71	21	28	2
CON044	25-09-2023	HHWIP	33:37	861	403	45.0640	-66.9248	41.2	80.5	80	31	31	2
CON045	25-09-2023	HHWIP	30:37	1020	521	45.0691	-66.9248	49.8	74.0	106	36	29	2
CON080	16-09-2024	HHWIP	20:15	537	263	45.0329	-66.9630	21.9	35.9	49	20	14	2
CON081	16-09-2024	HHWIP	54:20	1044	520	45.0358	-66.9523	15.1	39.8	97	36	28	2
CON082	16-09-2024	HHWIP	30:39	666	286	45.0458	-66.9385	28.8	35.7	74	25	17	1
CON046	25-09-2023	HHWIP	3:09	133	168	45.0192	-66.8918	45.3	68.3	1	0	NA	3
CON083	16-09-2024	HHWIP	20:14	408	181	45.0018	-66.9169	25.1	45.6	59	17	16	2
CON084	16-09-2024	HHWIP	20:17	477	243	45.0050	-66.9138	28.9	53.4	46	19	19	2
CON085	16-09-2024	HHWIP	20:15	492	348	44.9986	-66.8914	53.6	76.6	48	18	17	2
CON086	16-09-2024	HHWIP	21:24	657	462	44.9914	-66.8627	38.0	65.4	58	21	19	2
CON093	27-09-2024	HHWIP	20:50	378	238	44.9911	-66.8710	25.1	54.6	48	15	15	1
CON094	27-09-2024	HHWIP	20:21	288	123	44.9935	-66.8650	40.5	56.3	40	11	17	2
CON039	24-09-2023	HHWIP	20:23	580	290	44.9585	-66.9200	95.3	118.4	82	21	22	2

Transect	Date (DD-MM-YYYY)	Sub-area	Transect time (H:MM:SS)	Distance travelled (m)	Estimated area covered (m ²)	Start latitude (DD)	Start longitude (DD)	Minimum depth (m)	Maximum depth (m)	Number of still images	Number of still images analyzed	Number of taxa observed	Primary substrate
CON040	24-09-2023	HHWIP	15:54	635	583	44.9626	-66.9096	92.3	144.0	56	20	27	2
CON041	24-09-2023	HHWIP	44:03	1042	354	44.9638	-66.8908	92.5	111.9	178	43	26	3
CON036	24-09-2023	HHWIP	19:53	992	666	44.9279	-66.9466	28.0	61.3	58	34	30	2
CON037	24-09-2023	HHWIP	20:10	1170	656	44.9287	-66.9533	62.0	85.5	89	42	32	2
CON038	24-09-2023	HHWIP	20:12	601	219	44.9543	-66.9223	113.2	120.2	79	24	24	2
CON109	30-09-2024	HHWIP	41:00	975	424	44.9493	-66.9411	19.5	34.2	136	35	38	2
CON110	30-09-2024	HHWIP	40:11	610	235	44.9441	-66.9375	68.2	93.9	93	26	28	2
CON002	21-09-2022	HHWIP	26:05	345	145	44.9102	-66.9607	37.0	52.4	78	15	21	3
CON004	22-09-2022	HHWIP	18:45	338	169	44.9220	-66.9549	73.9	87.2	48	15	24	4
CON035	24-09-2023	HHWIP	20:23	504	185	44.9214	-66.9622	33.0	38.1	54	19	24	3
CON052	26-09-2023	HHWIP	26:01	2063	1421	44.9453	-67.0063	35.40	69.7	87	47	29	2
CON003	21-09-2022	HHWIP	21:32	956	478	44.9490	-67.0142	51.6	91.2	68	34	29	2
CON005	22-09-2022	HHWIP	23:20	849	519	44.9424	-67.0036	34.5	61.5	42	23	30	2
CON006	22-09-2022	HHWIP	28:17	340	196	44.9408	-67.0036	36.7	47.3	55	14	28	4
CON007	22-09-2022	HHWIP	27:45	498	281	44.9552	-67.0169	90.1	118.0	53	20	21	3
CON051	26-09-2023	HHWIP	1:02:13	2621	1145	44.9561	-67.0152	36.5	113.5	232	95	41	4
CON050	26-09-2023	HHWIP	12:01	327	133	44.9647	-67.0274	77.0	80.4	48	14	20	2
CON008	22-09-2022	HHWIP	19:40	289	157	44.9799	-67.0232	49.6	51.2	42	13	22	2
CON088	27-09-2024	W/DH	19:55	340	159	45.0148	-66.8390	29.0	31.1	60	13	6	1
CON089	27-09-2024	W/DH	20:17	315	167	45.0155	-66.8452	25.1	31.9	58	12	9	1
CON090	27-09-2024	W/DH	19:51	221	116	45.0459	-66.7591	28.7	38.1	36	8	4	1
CON091	27-09-2024	W/DH	20:23	294	134	45.0363	-66.7873	34.0	39.8	41	11	3	1
CON092	27-09-2024	W/DH	20:15	332	155	45.0221	-66.8223	35.5	36.3	40	13	1	1
CON111	30-09-2024	W/DH	20:20	483	235	44.9293	-66.7467	47.0	53.0	37	16	14	2
CON112	30-09-2024	W/DH	19:40	343	115	44.9218	-66.7496	65.8	72.0	56	13	20	2
CON113	30-09-2024	W/DH	20:21	350	130	44.9231	-66.7267	88.3	92.8	53	15	18	6
CON030	23-09-2023	W/DH	21:57	409	329	44.8774	-66.7204	43.8	57.8	64	14	22	3
CON031	23-09-2023	W/DH	25:40	448	357	44.8808	-66.7209	36.3	40.0	80	17	23	3

Transect	Date (DD-MM-YYYY)	Sub-area	Transect time (H:MM:SS)	Distance travelled (m)	Estimated area covered (m ²)	Start latitude (DD)	Start longitude (DD)	Minimum depth (m)	Maximum depth (m)	Number of still images	Number of still images analyzed	Number of taxa observed	Primary substrate
CON032	23-09-2023	W/DH	17:02	347	331	44.8816	-66.7200	24.4	40.6	47	12	19	6
CON033	23-09-2023	W/DH	15:02	290	241	44.8773	-66.7358	65.9	68.1	42	11	16	2
CON034	23-09-2023	W/DH	22:18	68	582	44.8747	-66.7296	53.2	115.6	66	21	27	2
CON118	03-10-2024	GM	20:23	469	234	44.8079	-66.7349	58.3	92.8	63	18	17	2
CON095	28-09-2024	GM	15:23	999	663	44.7791	-66.8272	67.6	77.6	57	32	26	3
CON096	28-09-2024	GM	14:53	856	587	44.7688	-66.8330	43.8	50.1	60	28	20	4
CON097	28-09-2024	GM	19:43	1113	527	44.7610	-66.8388	56.6	60.9	82	38	21	2
CON098	28-09-2024	GM	20:27	1333	626	44.7580	-66.8490	76.1	80.6	82	41	17	2
CON087	17-09-2024	GM	1:20:11	1085	603	44.6751	-66.6786	35.6	71.3	202	42	26	2
CON099	29-09-2024	GM	20:40	194	68	44.7377	-66.7128	40.9	41.5	35	8	5	2
CON100	29-09-2024	GM	20:56	292	134	44.7314	-66.7105	30.7	33.6	39	11	15	2
CON101	29-09-2024	GM	15:08	345	81	44.7338	-66.6948	82.6	84.8	27	8	3	1
CON102	29-09-2024	GM	25:15	579	310	44.7151	-66.7007	32.5	39.9	79	20	21	2
CON103	29-09-2024	GM	23:57	637	344	44.7071	-66.6955	25.4	33.3	63	24	19	6
CON104	29-09-2024	GM	20:00	634	165	44.7150	-66.6807	89.7	90.9	60	20	6	1
CON105	29-09-2024	GM	20:24	474	201	44.7120	-66.6918	48.7	58.3	50	18	11	2
CON106	29-09-2024	GM	20:07	455	250	44.6961	-66.6885	29.9	36.8	71	18	21	6
CON107	29-09-2024	GM	10:23	259	59	44.6902	-66.6721	88.9	91.5	27	7	4	1
CON108	29-09-2024	GM	19:37	316	130	44.6795	-66.6856	21.2	28.5	50	14	15	6
CON119	03-10-2024	GM	20:07	388	231	44.6104	-66.6305	79.9	88.1	45	14	20	2
CON114	02-10-2024	GM	20:30	487	281	44.5945	-66.6042	88.1	95.0	45	18	13	2
CON120	03-10-2024	GM	29:35	923	651	44.5379	-66.5926	80.7	132.4	111	35	27	3
CON121	03-10-2024	GM	34:54	1895	1652	44.5439	-66.6230	56.7	142.0	182	64	33	4
CON115	02-10-2024	GM	20:37	449	294	44.4431	-66.6783	78.7	84.5	49	17	17	2
CON116	02-10-2024	GM	45:45	1810	1689	44.4545	-66.6527	98.2	187.9	135	66	27	2
CON117	02-10-2024	GM	30:32	871	823	44.4174	-66.6463	101.2	120.2	77	29	30	3

Table 3 cont.

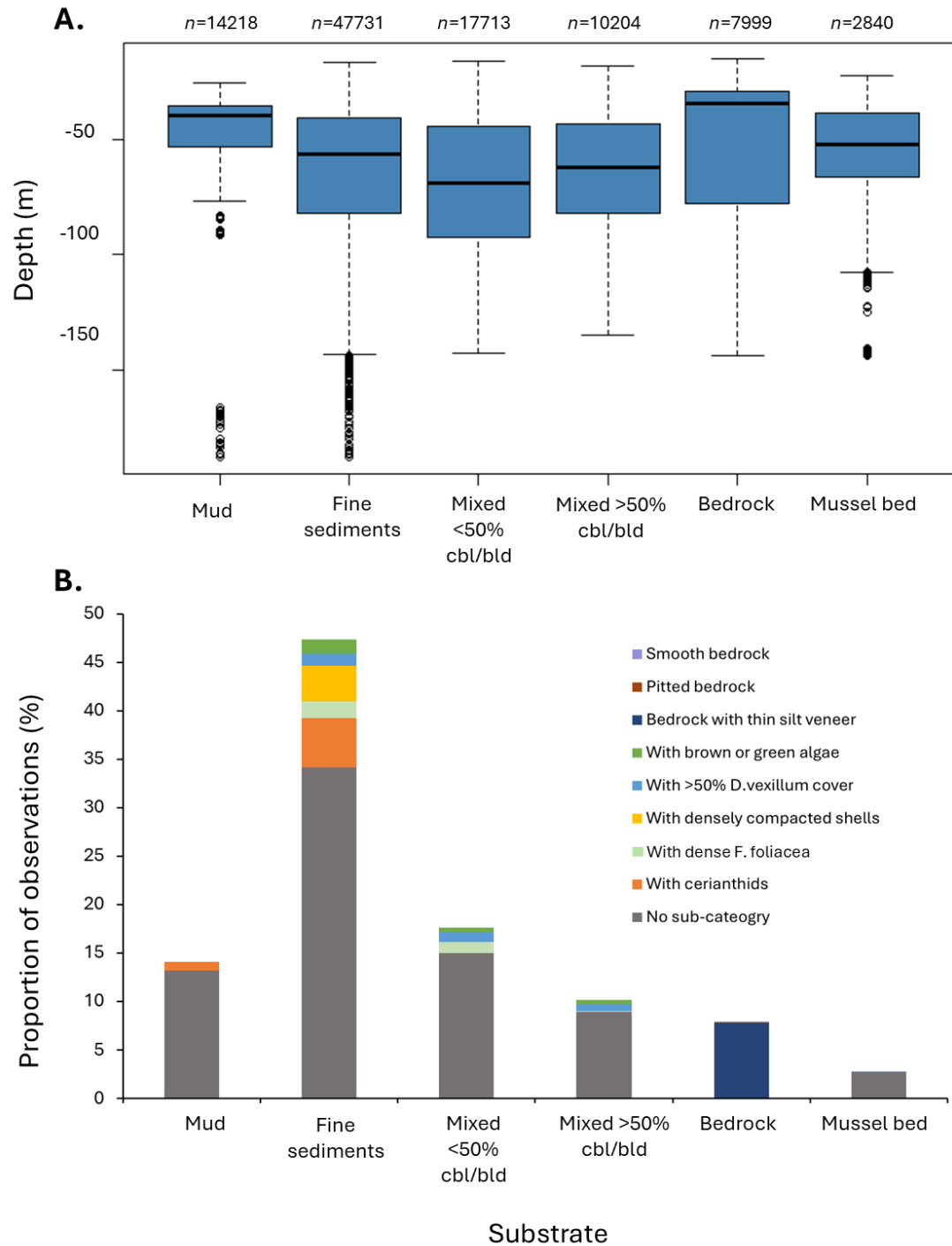


Figure 5. (A) Boxplot of substrate observations from video (~1 observation per second of video, number of observations per substrate are provided above) according to depth (m) including mud, fine sediments with >50% cover of sand/gravel/pebbles, mixed sediments with <50% cover of cobbles and boulders, mixed sediments with >50% cover of cobbles and boulders, bedrock, and mussel beds. (B) Proportion of video observation within each substrate category, colourized by sub-categories.

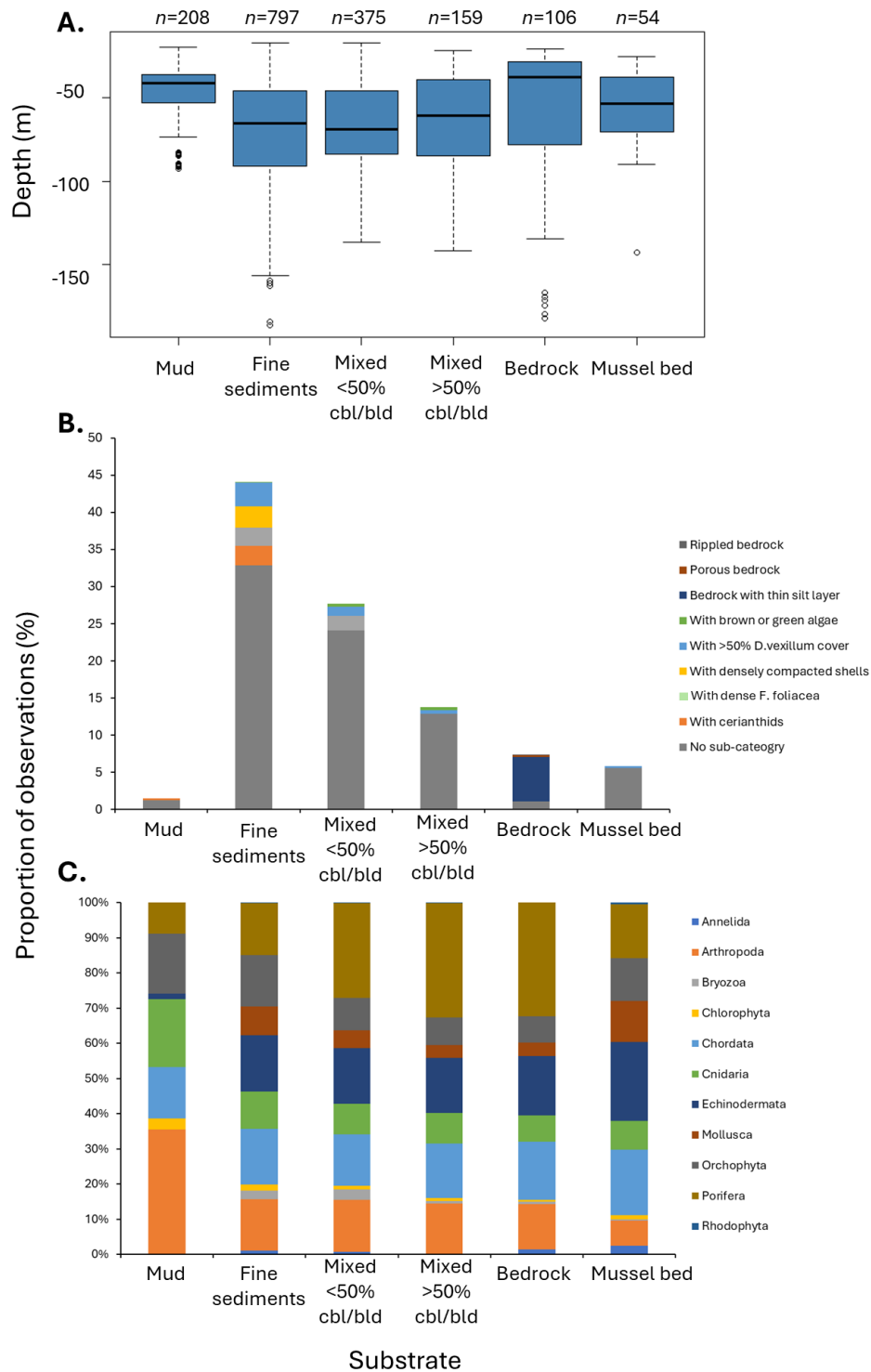


Figure 6. (A) Boxplot of substrate observations from analyzed still images ($n = 1699$; number of observations per substrate are provided above) according to depth (m) including mud, fine sediments with >50% cover of sand/gravel/pebbles, mixed sediments with <50% cover of cobbles and boulders, mixed sediments with >50% cover of cobbles and boulders, bedrock, and mussel beds. (B) Proportion of analyzed images within each substrate category, colorized by sub-categories. (C) Proportion of phyla occurrences identified in still images, according to substrate.

showing predominately fine sediments (Figure 6b). In contrast to video observations, this was followed by 22% of images dominated by mixed sediments with >50% cobbles and boulders. Mussel reefs (3%) and bedrock (6%) were similarly the least represented substrate categories. Only 23% of still images were ascribed to a sub-category, with the remainder allocated to one of six main substrate categories. For biota attributes within the sub-categories, cerianthids were prevalent in 4% and 6% of stills and video observations, respectively. Algae was present in 1% of stills and 2% of video observations (often drifting, unattached to the seafloor), while high densities and coverage of both *F. foliacea* and *D. vexillum* occurred in 4% of still images and 3% of video observations, respectively (Figure 5b, 6b).

A total of 8524 taxa occurrences were documented across the 1699 still images. Of the 68 taxa reported, encrusting sponges were the most commonly occurring taxa, present in 47% of analyzed still images (Table 2), observed across depths from 17 to 146 m. This was followed by common sea stars (*Asterias/Leptasterias* spp.) and knotted wrack (*Ascophyllum nodosum*), occurring in 43% and 38% of analyzed still images, respectively (Table 2). Common sea stars occurred across the entire depth range of the survey, while drifting knotted wrack was observed to depths of ~140 m. Algae beds are primarily located in depths <20 m, and the occurrence of algae taxa in deeper waters here reflect algal detritus advected from their original shallow site locations (Filbee-Dexter and Scheibling 2016).

Specific to phyla, annelids were scarce (in 5% of analyzed stills – Figure 6c), likely due to their endobenthic presence in fine sediments (and thus difficult to detect from imagery alone), but were observed at depths ranging from 21 to 133 m. Common arthropods included barnacles, shrimp, and *Cancer* spp. crabs (Table 2). Barnacles and *Cancer* spp. were found at depths of 20–144 m, while shrimp were recorded across the entire depth range surveyed. No toad crabs were observed. The bryozoan, *F. foliacea*, was rare across the study region; however, it was one of the dominant taxa in habitats off northwest and southern Grand Manan at depths from 21 to 140 m, and in some instances formed biogenic turf. Sea lettuce (*Ulva* spp.) was rare, and noted to be drifting along the seafloor at depths from 17 to 119 m, predominately in HH/WI/P transects. For chordates, all ascidian species contained moderate occurrences across images (in 10-26% of analyzed still images; Table 2); however the native *Didemnum albidum* was the most prominent. *Boltenia ovifera* and *Didemnum vexillum* occurred at depths from 20 to 144 m (representing a new DFO depth record for *D. vexillum* – September 2023), while *D. albidum* and *Dendrodoa carnea*

occurred across the entire depth range surveyed. Mobile taxa such as fishes, were scarce across analyzed still images, with the most common fishes including groundfish, sculpins, and redfish present in 4%, 3%, and 2% of images, respectively (Table 2). Groundfish were reported across the entire study area but generally limited to depths down to 100 m, primarily occurring on fine substrates. Sculpins predominately occurred in the HH/WI/P sub-area from 22 to 187-m depths, while redfish were most common off Grand Manan (to 118-m depths).

With regards to cnidarians, soft corals were rare (in 0.2% of images; 20 to 40-m depths), while *Urticina/Cribrinopsis* spp. anemones were common (in 33% of analyzed stills – Table 2) to depths of 144 m. For echinoderms (other than common sea stars), blood stars (*Henricia* spp.) were also commonly observed (in 25% of images, from 19 to 163-m depths), while *Solaster endeca* and sand dollars were not encountered (Table 2). Horse mussels (*Modiolus modiolus*) were the most common mollusc taxa (in 21% of images at depths of 17 to 144 m), followed by scallops (*Placopecten magellanicus* at 17 to 180-m depths), while no blue mussels (*Mytilus edulis*) were observed. For orchophytes, other than knotted wrack, *Fucus* spp. and *Laminaria* spp. were common (Table 2), from depths of 17 to 144 m, mainly in the HH/WI/P sub-area, but principally observed as unattached, drifting on the seafloor, with deeper observations likely a result of advection from coastal populations (as noted above). Besides encrusting sponges, *Iophon*-type sponges were the most common (11% of still images from 25 to 185-m depths), followed by the breadcrumb sponge (*Halichondria panicea* at 20 to 142-m depths), *Haliclona/Isodictya* spp. (at 20 to 135-m depths), and the massive *Mycale lingua* sponge (from depths of 22 to 118 m). Encrusting coralline algae was only rarely observed in analyzed still images (0.7% of stills; Table 2), but did occur across a broad depth range (17 to 118 m).

Of the 8524 recorded taxa occurrences, only 124 (1%) were observed on mud substrates, of which 22 were classified under the sub-category mud with cerianthids (Figure 6b). The most prominent taxa on mud substrates include cerianthids, shrimp, drifting knotted wrack, and lobster (Figure 6c). Fine sediments (mix of sand, gravel and pebbles) accounted for the highest number of taxa occurrences, with 3753 (44%) occurrences, most of which did not occur in sub-category substrates (Figure 6b). Fine sediment sub-categories (including presence of cerianthids, compacted shell hash, *D. vexillum*, *F. foliacea*) contained ~200 taxa occurrences, while taxa were scarce in algae dominated fine sediment images (6 occurrences). Dominant taxa in fine sediments include encrusting sponges, drifting knotted wrack, common sea stars, and anemones

(*Urticina/Cribrinopsis* spp.). A total of 2360 taxa occurrences (28%) were documented on mixed sediments with <50% cobbles/boulders, 164 of which contained *F. foliacea* and 110 occurrences were associated with extensive *D. vexillum* (Figure 6b). The most common taxa on mixed sediments with <50% cobbles/boulders include barnacles, shrimp, *D. albidum*, *F. foliacea*, common sea stars, and encrusting sponges (Figure 6c). Mixed sediments with >50% cobbles/boulders contained 1169 taxa occurrences (14%), with most occurrences not present on sub-categories. Dominant taxa here include encrusting sponges, *Urticina/Cribrinopsis* spp., common sea stars, and barnacles. A total of 625 taxa occurrences (7%) were reported on bedrock substrates, which includes 508 occurrences on silt-covered bedrock, 22 on pitted bedrock, and 5 on smooth bedrock. Predominant taxa on bedrock include encrusting sponges, blood stars and common sea stars, anemones, *M. lingua*, *D. albidum*, and barnacles. On mussel reefs 493 taxa occurrences were recorded (6% of the total occurrences), 22 of which were observed on mussel beds overgrown with *D. vexillum* (Figure 6b). Common taxa on mussel beds include both *Didemnum* spp., *B. ovifera*, crabs, anemones, common sea stars and blood stars, knotted wrack, and encrusting sponges (Figure 6c). Anthropogenic debris (fishing gear [cage, ropes], SCUBA gloves, garbage) was only encountered in seven instances (Table 2), within the HH/WI/P sub-area, and in the Long Island Bay – Great Duck Island MCN site.

3.1 AREA SUMMARIES

Benthic habitat characterization and taxa occurrences are summarized based on general distinctness of four sub-areas, aligned with conservation planning areas and site designations: (1) Passamaquoddy Bay, (2) the HH/WI/P sub-area (EBSA and surrounding area), (3) The Wolves and the nearby Deadman's Harbour (including in part, The Wolves EBSA), and (4) Grand Manan (including in part, the Southern Grand Manan EBSA and surrounding area).

3.1.1 PASSAMAQUODDY BAY

Four transects (CON029, 047, 048, 049) were conducted within Passamaquoddy Bay over two days in 2023, across depths ranging from 28 to 66 m, with the majority of video observations occurring at >35-m depths (Table 3, Figure 7a). A total of 100 still images were analyzed and contained 20 taxa, with an average taxa count of 1 taxa per still image (Figure 8a). Common phyla here include Arthropoda and Porifera (Figure 7b). The most prevalent taxa include shrimp, the fig

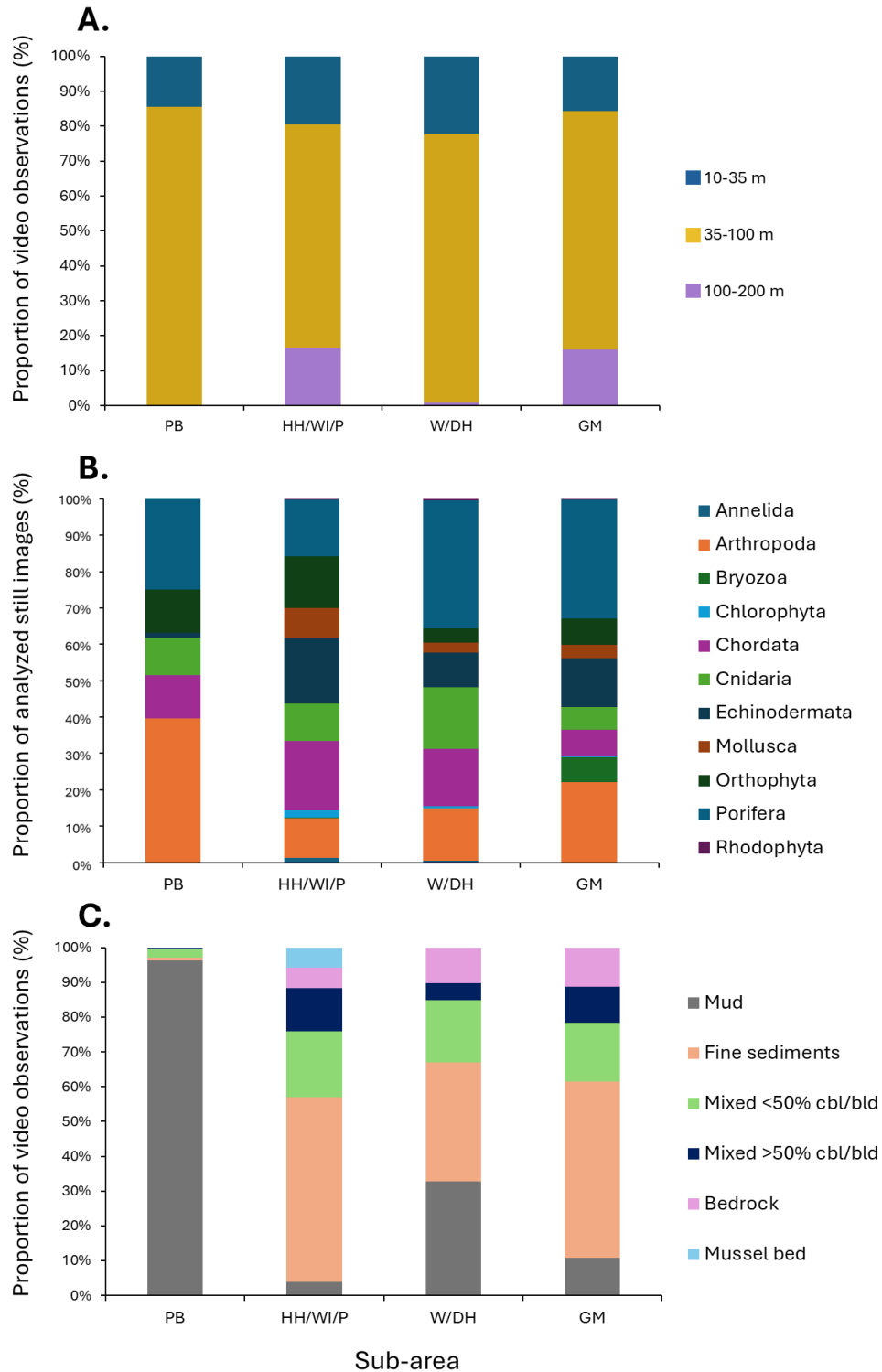


Figure 7. (A) Depth class distribution of video observations in each sub-area surveyed; Passamaquoddy Bay (PB), the Head Harbour/West Isles/Passages region (HH/WI/P), The Wolves and Deadmans Harbour (W/DH), and Grand Manan (GM). (B) Distribution of phyla ($n = 11$) observed in each still image, according to area (proportion - %). (C) Distribution of substrate categories from video observations, according to sub-area (proportion - %).

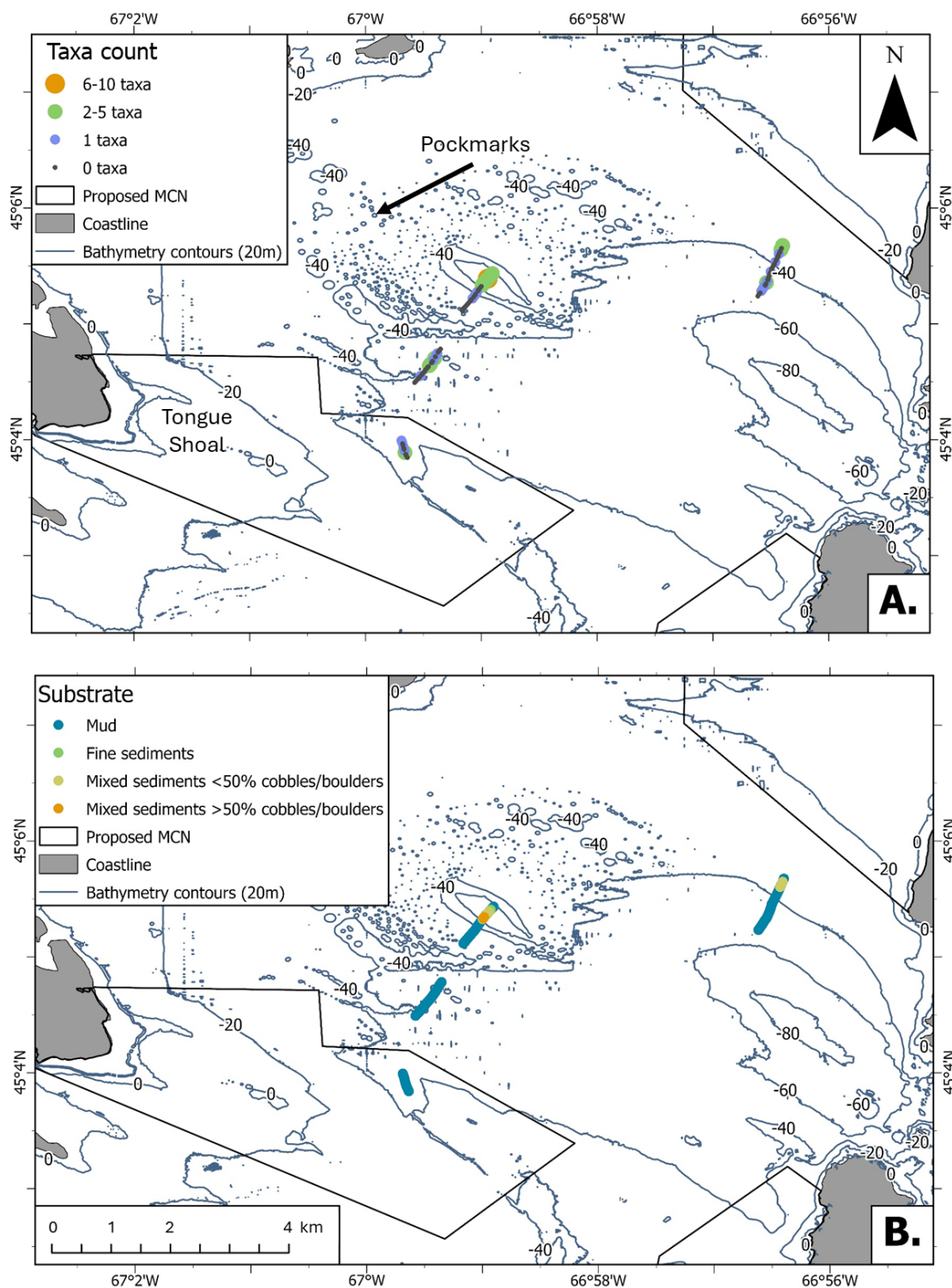


Figure 8. (A) Total number of taxa present (i.e., taxa count) of the 68 taxa analyzed in digital still images in Passamaquoddy Bay sub-area transects ($n = 4$). Proposed Marine Conservation Network (MCN) sites (outlined in black), and underlying 20-m bathymetry contours (navy blue). (B) Spatial distribution of substrates observed in continuous video (~1 observation per second) from the four transects in this area.

Table 4. Occurrence and proportion (%) present of taxa and morphotypes of interest across analyzed still images in the sub-areas: Passamaquoddy Bay ($n = 100$), the HH/WI/P region ($n = 833$), The Wolves/Deadman's Harbour ($n = 176$), and Grand Manan ($n = 590$) listed according to phylum, from SWNB imaging surveys (2022 to 2024). Taxa with an asterisk (*) are unsure or may be later confirmed. The five most prevalent taxa in each sub-area are highlighted in bold.

Phylum	Taxa of interest	Number of Pass. Bay occurrences	Proportion (%) present	Number of HH/WI/P occurrences	Proportion (%) present	Number of Wolves/DH occurrences	Proportion (%) present	Number of Grand Manan occurrences	Proportion (%) present
Annelida	<i>Myxicola</i> spp.*	0	0	74	9	3	2	2	0.5
Arthropoda	Barnacles	8	8	200	24	7	4	239	41
	<i>Cancer</i> spp.	2	2	112	13	12	7	105	18
	<i>Carcinus maenas</i>	0	0	0	0	3	2	0	0
	<i>Homarus americanus</i>	2	2	34	4	5	3	23	4
	<i>Hyas coarctatus</i>	0	0	0	0	0	0	0	0
	<i>Pagurus</i> spp.	0	0	77	9	3	1.7	7	1
	Pandalidae	11	11	150	18	53	30	120	20
	Euphausiacea	4	4	24	3	5	3	17	3
Bryozoa	<i>Flustra foliacea</i>	0	0	15	2	0	0	160	27
Chlorophyta	<i>Ulva</i> spp.	0	0	107	13	4	2	3	0.5
Chordata	<i>Boltenia ovifera</i>	0	0	209	25	3	2	2	0.3
	<i>Dendrodoa carnea</i>	0	0	200	24	8	5	65	11
	<i>Didemnum albidum</i>	1	1	330	40	52	30	51	9
	<i>Didemnum vexillum</i>	0	0	166	20	0	0	0	0
	<i>Aspidophoroides monopterygius</i>	0	0	1	0.1	0	0	4	0.7
	<i>Myoxocephalus</i> spp.*	0	0	45	5	2	1	7	1
	<i>Pholis gunnellus</i>	0	0	6	0.7	4	2	3	0.5
	<i>Hemitripterus americanus</i>	0	0	2	0.2	0	0	0	0
	<i>Sebastes</i> spp.	0	0	3	0.4	9	5	24	4
	<i>Zoarces americanus</i>	0	0	6	0.7	0	0	2	0.3
	<i>Tautoglabrus adspersus</i>	0	0	5	0.6	2	1	6	1
	<i>Melanogrammus aeglefinus</i>	0	0	0	0	0	0	2	0.3
	<i>Gadus</i> spp.	0	0	8	1	1	0.6	1	0.1

Phylum	Taxa of interest	Number of Pass. Bay occurrences	Proportion (%) present	Number of HH/WI/P occurrences	Proportion (%) present	Number of Wolves/DH occurrences	Proportion (%) present	Number of Grand Manan occurrences	Proportion (%) present
	<i>Urophycis</i> spp.	0	0	17	2	4	2	2	0.3
	<i>Clupea harengus</i>	0	0	3	0.4	1	0.6	1	0.2
	<i>Scomber scombrus</i>	0	0	2	0.2	0	0	0	0
	<i>Lophius americanus</i>	0	0	0	0	0	0	1	0.2
	Pleuronectiformes*	6	6	47	6	10	6	2	0.3
	Skates – <i>Leucoraja</i> spp.	1	1	1	0.1	0	0	1	0.2
Cnidaria	<i>Urticina felina</i> / <i>Cribrinopsis similis</i> *	0	0	456	55	28	16	72	12
	<i>Metridium senile</i>	0	0	12	1	0	0	0	0
	<i>Pachycertianthus borealis</i>	6	6	96	12	76	43	72	12
	<i>Gersemia rubiformis</i>	1	1	3	0.4	0	0	0	0
Echinodermata	<i>Asterias/Leptasterias</i> spp.*	0	0	539	65	34	19	159	27
	<i>Henricia</i> spp.	1	1	261	31	17	10	149	25
	<i>Porania pulvillus</i>	0	0	0	0	0	0	4	0.7
	<i>Pteraster militaris</i>	0	0	0	0	0	0	1	0.2
	<i>Crossaster papposus</i>	0	0	1	0.1	3	2	2	0.3
	<i>Solaster endeca</i>	0	0	0	0	0	0	0	0
	Ophiuroidea	0	0	11	1	4	2	2	0.3
	<i>Echinarachnius parma</i>	0	0	0	0	0	0	0	0
	<i>Strongylocentrotus droebachiensis</i>	0	0	3	0.4	0	0	0	0
	<i>Cucumaria frondosa</i>	0	0	186	22	0	0	0	0
Mollusca	<i>Mytilus edulis</i>	0	0	0	0	0	0	0	0
	<i>Modiolus modiolus</i>	0	0	299	36	11	6	49	8
	<i>Placopecten magellanicus</i>	0	0	153	18	5	3	34	6
Orchophyta	<i>Ascophyllum nodosum</i>	4	4	503	60	18	10	129	22
	<i>Fucus</i> spp.	0	0	108	13	1	0.6	26	4
	<i>Chorda filum</i>	0	0	17	2	3	2	0	0
	<i>Desmarestia</i> spp.	1	1	45	5	1	0.6	5	0.8
	<i>Laminaria</i> spp.	3	3	111	13	1	0.6	7	1

Phylum	Taxa of interest	Number of Pass. Bay occurrences	Proportion (%) present	Number of HH/WI/P occurrences	Proportion (%) present	Number of Wolves/DH occurrences	Proportion (%) present	Number of Grand Manan occurrences	Proportion (%) present
Porifera	<i>Aplysilla sulfurea</i>	0	0	1	0.1	9	5	28	5
	<i>Haliclona/Isodictya</i> spp.*	0	0	80	10	4	2	62	11
	<i>Hymedesmia canadensis</i>	1	1	63	8	12	7	28	5
	<i>Hymedesmia paupertas</i>	0	0	0	0	1	0.6	21	4
	<i>Iophon</i> spp.*	0	0	13	2	2	1	114	2
	<i>Iophon</i> spp. type*	0	0	11	1	57	32	11	19
	<i>Mycale lingua</i>	1	1	42	5	30	17	56	10
	<i>Myxilla fimbriata</i>	0	0	18	2	1	0.6	3	0.5
	<i>Polymastia bartletti</i>	0	0	24	3	3	2	33	6
	<i>Polymastia uberrima</i>	1	1	17	2	23	13	50	9
	<i>Sphaerotylus capitatus</i>	0	0	9	1	10	6	7	1
	<i>Halichondria panicea</i>	0	0	107	13	1	0.6	51	9
	<i>Halichondria sitiens</i>	2	2	14	2	5	3	4	0.7
	<i>Suberites ficus</i>	8	8	14	2	7	4	1	0.2
	Encrusting species	4	4	449	54	51	29	296	50
Rhodophyta	Encrusting calcareous algae	0	0	7	0.8	2	1	3	0.5

Table 4 cont.

sponge (*Suberites ficus*), groundfish, and cerianthids (Table 4). Taxa occurrences in this sub-area are likely underrepresented due to the small number of transects.

Muddy habitats were predominant, with few patches of heterogenous gravels/pebbles and shell hash (Figure 7c, 8b). Transects CON029, 047 and 049 occurred over continuous lines of pockmarks, some of which contained crabs (*Cancer* spp.) and were surrounded by sponge habitats (namely *S. ficus*). No pockmarks were observed in CON048. Only CON029 occurred within a proposed MCN site (Tongue Shoal), covering 103 m², with 12 images analyzed containing a taxa count of 3 (Table 5). Drifting knotted wrack (*A. nodosum*) was seen in all transects in the continuous video coverage, often with few shrimp, crabs, and groundfish. Cerianthids (*Pachycerianthus borealis*) and massive sponges were common along the muddy seafloor. Additionally, while lobsters were scarce, visible lobster burrows and track marks (of which some were likely by lobsters) were often observed (Appendix Table 1).

Table 5. Number of SWNB 2022 to 2024 near-seafloor imaging transects conducted by DFO Science Maritimes Region Marine Conservation Targets (MCT) project 691 according to Marine Conservation Network (MCN) plan polygon and area (km²), including the estimated area covered (m²) hours (h) and minutes (min) of video, the number of analyzed images ($n = 1070$ of 1699) and the total taxa present ($n = 68$) in the MCT survey.

MCN site	MCN site area	MCT transects	Area covered	Amount of video	Images analyzed	Taxa present
Tongue Shoal	11.9 km ²	1	103 m ²	16 min	12	3
Little Letete Passage	6.3 km ²	3	1069 m ²	1 h 47 min	81	32
Simpsons and Whitehorse Island	13.4 km ²	6	1595 m ²	2 h 11 min	98	35
Head Harbour Passage	4.9 km ²	5	1584 m ²	2 h 1 min	104	47
Western Passage North	1.6 km ²	3	1067 m ²	59 min	58	37
Western Passage South	1.6 km ²	1	620 m ²	20 min	12	23
Deadmans Harbour	17 km ²	5	730 m ²	1 h 53 min	57	14
The Wolves – Wolves Bank	23 km ²	8	2319 m ²	2 h 54 min	119	49
Northwest Grand Manan	4.7 km ²	4	2403 m ²	1 h 12 min	96	32
Long Island Bay – Great Duck Island	32 km ²	11	2344 m ²	4 h 31 min	190	42
Old Proprietor Shoal – The Prong	266 km ²	6	5621 m ²	3 h 27 min	243	49

3.1.2 HEAD HARBOUR/WEST ISLES/PASSAGES

A total of 33 transects occurred in the HH/WI/P sub-area, collected across 8 survey days from depths of 15 to 144 m, with most video observations in the 35 to 100-m depth class (Table 3, Figure 7a). A total of 833 still images (49% of the 1699 image set) were analyzed and contained 58

taxa, with an average taxa count of 7 per still image (Figure 9a). This sub-area was diverse, with no clear dominant phyla (Figure 7b). Common taxa included barnacles, ascidians (*B. ovifera*, *D. albidum*, *D. vexillum*, and *D. carnea*), anemones, common sea stars, blood stars, horse mussels, knotted wrack, and encrusting sponges. The most prevalent fish were sculpins and groundfish with 45 and 47 occurrences, respectively (Table 4).

Fine sediments dominated HH/WI/P transects (Figure 7c); however, transects were highly heterogenous, changing from gravel and shell hash to boulders and *M. modiolus* reefs over 1 to 10-m spatial scales (Figure 9b). Encrusting sponges were abundant on hard substrates, along with extensive patches of *D. vexillum*, particularly in Head Harbour and Western Passages, where it was seen overgrowing scallops, horse mussels, and surrounding anemones, creating a homogenous tunicate mat. The native colonial tunicate, *D. albidum* was common throughout all HH/WI/P transects in small patches on gravel and cobble substrates, and was distinguished from *D. vexillum* using criteria outlined in Teed et al. (2024). *M. modiolus* formed mussel reefs along Head Harbour Passage from 43 to 143-m depths and in Western Passage from 37 to 67-m depths (Figure 9b).

In the northwest corner of the HH/WI/P sub-area, including the Little Letete Passage MCN site, seven transects were completed covering depths from 15 to 81 m, including three transects directly in the MCN site (CON080-082) containing 81 analyzed images (Table 5). Average number of taxa occurring in these transects was 5 taxa per still image (Figure 9a). Within the proposed MCN site, 32 taxa were present (Table 5) and the video covered an estimated area of 1069 m², crossing various substrates from mud to silty gravels and pebbles with shell hash and the rare cobble/boulder or bedrock patch. Throughout these transects, taxa observed included sponges (massive and encrusting), groundfish, scallops, sea cucumbers, lobster, crabs, drifting algae, with few patches of mussel turf (Appendix Table 1). To the north, in Big Letete Passage, silty mixed sediments were observed, with scarce bedrock patches (including some pitted bedrock patches). Sea cucumbers were dense in some spots, aggregating on boulders or bedrock, often entangled in knotted wrack. Green sea urchins were uncommon, with only a few individuals observed in CON044. Tunicates were common here, including the first record (September 2023) of the invasive *D. vexillum* north of Deer Island in DFO's SWNB benthic imagery database (Lawton and Teed 2025). Encrusting sponges, scallops, mussels, fish, skates, lobster, and crabs were encountered throughout (Appendix Table 1).

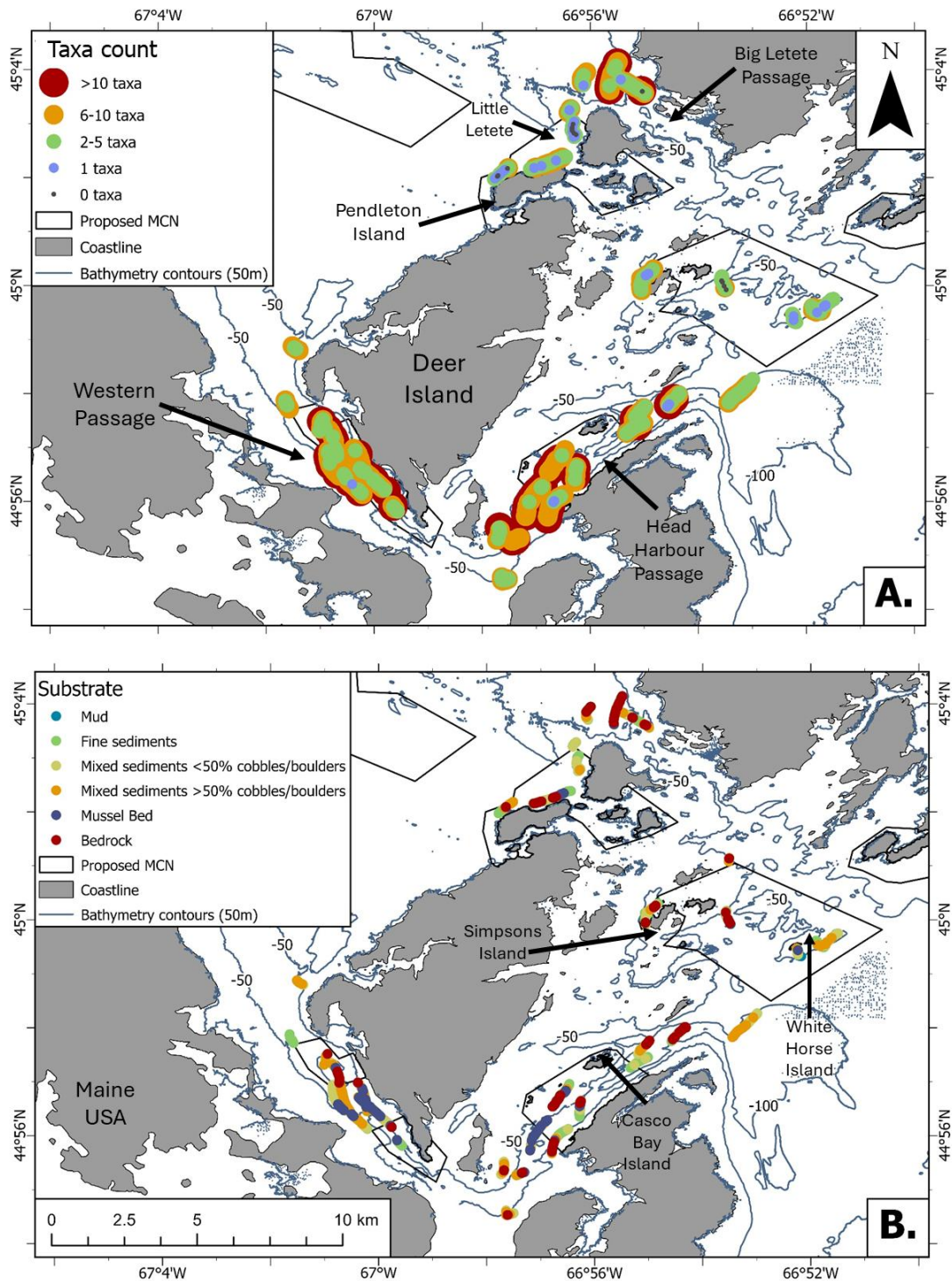


Figure 9. (A) Total number of taxa present (*i.e.*, taxa count) of the 68 taxa analyzed in the digital still images in the Head Harbour/West Isles/Passages sub-area transects ($n = 33$). Proposed Marine Conservation Network (MCN) sites (outlined in black), and underlying 50-m bathymetry contours (navy blue). (B) Spatial distribution of substrates observed in continuous video (~1 observation per second) from the 33 transects in this area.

East of the Letete Passages is the Simpsons and Whitehorse Islands MCN site. Six transects were conducted here (CON083-086, CON093-094) covering depths of 25 to 77 m and an estimated area of 1595 m² (Table 5). A total of 98 images were analyzed resulting in a taxa count of 35 (Table 5), with an average of 4 taxa occurring per still image (Figure 9a). In a few of these transects, on FOBIS descent, numerous mackerel were observed surrounding the system. Silty mixed sediments were prevalent and formed benthic habitat for cerianthids, crabs, lobster, fishes, occasional scallops, drifting algae and dulse (*D. albidum*), sea cucumbers, and sponges (encrusting and massive) associated with sporadic, silt-covered bedrock patches (Appendix Table 1). CON046 was situated just outside the proposed MCN site; however, due to strong currents, this transect was aborted (*i.e.*, no images were taken, and only ~1 minute of video was analyzed for substrate: silty mixed sediments).

In Head Harbour Passage, off of Campobello Island, 11 transects were conducted, with an average of 8 taxa observed per still image (Figure 9a). Five of these 11 transects were at least partially within the proposed Head Harbour MCN site (CON036-038, and CON109-110) from 19 to 120-m depths, covering an estimated area of 1584 m² (Table 5). Of the 294 images analyzed in Head Harbour Passage, 104 occurred within the MCN site, containing a taxa count of 47 (Table 5). While these transects sampled a large depth range, they only partially represent cross-section profiles of the passage, as the current-driven drifts typically ran parallel to the shore (*e.g.*, CON036 and 037, Figure 3b; but see CON110, Figure 10). Substrates were heterogenous throughout these transects, switching from gravel and pebbles to boulder fields and bedrock patches (Figure 9b) over short linear extents of 1 to 10 m. Mussel reefs were also observed here, with some areas of mussel turf (*i.e.*, biogenic aggregations of live and dead individuals distinct from surrounding habitat; see Morris 2015) primarily comprised of empty and/or compacted mussel shells, along with some extensive colonies of *D. vexillum*. Sea stars, sponges, and anemones were common throughout, with some observations of *B. ovifera*, crabs, lobster, scallops, sea cucumbers, various fishes and algae (Figure 10, Appendix Table 1). During one transect (CON109), anemones were observed feeding on high densities of krill that were swimming above the seafloor. Soft corals (*G. rubiformis*) were only observed in CON109 in three images. Three other transects (CON039-041) occurred to the north of the MCN site in the deepest parts of the passage (92 to 144-m depths), where muddy mixed sediments were common, comprised of gravel, pebbles and significant coverage of shell hash, including compacted mussel shells. In CON039 and 040 along the tip of Head Harbour Passage, substantial areas of compacted mussel shells dominated the seafloor along steep slopes from

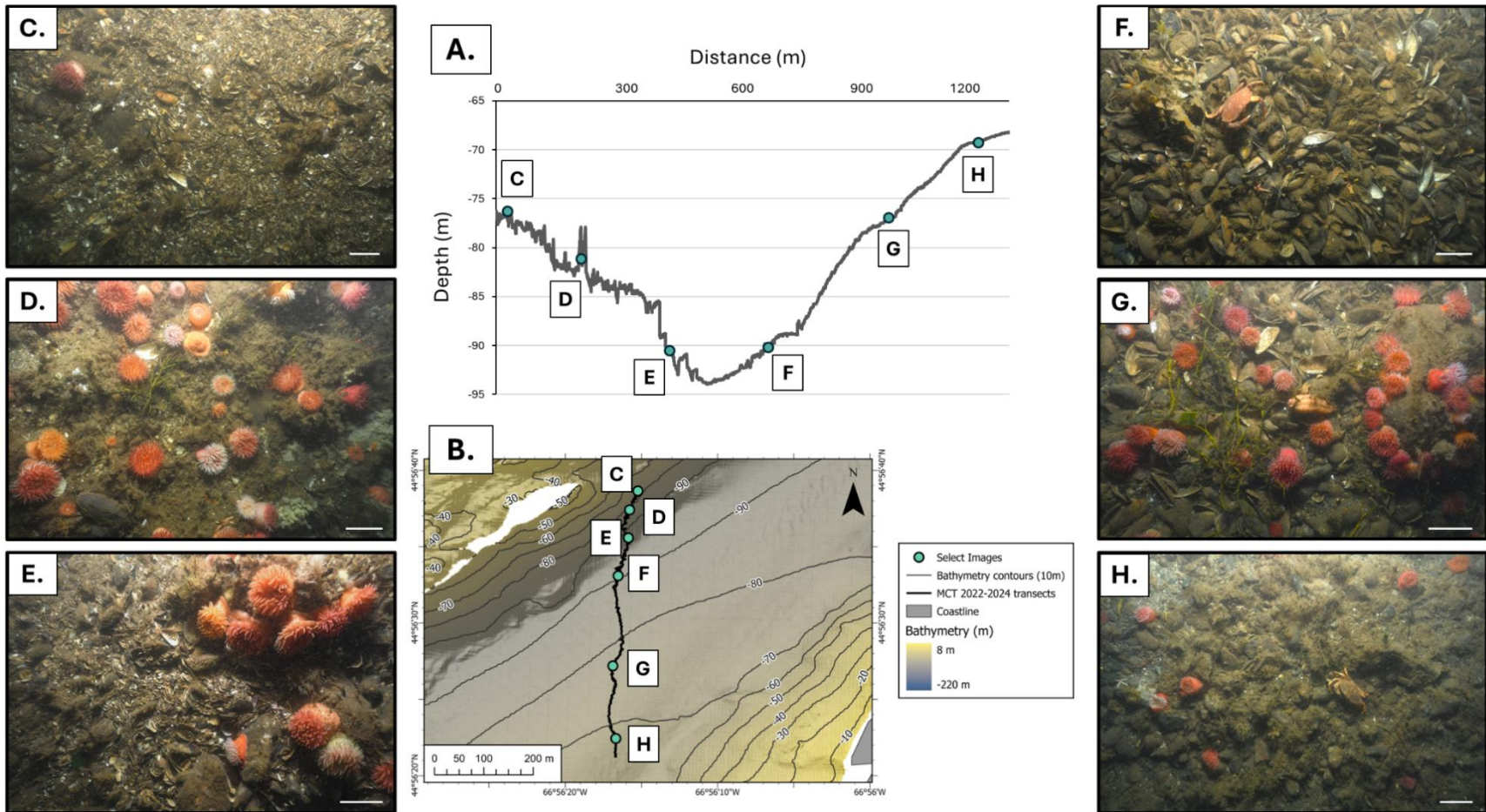


Figure 10. (A) Depth profile (m) and (B) bathymetry map with 10-m contours of transect CON110 in Head Harbour Passage. Distance is along the transect, which ran north to south. Select images are positioned along the transect line according to the time the image was taken (included in filename): (C) CON110-20240930T142705.jpg, (D) CON110-20240930T143217.jpg, (E) CON110-20240930T144021.jpg, (F) CON110-20240930T144658.jpg, (G) CON110-20240930T145642.jpg, and (H) CON110-20240930T150447.jpg. White scale bars represent a 10-cm scale.

depths of 96 to 117 m, likely the result of trawling and/or strong current impacts. Though we cannot be certain of what leads to these shell aggregations, particularly where they are found on high slope locations, these accumulations did appear to provide stable substrate for epifauna, including sponges (discussed in 4.1.2). Anemones, horse mussels, and *Didemnum* spp. were common throughout, with few crabs, scallop, fishes, sponges, *B. ovifera* also observed on or surrounding infrequent boulder/cobble or pitted bedrock patches (Appendix Table 1). Some bedrock patches encountered were steep and fissured, transitioning upslope from depths of 143 to 104 m over a 500-m linear distance (in CON040). The remaining three transects in this area (CON002, 004, and 035) were completed south of the proposed MCN site from 33 to 87-m depths, encountering extensive patches of *D. vexillum* (up to 100% coverage in CON002, overgrowing benthic substrates), along with patches of mussel reef, surrounded by silty mixed sediments (predominately gravel, pebbles and cobbles). Shell hash was also common, and anemones, sponges, scallops, cucumbers, algae, crabs, and fishes were observed throughout on the rare boulder or bedrock patch (Appendix Table 1). Few *B. ovifera* occurred in these transects, however, when present, they were small in size, suggesting more recent establishment.

In Western Passage, eight transects were conducted, with only CON052 partially falling within the Western Passage South MCN site (from depths of 35 to 67 m, covering an estimated area of 620 m²), while CON007 and 051 occurred within the Western Passage North site (from 36 to 118-m depths, estimated area of 1067 m²). More specifically, 58 and 12 images were analyzed within the Western Passage North and South MCN sites, containing taxa counts of 37 and 23 taxa, respectively (Table 5). Transects CON003, 005, and 006 (71 images) occurred between these sites at depths ranging from 34 to 91 m, yielding similar observations to CON007, and CON051-052 (Appendix Table 1). All of these transects occurred on silty mixed sediments and contained areas of extensive mussel reefs (Figure 9b). The densest horse mussel reef areas were actually located in the sections of the transects between the two proposed sites (*i.e.*, would remain unprotected if both the northern and southern MCN sites were adopted). Anemones, sponges, *Didemnum* spp., sea cucumbers, and crabs were common on scattered boulders, rare bedrock patches (sometimes pitted or smooth) and rock walls. Densely compacted mussel shells were observed throughout, along with drifting knotted wrack and sparse scallops, *B. ovifera*, and fishes (Appendix Table 1). Transects CON050 and CON008 (27 images) were conducted further west of Deer Island (from 49 to 80-m depths), encountering muddy mixed sediments with shell hash, drifting algae, and various fishes. In CON050, substrates were covered in *D. vexillum* throughout, with only few *B. ovifera*,

scallops, crabs, and cucumbers observed. Transect CON008 did not have tunicate coverage, but contained patches of the mat-forming *lophon* spp. type sponge (Appendix Table 1). Across all eight transects in Western Passage, the average taxa count was 8 taxa per still image (Figure 9a).

3.1.3 THE WOLVES AND DEADMANS HARBOUR

Thirteen transects were conducted in The Wolves and Deadmans Harbour sub-area, sampled across three survey days in 2023 and 2024 (Table 3). A total of 176 digital still images were analyzed, from depths of 24 to 116 m, with most video observations in depths >35 m (Figure 7a). Of the 68 taxa analyzed, 50 taxa were observed in The Wolves and Deadmans Harbour transects, with an average number of 4 taxa per still image (Figure 11a). The most common phyla observed here include Porifera and Cnidaria (Figure 7b). Dominant taxa include shrimp, the native *D. albidum*, and cerianthids – specifically in deeper transects (Table 4). On the shallow bank south of The Wolves (Wolves Bank), encrusting sponges, mat-forming *lophon* spp. type, and the massive *Mycale lingua* were common on complex topography.

Northwest of The Wolves, five transects were conducted in 2024 in the proposed Deadmans Harbour MCN site, (CON088-092; 57 analyzed images) covering depths of 25 to 40 m (Table 3), and an estimated area of 730 m² (Table 5). Near-seafloor conditions were very turbid, and habitats observed here were dominated by mud with visible lobster burrows (Appendix Table 1). Coarser mixed sediments were sparse (Figure 11b), but when observed, they were occupied by crabs, sponges, *D. albidum*, and anemones. Cerianthids were scattered throughout these transects, along with limited observations of groundfish, lobsters, and drifting *Laminaria* spp. (Appendix Table 1). Overall taxa occurrences were low with an average taxa count of 0 - 1 per still image and a combined taxa count of 14 across these five transects (Figure 11a; Table 5).

Off the coast of Southern Wolf Island, three transects (CON111-113) were conducted in 2024 from 47 to 97-m depths (Table 3), within the proposed Wolves/Wolves Bank MCN site. During the descent, herring were observed surrounding the FOBIS package. Once on the seafloor, muddy gravel habitats were prominent with sparse coarser sediments and possibly some small patches of underlying bedrock (Figure 11b). Shell hash was common along with drifting algae, cerianthids, and encrusting sponges, while few groundfish, *B. ovifera*, lobster, scallops, and crabs were observed throughout (Table 4, Appendix Table 1). However, *B. ovifera* was only observed in two analyzed still images. Average taxa count per still image here was 4 taxa (Figure 11a).

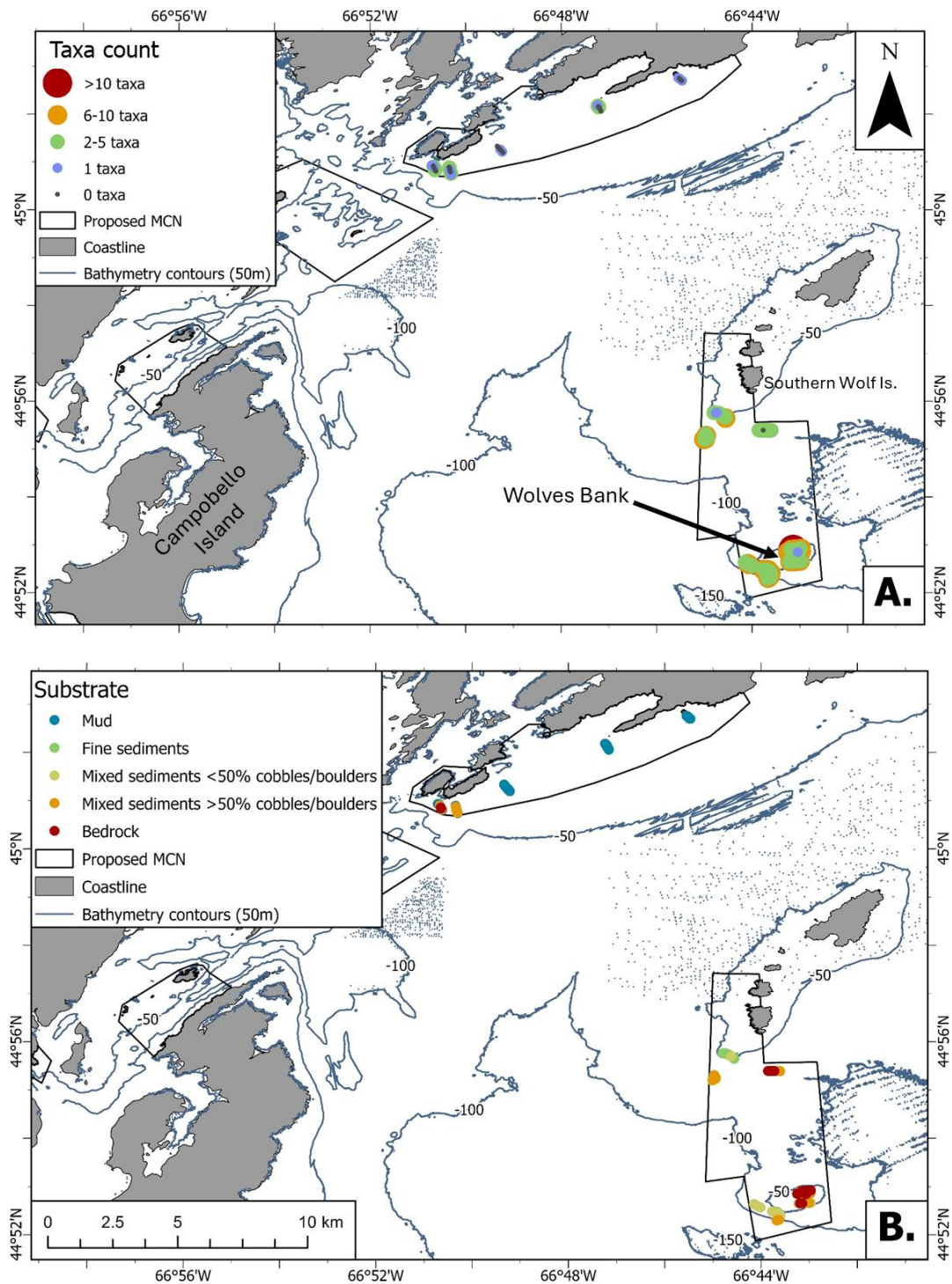


Figure 11. (A) Total number of taxa present (*i.e.*, taxa count) of the 68 taxa analyzed in the digital still images in The Wolves/Deadmans Harbour sub-area transects ($n = 13$). Proposed Marine Conservation Network (MCN) sites (outlined in black), and underlying 50-m bathymetry contours (navy blue). (B) Spatial distribution of substrates observed in continuous video observations (~1 observation per second) from the 13 transects in this area.

Further south on Wolves Bank (within the same MCN site as above), five transects were conducted (CON030-034) in 2023 from depths of 24 to 116 m (Table 3). Highly-sloped walls and rocky outcrops interspersed with silty gravel were common, housing high abundances of sponges and anemones (Figure 12), particularly in CON031 and 032 which ran directly on top of the bank that plateaued around depths of 30 m. The average number of taxa per still image on Wolves Bank was 6 taxa (Figure 11a). Sponges observed include *Aplysilla sulfurea*, *Hymedesmia canadensis*, *Mycale lingua*, *Myxilla fimbriata*, Polymastiidae, and numerous encrusting species (Figure 12). Very steep slopes were transited over the southern tip of Wolves Bank in CON033 and 034, from depths of ~70 to 116 m over a 90-m linear distance. Boulders and rock walls were common along the slope, interspersed with till and mixed sediments, housing diverse anemones, sponges, fishes, and scallops. Of the primary species of conservation interest (*B. ovifera*, *M. modiolus*, *G. rubiformis*, and *P. borealis*), *B. ovifera* was observed on boulders and bedrock throughout CON032 video; however, it only occurred in one analyzed still image and individuals were small. *M. modiolus* was observed on Wolves Bank attached to boulders, forming clumps, and documented in images from CON030, 031, 032 and 034. Soft corals and cerianthids were not observed on Wolves Bank. Overall, within The Wolves-Wolves Bank MCN site, 199 images were analyzed containing a count of 49 taxa and the continuous video encompassed an estimated area of 2319 m² (Table 5).

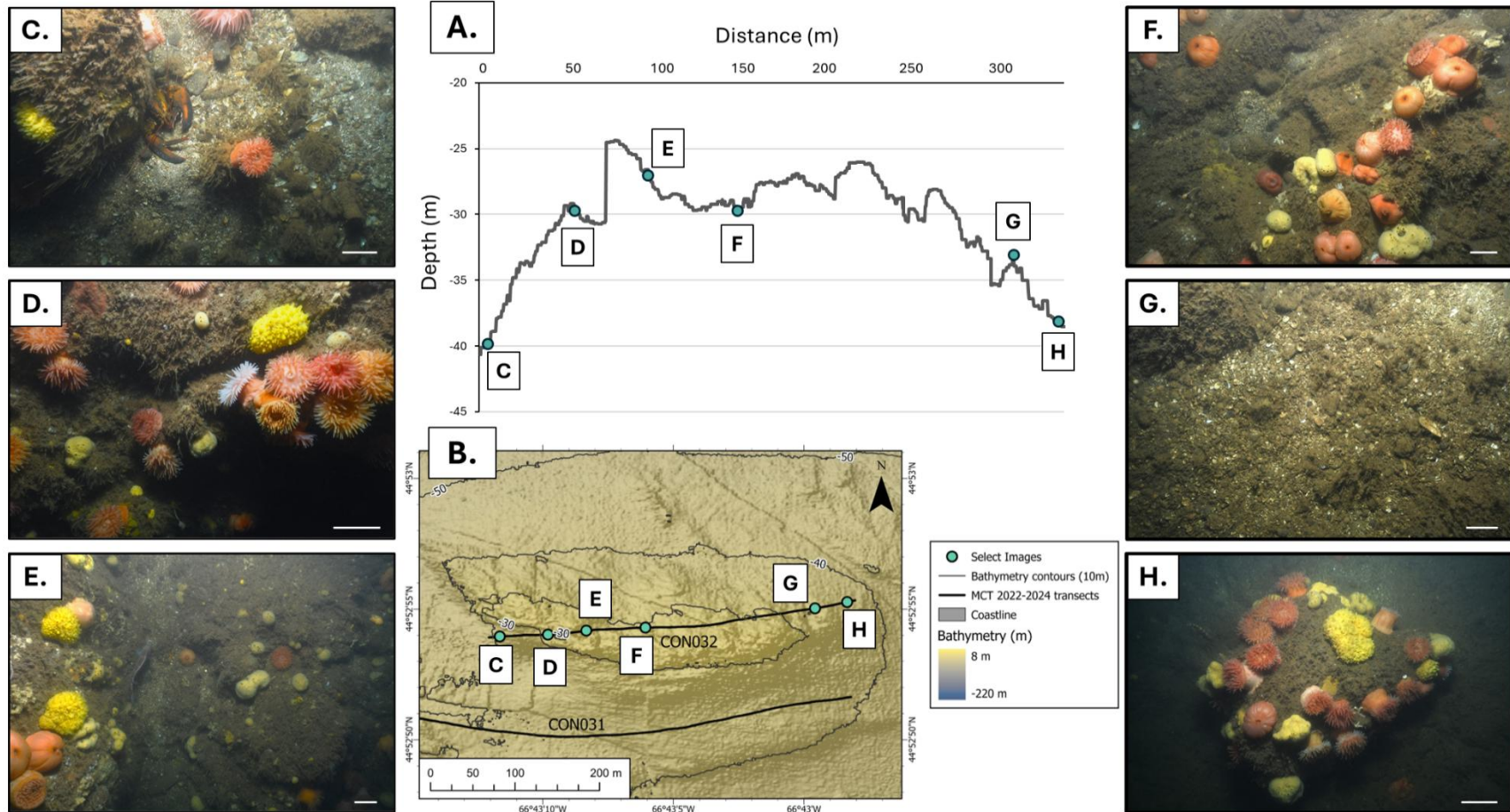


Figure 12. (A) Depth profile (m) and (B) bathymetry map with 10-m contours of transect CON032 on Wolves Bank. Distance is along the transect, which ran east to west. Select images are positioned along the transect line according to the time the image was taken (included in filename): (C) CON032-20230923T142933.jpg, (D) CON032-20230923T143154.jpg, (E) CON032-20230923T143347.jpg, (F) CON032-20230923T143637.jpg, (G) CON032-20230923T144425.jpg, and (H) CON032-20230923T144545.jpg. White scale bars represent a 10-cm scale.

3.1.4 GRAND MANAN

A total of 23 transects were conducted off Grand Manan Island, surveyed across five days in 2023 and 2024 (Table 3). Of the 1699 images analyzed in this report for taxa occurrences, 590 (35%) occurred in these 23 transects, with an observed taxa count of 56, and an average of 5 taxa per still image (Figure 13a). Transects covered a broad depth range from 21 to 188 m, including the deepest transect across the entire survey (CON116 in the Old Proprietor Shoal/The Prong MCN site). Most video observations occurred in the 35 to 100-m depth class, with 16% occurring in both the shallower (10 to 35-m) and deeper (100 to 200-m) depth classes (Figure 7a). Porifera and Arthropoda were the dominant phyla documented in the Grand Manan transects (Figure 7b). Common taxa observed here include barnacles, the bryozoan *F. foliacea* (predominantly in the Northwest MCN site), common sea stars and blood stars, knotted wrack, encrusting sponges, and the mat-forming *lophon* spp. sponge (Table 4). Fish were sparse with the exception of *Sebastes* spp., which were commonly observed swimming around mixed hard substrates in southeast Grand Manan (mainly in the Old Proprietor Shoal/Prong [CON116, 117, 120 and 121] and Long Island Bay/Great Duck Island [CON087, 100, 102, 103 and 106] MCN sites).

Fine sediment was the most common substrate reported in Grand Manan video transects (Figure 7c, 13b), with no horse mussel beds observed. In northern Grand Manan (*i.e.*, south of Wolves Bank - CON118, at depths of 58 to 93 m), gravel and cobbles were common with sparse silty boulders along a gentle slope transitioning from 60 to 90 m over a linear extent of 400 m. Shell hash was also common, and few scallops, crabs, cerianthids, lobster, and herring were observed (Appendix Table 1) with an average of 3 taxa per still image (Figure 13a). In the Northwest Grand Manan MCN site off the northwest coast of Grand Manan, four transects were conducted from depths of 44 to 81 m (CON095-098; 96 images analyzed), covering an estimated area of 2403 m² (Table 5). An average of 5 taxa per still image (Figure 13a) and an overall taxa count of 32 taxa (Table 5) were observed here. The drift speed was very fast, indicating strong bottom currents which did not allow for transect profiles running perpendicular to the coast; instead transects ran parallel to shore (Figure 3d). Variable mixed substrates were observed (Figure 13b), often with underlying sand, with the bryozoan *F. foliacea* forming dense colonies on scattered cobbles and boulders. Drifting algae and kelp was observed throughout these transects, along with sponges, crabs, common sea stars, anemones, scallops, and few lobster and fishes (Appendix Table 1).

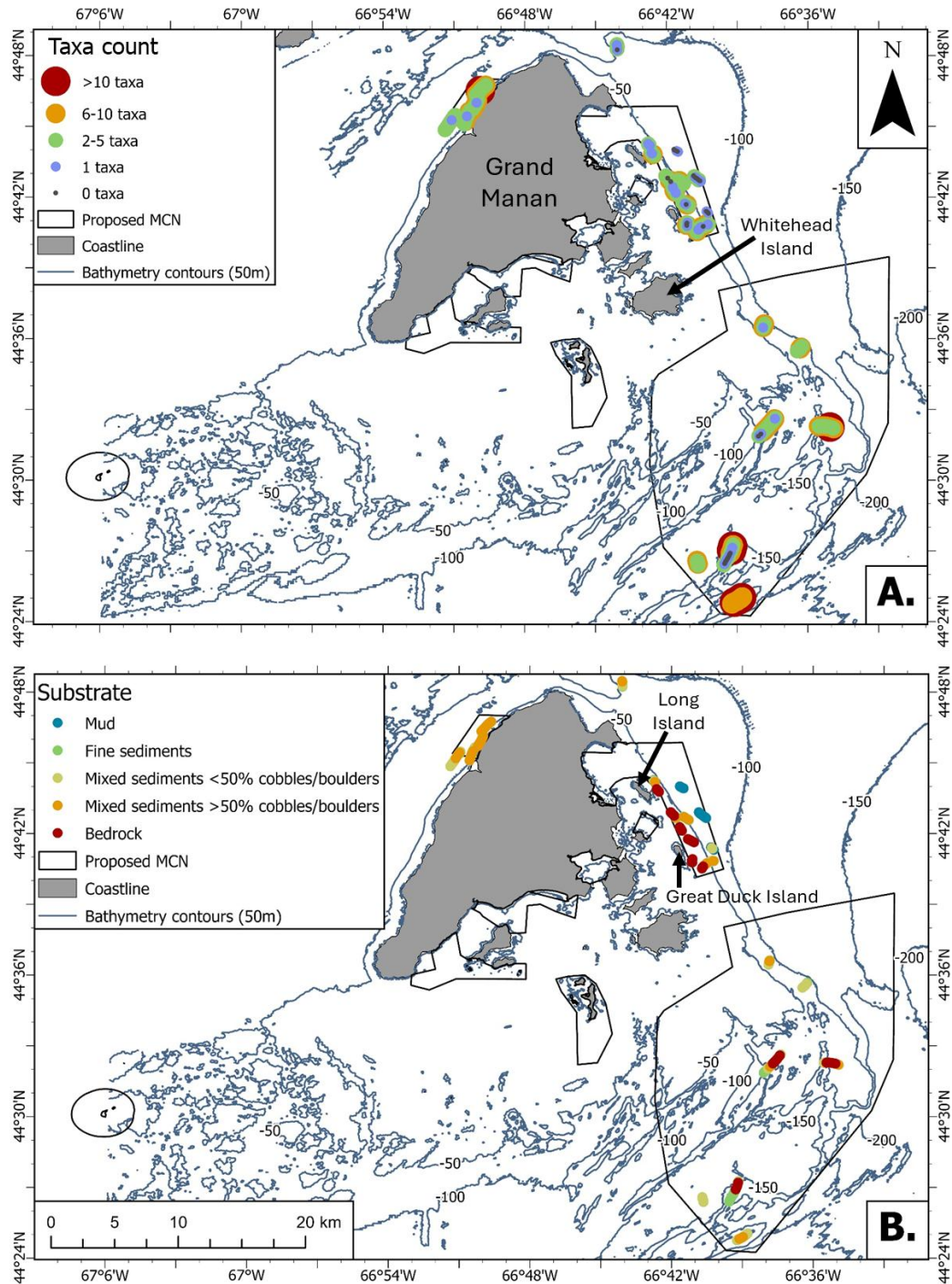


Figure 13. (A) The total number of taxa present (*i.e.*, taxa count) of the 68 taxa analyzed in the digital still images in Grand Manan sub-area transects ($n = 23$). Proposed Marine Conservation Network (MCN) sites (outlined in black), and underlying 50-m bathymetry contours (navy blue). (B) Spatial distribution of substrates observed in continuous video (~ 1 observation per second) from the 23 transects in this area.

Along the east coast of Grand Manan, 11 transects (CON087, CON099-108) were completed in the Long Island Bay/Great Duck Island MCN site, covering depths from 21 to 92 m and an estimated area of 2344 m² (Table 5). Near-seafloor water conditions were turbid, with the dominant substrate being mud, with mixed coarser substrates scattered throughout (Figure 13b). An average of 3 taxa were identified per still image, with an overall taxa count of 42 taxa across 140 analyzed images (Table 5). Both massive and encrusting sponges were observed throughout, with infrequent observations of crabs, lobster, cerianthids, patches of *D. albidum*, and scallops. Fish were commonly observed throughout these transects (predominately in shallower areas with more mixed substrates) and included redfish, groundfish, herring, and cunners (Appendix Table 1).

Off the southern coast of Grand Manan, seven transects (CON114-117, CON119-121) were conducted in the expansive Old Proprietor Shoal/The Prong proposed MCN site, sampling depths ranging from 56 to 188 m, over an estimated area of 5621 m² (Table 5). Due to the broad depth range, various habitats were surveyed here, containing an average taxa count of 6 taxa per still image (Figure 13a, 14), with an overall taxa count of 49 taxa across 243 analyzed images (Table 5). In the northern part of this MCN site, CON114 and 119 transited sandy gravel extensive shell hash and *F. foliacea* colonies were common. Sand was also observed forming ripples in a few locations along CON114, indicative of high bottom currents. Few pebbles and boulders were observed throughout with encrusting sponges, scallops, crabs, anemones, fishes, drifting knotted wrack, and a possible patch of the invasive *D. vexillum* (October 2024; particularly in CON119 – Appendix Table 1). Slightly south of these transects, CON120 and 121 explored predominately gravel and pebble substrates with high densities of shell hash and *F. foliacea*. As these transects drifted across small channels, steep bedrock walls were observed providing habitat for crabs, anemones, sponges (predominately encrusting), scallops, large barnacles (*Chirona* spp.), dense patches of common sea stars, and redfish (Appendix Table 1). Bedrock walls were surrounded by silty boulder and cobble fields before transitioning back to pebble and gravel. Noticeable slopes included the transition from 70 to 141-m depths in CON121 over a 900-m linear distance. Transect CON120 contained a much steeper slope, transitioning from 130 to 88-m depths over a linear distance of 150 m. Further south, near the edge of the proposed MCN site, transects CON115-117 were also predominately comprised of silty gravel and pebble substrates with shell hash and containing sponges, crabs, lobster, patches of *D. albidum*, cerianthids and anemones, scallops, fishes (namely mackerel and redfish), and

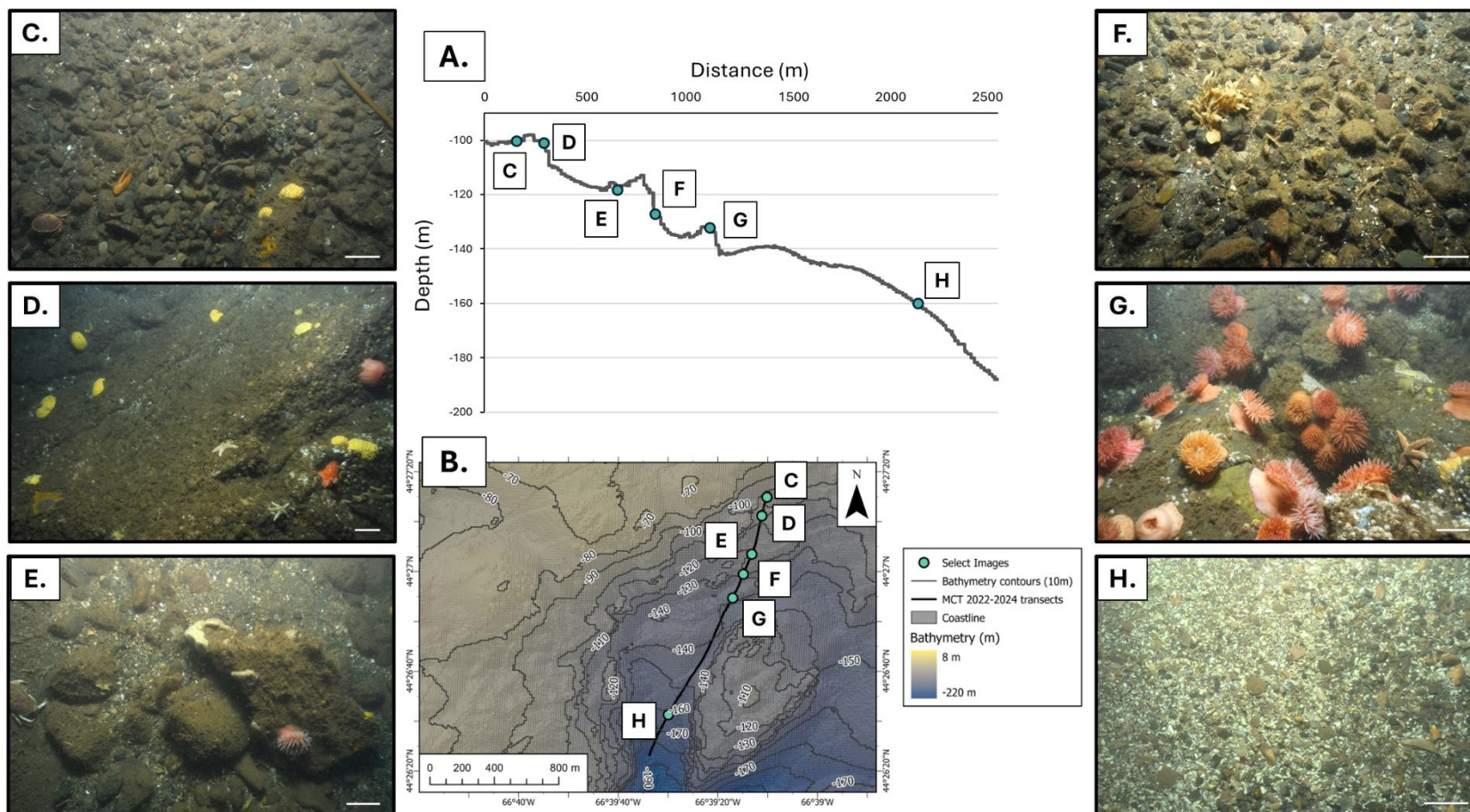


Figure 14. (A) Depth profile (m) and (B) bathymetry map with 10-m contours of transect CON116 from the Old Proprietor Shoal/The Prong MCN site. Distance is along the transect, which ran from the north-east to the south-west. Select images are positioned along the transect line according to the time the image was taken (included in filename): (C) CON116-20241002T154610.jpg, (D) CON116-20241002T154936.jpg, (E) CON116-20241002T155639.jpg, (F) CON116-20241002T160019.jpg, (G) CON116-20241002T160449.jpg, and (H) CON116-20241002T162403.jpg. White scale bars represent a 10-cm scale.

drifting knotted wrack. Small, steep bedrock patches were observed in CON116 (*i.e.*, the deepest transect conducted by FOBIS to date), surrounded by cobbles and boulders supporting sponges, crabs, anemones and redfish (Figure 14, Appendix Table 1). Steep slopes were encountered in a few instances along CON116, dropping 5 to 10-m depths over a linear distance of <10 m (Figure 14a).

3.2 SELECT TAXA ABUNDANCE

Abundance data were reported for a select subset of taxa of conservation priority (*B. ovifera* [stalked tunicate], *M. modiolus* [horse mussel], *G. rubiformis* [sea strawberry – soft coral], and *P. borealis* [Northern cerianthid]) and commercial importance (*P. magellanicus* [Atlantic sea scallop], *C. frondosa* [orange-footed sea cucumber], *S. droebachiensis* [green sea urchin], and *H. americanus* [American lobster]). The stalked tunicate *B. ovifera* reached densities of 32 ind. m⁻² (24 ind. image⁻¹), but when encountered, the most common abundance was 2-5 ind. image⁻¹ (mostly in Western and Head Harbour Passages), with few observations >5 ind. image⁻¹ (Figure 15). The highest reported *B. ovifera* abundances occurred in Letete Passage and off the western-most point of Deer Island (both in the HH/WI/P sub-area – Figure 15a).

Horse mussels (*M. modiolus*) reached the highest observed densities of any species for which we documented abundance, reaching densities of 202 ind. m⁻² (187 ind. image⁻¹). Instances of high abundance were isolated to Pendleton Island, Head Harbour and Western Passages (Figure 16a), where *M. modiolus* were observed forming extensive mussel beds. Otherwise, *M. modiolus* had abundances predominately in the 2-5 ind. image⁻¹ category, and was reported across the entire survey region (Figure 16) with the exception of Passamaquoddy Bay.

Cerianthids (*P. borealis*) reached abundances of 24 ind. image⁻¹ and densities of 17 ind. m⁻² off Wolves Bank at moderate depths (~40 to 70 m), however, most cerianthid occurrences had abundances of 1-5 ind. image⁻¹ (Figure 17). Overall, cerianthids occurred broadly across the entire study area from Big Letete Passage to Southern Grand Manan, occurring to 187-m depths in transect CON116.

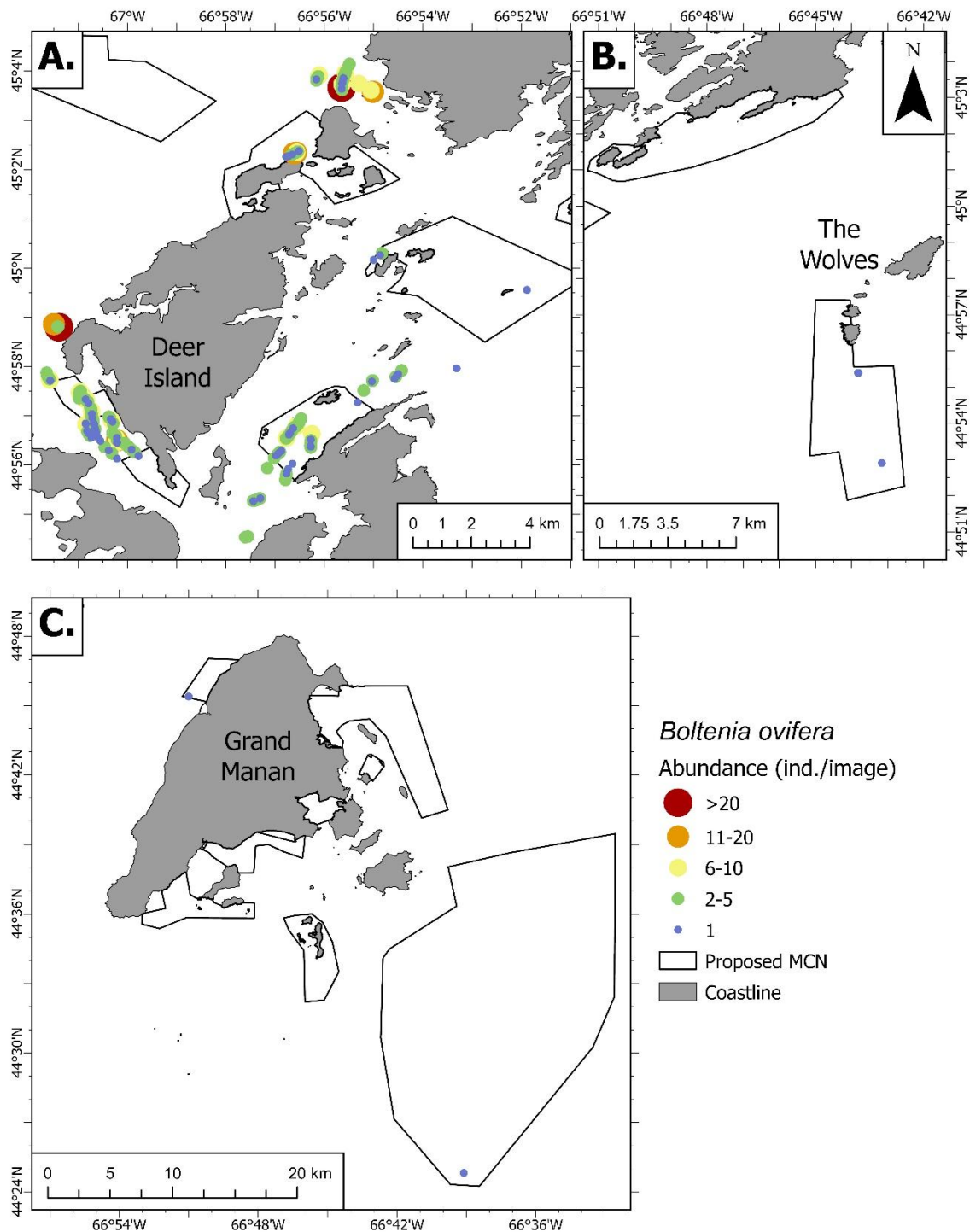


Figure 15. Abundance (ind. image⁻¹) of *Boltenia ovifera* (stalked tunicate) across analyzed still images in (A) the Head Harbour/West Isles/Passages and Passamaquoddy Bay sub-areas, (B) The Wolves and Deadmans Harbour sub-area, and (C) Grand Manan sub-area with underlying proposed Marine Conservation Network (MCN) polygons.

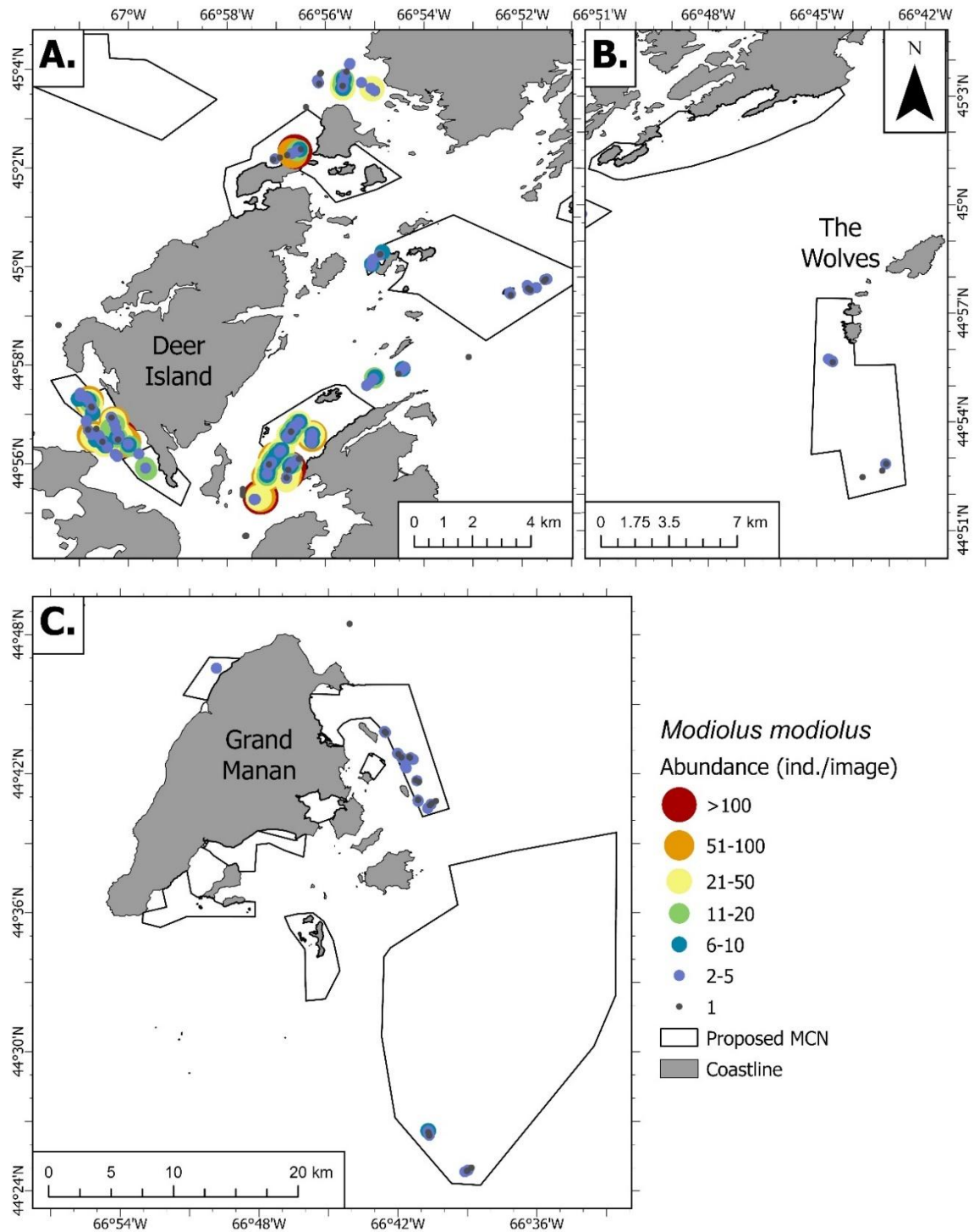


Figure 16. Abundance (ind. image⁻¹) of *Modiolus modiolus* (horse mussel) across analyzed still images in (A) the Head Harbour/West Isles/Passages and Passamaquoddy Bay sub-areas, (B) The Wolves and Deadmans Harbour sub-areas, and (C) Grand Manan sub-area with underlying proposed Marine Conservation Network (MCN) polygons.

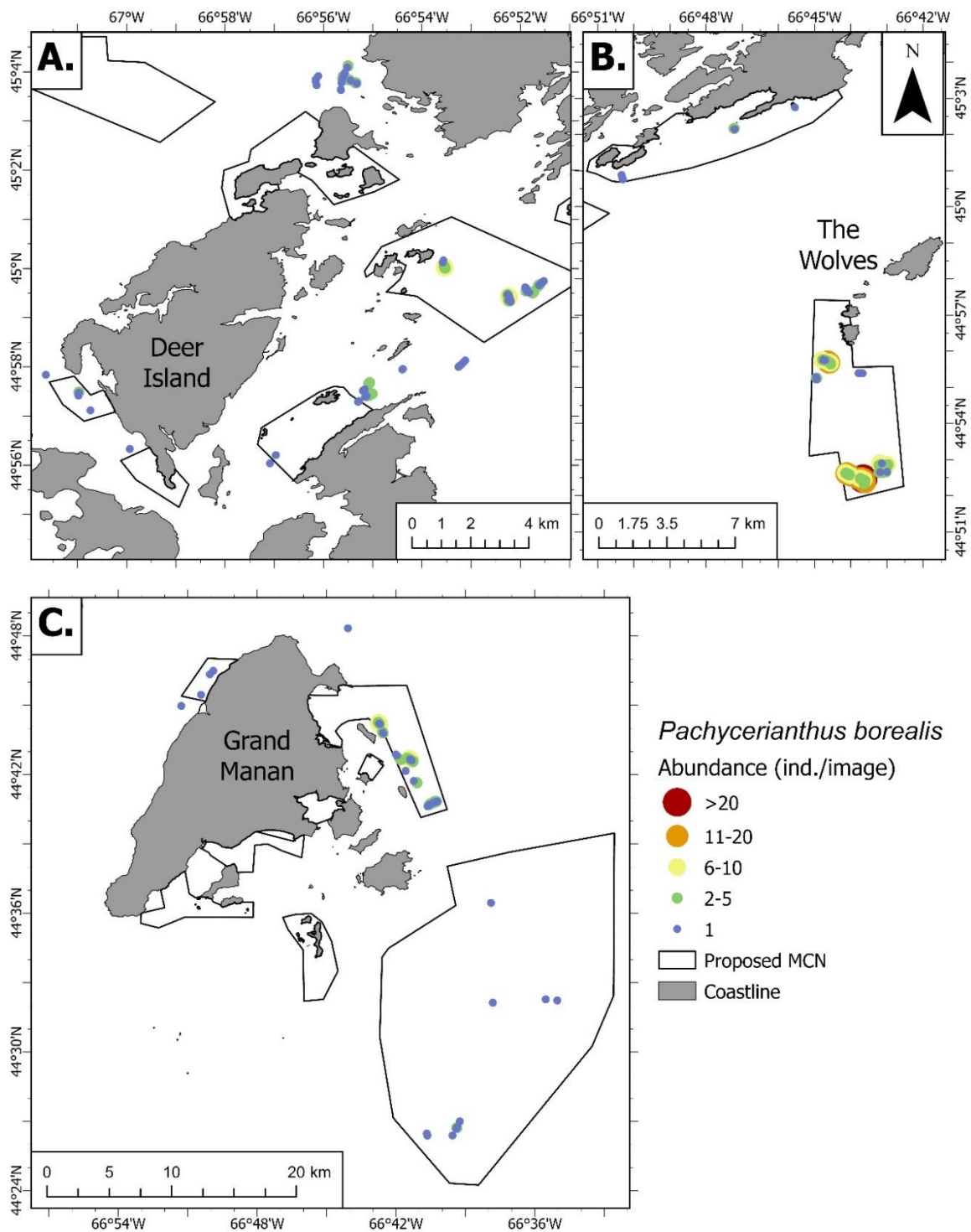


Figure 17. Abundance (ind. image⁻¹) of *Pachycerianthus borealis* (Northern cerianthid; tube-dwelling anemone) across analyzed still images in (A) the Head Harbour/West Isles/Passages and Passamaquoddy Bay sub-areas, (B) The Wolves and Deadmans Harbour sub-area, and (C) Grand Manan sub-area with underlying proposed Marine Conservation Network (MCN) polygons.

Soft corals (*G. rubiformis*) were scarce across the analyzed still images, occurring in only four images, three of which had one individual present (in Head Harbour Passage), and thus are not visualized in this report. The remaining image occurred in Passamaquoddy Bay (CON048) and contained three *G. rubiformis* individuals. Similarly, green sea urchins (*S. droebachiensis*) were very rare across still images, occurring in only four images: three in Letete Passage (CON044) with abundances of 2-5 ind. image⁻¹, and one image in Head Harbour Passage (CON036; one individual).

Scallops (*P. magellanicus*) occurred in 202 analyzed still images, and when observed, reached densities of up to 11 ind. m⁻² (10 ind. image⁻¹), with higher densities mostly comprised of smaller individuals (with a shell diameter of 0.8-3.2 cm). However, most scallop occurrences had only 1 ind. image⁻¹ (Figure 18). Scallops were not observed in Passamaquoddy Bay or Deadmans Harbour transects, but did occur in the HH/WI/P sub-area, surrounding The Wolves, as well as in the Grand Manan sub-area (Figure 18).

Sea cucumbers (*C. frondosa*) only occurred in the HH/WI/P sub-area (Figure 19), isolated to Big Letete, Head Harbour, and Western Passages transects. Sea cucumber density reached up to 84 ind. m⁻² (81 ind. image⁻¹) in Head Harbour Passage. However, 45% of cucumber occurrences had only 1 ind. image⁻¹, and 41% had 2-5 ind. image⁻¹ (Figure 19). Lobsters (*H. americanus*) were only noted at 1 ind. image⁻¹, scarcely observed across analyzed images, but occurring in all areas surveyed (Figure 20).

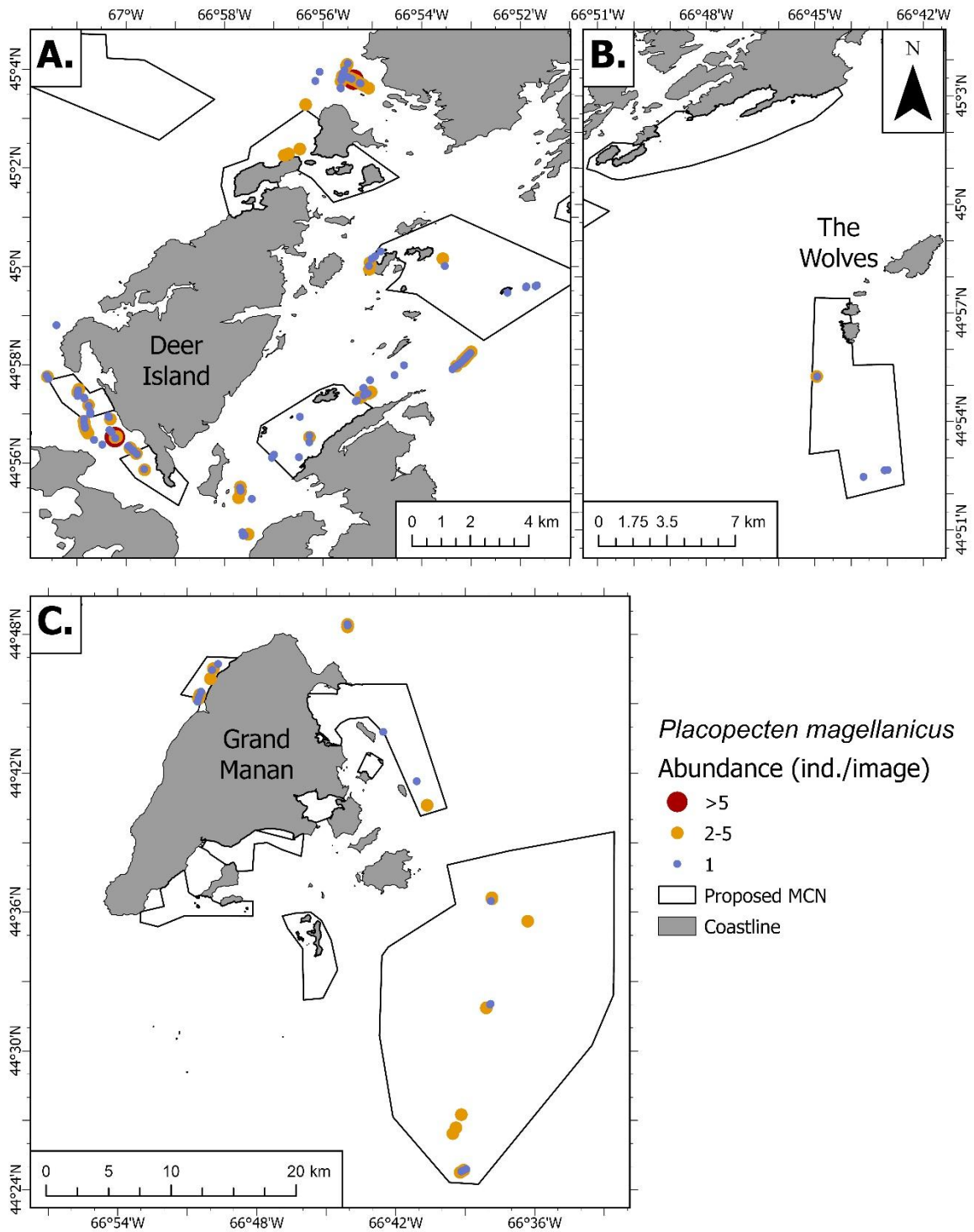


Figure 18. Abundance (ind. image⁻¹) of *Placopecten magellanicus* (Atlantic sea scallop) across analyzed still images in (A) the Head Harbour/West Isles/Passages and Passamaquoddy Bay sub-areas, (B) The Wolves and Deadmans Harbour sub-area, and (C) Grand Manan sub-area with underlying proposed Marine Conservation Network (MCN) polygons.

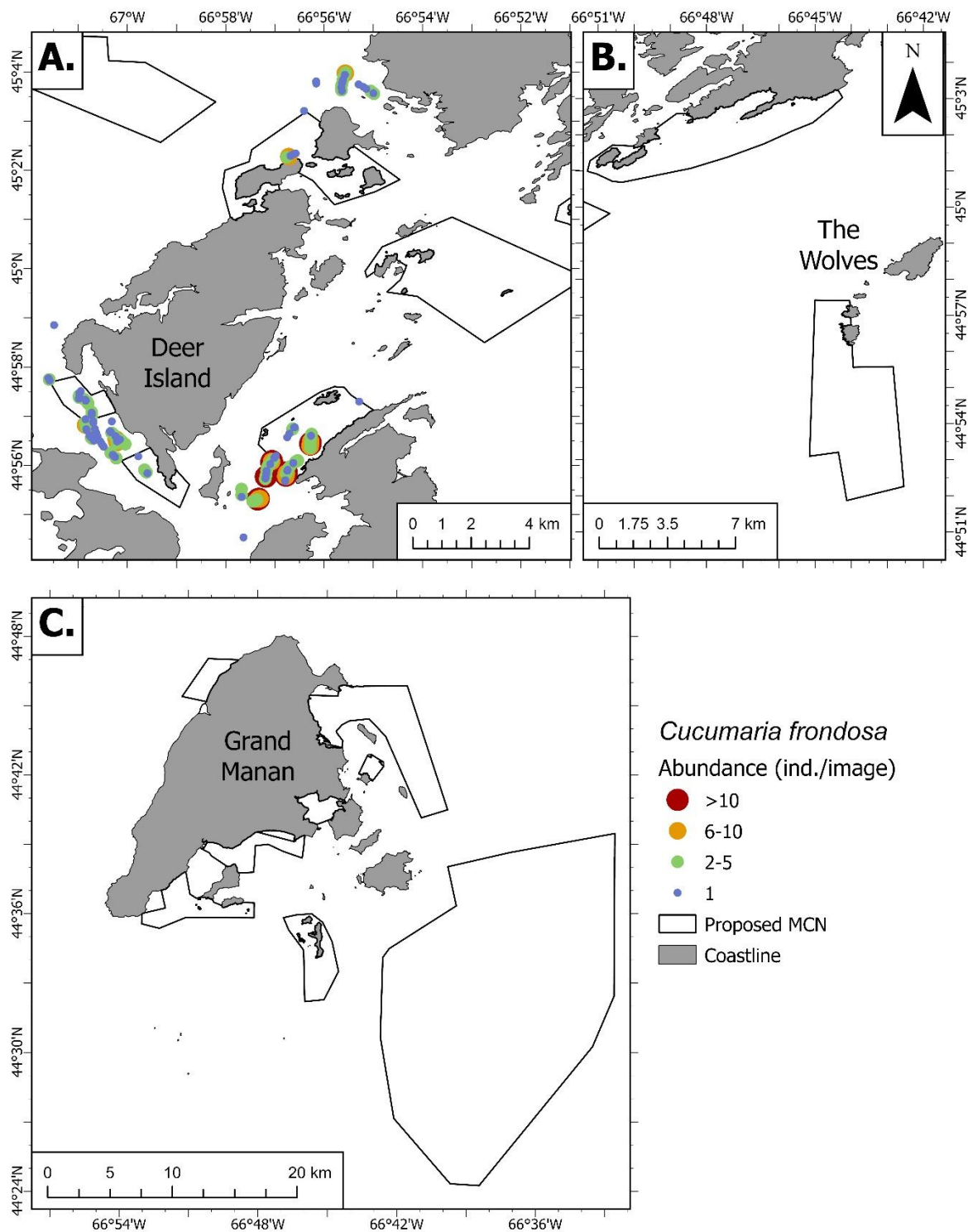


Figure 19. Abundance (ind. image⁻¹) of *Cucumaria frondosa* (orange-footed sea cucumber) across analyzed still images in (A) the Head Harbour/West Isles/Passages and Passamaquoddy Bay sub-areas, (B) The Wolves and Deadmans Harbour sub-area, and (C) Grand Manan sub-area with underlying proposed Marine Conservation Network (MCN) polygons.

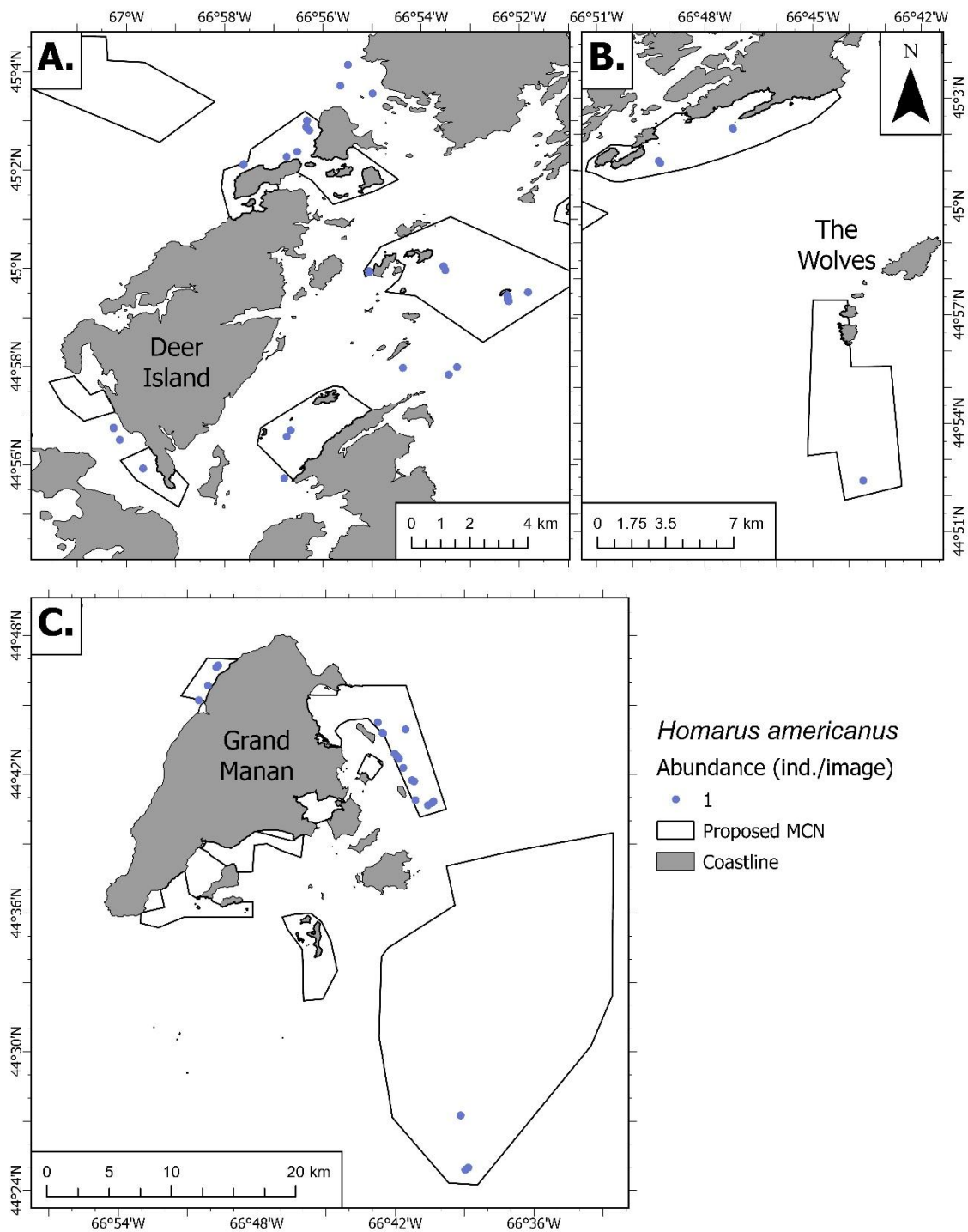


Figure 20. Abundance (ind. image⁻¹) of *Homarus americanus* (American lobster) across analyzed still images in (A) the Head Harbour/West Isles/Passages and Passamaquoddy Bay sub-areas, (B) The Wolves and Deadmans Harbour sub-areas, and (C) Grand Manan sub-area with underlying proposed Marine Conservation Network (MCN) polygons.

3.3 PROXIMITY ANALYSIS

To assist with potential follow-on analysis to quantitatively compare benthic imagery between surveys, we conducted a proximity analysis of the 1699 selected still images from the current survey against imagery obtained in 2016 to 2017. Approximately 700 still images were within 1-km of prior imagery survey locations, with 42 of these images within 100 m. Overall, proximity of imagery from the two surveys ranged from 15 m to 14 km (Figure 21). Such a large range is due to the current survey objectives, which were focused on expanding depth coverage, and sampling in newly proposed MCN areas, particularly around Grand Manan (Table 5), rather than to specifically reoccupy prior survey locations as closely as possible using drift transect techniques.

While most still images did not directly overlap prior survey image locations, two transect tracks (CON006 and 052) did directly overlap with two 2016 transects (CD65 and 66) in the HH/WI/P sub-area in Western Passage (Figure 21b), and contained similar taxa counts: up to 34 of the 41 taxa analyzed in Lawton et al. (2026), compared to the 29 taxa reported in CON006 and 052. Taxa occurrences that were dissimilar included green sea urchins which were common in these two 2016 transects, along with high densities of stalked tunicates. In the current survey, green sea urchins were not observed here, and stalked tunicates were rare. Furthermore, in the current study, CON006 and 052 also recorded a higher prevalence of horse mussels compared to 2016 to 2017 surveys, along with dense mats of invasive tunicate (*D. vexillum*) that is not thought to have been established in the area in 2016 (Teed et al. 2024).

For prior and current imagery transects in close proximity in the proposed MCN areas (Table 6, Figure 21), qualitative observations of possible community changes were noted. While we can make general qualitative observations of possible taxa shifts in the HH/WI/P sub-area (due to numerous transects occurring in the area from 2016 to 2017 surveys and from the 2022 to 2024 surveys – Table 6), this is difficult to translate to other transects surrounding The Wolves and Grand Manan, as transects are at much greater distances apart ($>>1$ km), sampling a broader depth range and features not previously surveyed. One key observation in the HH/WI/P EBSA was the scarcity at which the stalked tunicate *Boltenia ovifera* was observed in recent surveys compared to the 2016 to 2017 dataset. In particular few, small individuals were observed, reaching a maximum density of only 32 ind. m^{-2} (with most occurrences containing just 1 ind. image $^{-1}$), suggesting a significant shift from the extensive stalked tunicate fields observed along hard substrate features in 2016 (maximum density from Mireault et al. 2025 was 456 ind. m^{-2} and 564 ind. m^{-2} from Lawton et al.

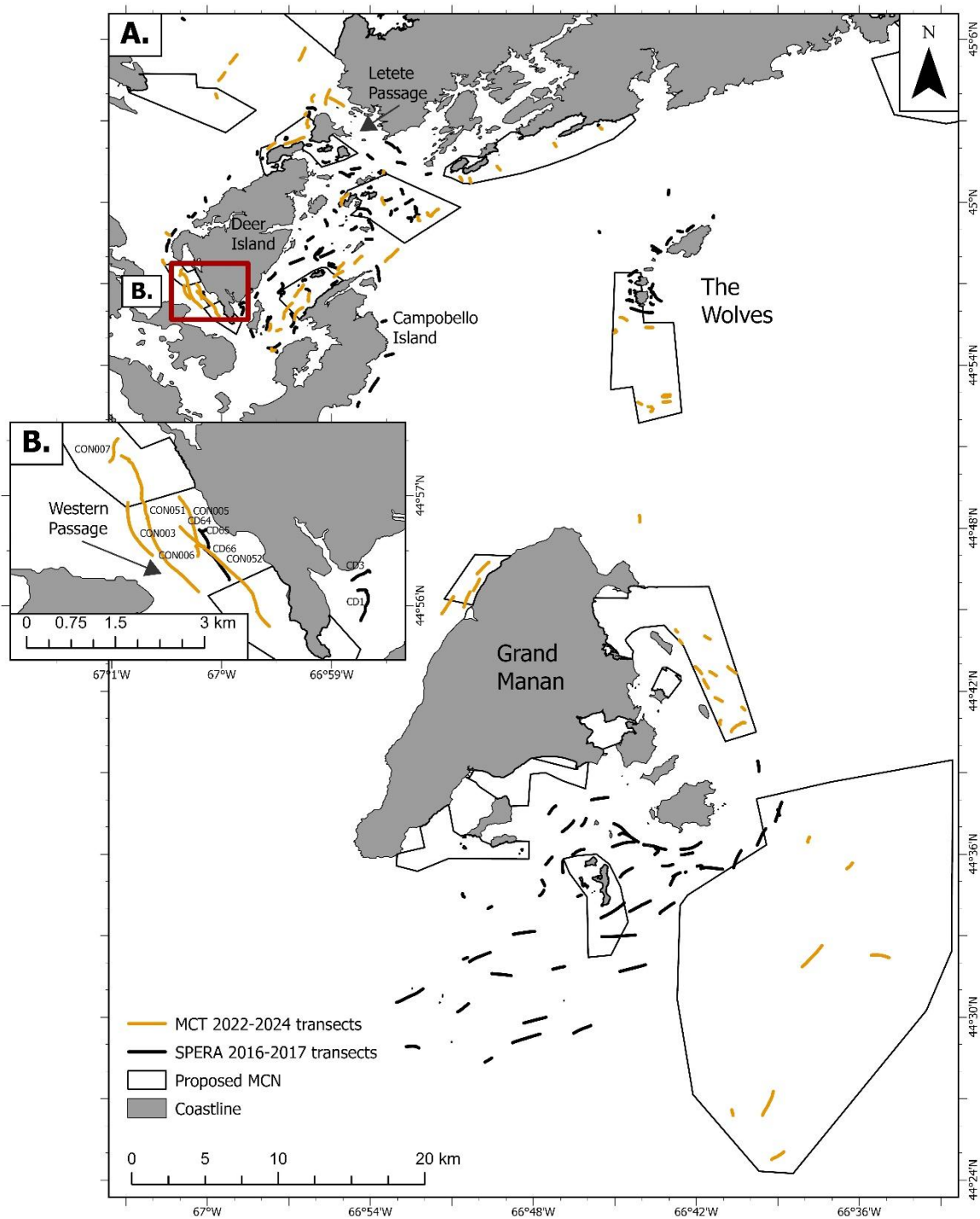


Figure 21. Proximity map including (A) all transect locations of the current survey (2022 to 2024, 73 transects, orange) and the prior 2016 to 2017 imagery transect locations (150 transects, black), with the Marine Conservation Network MCN) site polygons. (B) Highlights directly overlapping transects in Western Passage.

Table 6. Number of SWNB 2022 to 2024 Marine Conservation Targets (MCT) funded near-seafloor imaging transects conducted according to Marine Conservation Network (MCN) site surveyed and associated prior designated EBSAs. Several prior benthic survey transects and sediment sampling activities occurring in MCN sites are also provided including: Strategic Program for Ecosystem-based Research and Advice (SPERA) 2016 to 2017 near-seafloor imaging transects, SPERA dive transects, SPERA sediment grab samples, and early 2000s near-seafloor imaging transects (Strong and Lawton 2004; P. Lawton, unpublished data).

MCN site	Part of an EBSA	MCT Transects	SPERA Transects	SPERA Dive sites	SPERA Grab samples	URCHIN 2008 Transects	Strong and Lawton (2004)
Tongue Shoal	Yes (Tongue Shoal)	1	0	0	0	0	0
Little Letete Passage	Yes (HH/WI/P)	3	2	0	0	0	0
Simpsons and Whitehorse Island	Yes (HH/WI/P)	6	13	5	15	9	0
Head Harbour Passage	Yes (HH/WI/P)	5	3	1	0	5	0
Western Passage North	Yes (HH/WI/P)	3	0	0	0	0	0
Western Passage South	Yes (HH/WI/P)	1	0	0	0	0	0
Deadmans Harbour	Yes (Quoddy Region)	5	0	0	0	0	0
The Wolves – Wolves Bank	Partially (The Wolves)	8	6	6	7	0	0
Northwest Grand Manan	Partially (Long Eddy)	4	0	0	0	0	0
Long Island Bay – Great Duck Island	Partially (Flagg Cove)	11	0	0	0	0	18
Old Proprietor Shoal – The Prong	Yes (South Grand Manan)	6	4	0	0	0	0

2026). Green sea urchins were also rare in the current survey with only 11 individuals observed across 4 of the 1699 analyzed images, in one Head Harbour Passage and one Letete Passage transect. This seems to corroborate an apparent shift towards reduced green sea urchin abundance since the 2016 and 2017 survey reached abundances of $>100 \text{ ind. image}^{-1}$ near Whitehorse Island, and $>50 \text{ ind. image}^{-1}$ throughout the HH/WI/P sub-area (Lawton et al. 2026). Soft corals were also more prevalent in the 2016 survey, occurring in 13 transects across the HH/WI/P sub-area, while *G. rubiformis* was present in only four images isolated to the Head Harbour Passage in 2024 and Passamaquoddy Bay in 2023. Soft corals are often encountered at SCUBA diving sites in Head Harbour Passage; the generally shallower depth range covered in the 2016 survey may, in part, account for higher prevalence. As well, the invasive *D. vexillum*, suggested to have established in the area only in recent years (Teed et al. 2024), did not occur in the 2016 and 2017 surveys, yet was observed forming widespread homogenous tunicate mats across various substrates in the HH/WI/P sub-area, often overgrowing underlying habitat features. Horse mussel beds are still common throughout the HH/WI/P sub-area, with densities of up to 202 ind. m^{-2} in the current survey, similar to those previously documented in 2016 (276 ind. m^{-2}) and 2017 (240 ind. m^{-2}) by Mireault et al. (2025). In the current survey, we also encountered extensive patches of compacted empty horse mussel shells, particularly along the edges of Head Harbour Passage (Appendix Table 1). Sea cucumber abundances in the most recent surveys resembled those recorded in 2016 to 2017 ($\sim 48 \text{ ind. m}^{-2}$, Lawton et al. 2026), although, due to the extensive transect coverage in the HH/WI/P EBSA in 2016, cucumbers appear to have previously been more broadly distributed, with the highest abundances observed in both Western and Head Harbour Passages. Similar observations were made regarding scallops, with the highest previously reported abundances occurring in Letete Passage, while the current survey reported the highest abundances in Western Passage.

4 DISCUSSION

Analyses in this report are based on review of 28 hours of continuous seafloor video and 1699 digital still images used to document seafloor substrates and select taxa prevalence and abundance across and adjacent to 11 of 20 regional Marine Conservation Network (MCN) sites in SWNB. While this survey provides high-resolution information on benthic habitats in SWNB, we acknowledge that it does not represent a full benthic ecosystem characterization, which would

come from considering other sources of scientific and stakeholder knowledge (such as trawl surveys, sediment samples, dive surveys/collections, etc.). The 2022 to 2024 benthic imagery surveys completed a total of 73 benthic imagery transects, yielding an overall geospatial imagery archive of over 30 h of video and 5081 digital still images (Lawton and Teed 2025). We provide an initial characterization of several significant benthic features in sub-areas of SWNB that have not been previously documented, namely Wolves Bank and the deep waters off Southern Grand Manan (Old Proprietor Shoal/The Prong). We also provide additional characterization of well-sampled and intensively-used (*i.e.*, fishing, aquaculture, recreation, etc.) areas including Letete, Head Harbour and Western Passages within the HH/WI/P EBSA. The 2022 to 2024 surveys impart new and detailed descriptions of heterogeneous habitats present in SWNB from shallow coastal areas at depths of 15 m, down to deep channels off southern Grand Manan to 188-m depths.

4.1 BENTHIC HABITATS OF SOUTHWEST NEW BRUNSWICK

4.1.1 PASSAMAQUODDY BAY

In Passamaquoddy Bay, we collected over 1 hour of continuous video footage over a distance of ~2.5 km, covering a seafloor area of ~1110 m² and depths ranging from 28 to 66 m. Historical dive surveys in Passamaquoddy Bay in the 1970's documented common molluscs, echinoderms, and marine plants, while sponges were poorly represented (MacKay et al. 1978a). The current survey, covering deeper water depths in the bay, found sponges to represent 25% of all taxa occurrences, primarily comprised of the fig sponge, *Suberites ficus*. The fig sponge is known to occur around the region (Bouchard Marmen et al. 2025), commonly found from subtidal zones to 200-m depths, as it can tolerate high environmental variability (Bay-Nouailhat and Bay-Nouailhat 2004). Arthropods were the most prevalent phyla in this area, likely due to the substrates encountered; instances of barnacles occurring on the rare boulder or cobble, along with a number of crabs and lobsters near pockmarks and encountered moving along sandy/muddy bottoms. Observations align with geological interpretations and previous substrate classifications that suggest the area is dominated by mud with patches of sand and gravel (Greenlaw and Harvey 2022; Philibert et al. 2024). Benthic imagery surveys conducted via a towed system by Wildish et al. (2008) specifically targeted the pockmarks in this area to observe megafauna assemblages within and outside of them. They primarily documented common sea stars (*A. rubens*), adjacent to pockmarks, and sea cucumbers (*C. frondosa*) which occurred at highest densities on pockmark

bottoms (Wildish et al. 2008). However, we did not observe any megafauna within pockmarks with the exception of few *Cancer* spp., and did not observe any *Asterias* spp. or *C. frondosa* in the 100 still images analyzed across four transects. *C. frondosa* are likely more prevalent in the nearby Letete Passage, which accounts for ~90% of cucumber fishery landings in the SWNB region, though overall catch is in decline (Martin et al. 2023).

Compared to the other areas surveyed, Passamaquoddy Bay is known to be distinct, in part due to the presence of pockmarks, but also in terms of benthic species assemblages inventoried using SCUBA diving approaches, which Buzeta (2008) found was most dissimilar to all other areas in the SWNB region. Dissimilarity was mostly influenced by commonly occurring shrimp (*Crangon* spp.) and the winter flounder (Buzeta 2008). Such observations were not made in the current survey, as shrimp were not categorized beyond family (Pandalidae), and groundfish were not identified beyond the order (Pleuronectiformes). Future research could revisit the current imagery dataset and attempt to further identify groundfish and shrimp to determine if these taxa observed in deeper waters are similar to those in historical SCUBA surveys.

4.1.2 HEAD HARBOUR/WEST ISLES/PASSAGES

Previous benthic habitat surveys in SWNB noted the Head Harbour/West Isles/Passages (HH/WI/P) EBSA as an area of high biodiversity and productivity, given its complex topography and strong tidal influences moving against small islands and narrow channels (Buzeta 2008, 2014). New SCUBA surveys have been completed in the area in recent years with the intent to update extensive baseline surveys completed by Art MacKay in the 1970s (C. Goodwin pers. comm.; MacKay et al. 1978b), however, data is still being analyzed, with reports in development. Preliminary subsets of the SCUBA survey results have described diverse sessile invertebrate communities, including sponges along slopes and bedrock walls, and documented dense colonies of the invasive tunicate *D. vexillum* in areas surrounding Deer Island (Teed et al. 2024). Based on DFO's 2016 to 2017 benthic imagery surveys, which completed 74 transects within the HH/WI/P sub-area, Lawton et al. (2026) characterized the area as structurally complex with high heterogeneity of substrates, supporting extensive horse mussel beds, stalked tunicate fields, and localized areas of high green sea urchin abundances.

Here, we collected over 15 hours of high-definition video across ~23.4 km, surveying an estimated area of 12318 m² within and surrounding the HH/WI/P EBSA. Horse mussel beds were

further confirmed within the HH/WI/P EBSA, primarily in the Head Harbour and Western Passages, with densities comparable to those reported from the 2016 to 2017 surveys (Lawton et al. 2026). Conversely, *B. ovifera* were only rarely documented, and when encountered, did not form tunicate fields. The much lower prevalence and abundance of *B. ovifera* provides new information towards development of management strategies at local scales. Prior Species Distribution Models (SDMs) of *B. ovifera* habitat suitability and prevalence (Mireault et al. 2025) were used to inform select MCN sites currently proposed. Mireault et al. (2025) also modelled horse mussel habitat suitability and prevalence; however the resulting in SDM models performed more poorly than those developed for *B. ovifera*. As described in Mireault et al. (2025), while the SDM modelling approach represented one of very few attempts world-wide to model benthic species distribution patterns at a high spatial resolution (≤ 5 m), resulting abundance models for both species did not perform well within the heterogeneous benthic habitats in the HH/WI/P EBSA. Additionally, the resulting presence models do not fully capture information on priority species needed to inform management (*i.e.*, high density aggregations required to warrant protection; DFO 2018). Notwithstanding these issues with full area model predictions, the accumulated empirical observations from benthic imagery surveys in 2016 to 2017 and 2022 to 2024 establish multiple known hotspots and high-density aggregations, and this information should be prioritized and utilized when finalizing MCN sites. This would allow for better protection of aggregations to ensure on-going recruitment of these biogenic habitat-forming species.

Green sea urchins were essentially absent from the latest benthic transects in the HH/WI/P sub-area, potentially reflecting shifts in community assemblages compared to previous surveys. However, the lack of green sea urchin observations could also be due to the prioritization of deeper sites, considering that they are known to predominately occur in the shallow subtidal, often associated with kelp and bedrock or boulder substrates (Robichaud 2010). Population changes in green sea urchin occurrences could be due to various individual or correlated factors including exposure to increased temperatures (Feehan et al. 2012), disease (Feehan and Scheibling 2014), predation (Scheibling 1996), or decreased food availability (Minor and Scheibling 1997). A notable decrease in green sea urchin populations has been recorded in SWNB in recent decades across all available survey data (M. Finley, pers. comm.; Robichaud 2010).

For sea cucumbers, densities in the current survey exceed those reported in the 2016 to 2017 surveys (by ~ 30 ind. m^{-2} ; Lawton et al. 2026), with the highest reported densities in Head

Harbour Passage. However, the current survey identified numerous occurrences in Western Passage that were not documented during the 2016 to 2017 surveys. Though sea cucumbers are known to be broadly distributed across the SWNB region, the highest catches of the local drag fishery occurs in Little and Big Letete Passages, north of Deer Island, accounting for 90% of the fishery catch in SWNB (Martin et al. 2023). However, annual catch is very depressed from historical levels, even in these concentrated areas (Martin et al. 2023). Previous surveys conducted in Little Letete Passage support this, noting extensive juvenile populations (R. Singh and P. Lawton, unpublished data), though the current survey only noted sporadic occurrences of sea cucumbers in the area, with only one image containing >5 individuals. Generally, our observations of sea cucumber distribution include locations of very rugged terrain and higher-slope features that may provide refugia from bottom-contact gear.

Similar to recent SCUBA dive surveys (Teed et al. 2024; P. Lawton, pers. obs. 2024 and 2025), we observed extensive homogenous *Didemnum vexillum* mats overgrowing seafloor substrates across the depth strata surveyed. *D. vexillum* was first detected in the HH/WI/P sub-area from eDNA samples in fall 2018, and documented from imagery down to 118-m depths in 2022 (Teed et al. 2024). Subsequent DFO surveys expanded the known depth range of *D. vexillum* by >20 m to 144 m (September 2023; Head Harbour Passage). Increased invasion could be detrimental to fisheries -considering *D. vexillum* mats hinder juvenile fish and scallop spat settlement and adult scallop swimming (Morris et al. 2009; Kaplan et al. 2017). Fishing vessel uptake paired with strong bottom currents in the region indicate a high likelihood of further *D. vexillum* invasion (Moore et al. 2018), especially given the numerous scallop and sea cucumber drag-fisheries that occur in the area (DFO 2019, 2021; Rozalska and Coffen-Smout 2020; Martin et al. 2023). A new project by DFO and the Huntsman Marine Science Centre has been established to address further spread of *D. vexillum* and possible mitigation strategies, working closely with local fisheries stakeholders.

Commercial bottom-contact fisheries could be the cause of the expansive areas of high densities of compacted mussel shells we observed throughout the Head Harbour and Western Passages (*i.e.*, death assemblages). Bottom trawling is known to disturb and reconfigure the benthic environment, and can result in significantly lower community abundance and biomass (McLavery et al. 2020, 2024), though fully separating the effects of fishing activities on benthic habitats from natural dynamic conditions is near impossible (McLavery et al. 2024). Trawling of the seafloor combined with strong tidal currents, likely disturbs seafloor sediments and redistributes

empty shells, potentially leading to accumulations of shell hash, that reduces seafloor accessibility and limit epibenthic and infaunal organism activity. For example, Cao et al. (2023) found that shell accumulations on the seafloor under an oyster farm negatively impacted the burrowing capacity of polychaetes, forcing them to expend more energy, resulting in weight loss. Conversely, shell accumulations may also generate small-scale biogenic structure on what may otherwise be a homogenous muddy seafloor, and thus promote diversity, offering settlement surfaces for flora and fauna (Hewitt et al. 2005; McLaverty et al. 2020). In our study, these shell accumulations comprise, in part, some of the mussel turf observations, appearing to provide suitable substrate for epifauna. Future studies could investigate benthic species associations and abundances within and outside bivalve shell accumulations, which in some cases occur at depths accessible by SCUBA, to better understand the function and cause of such accumulations (e.g., anthropogenic activities, hydrodynamic forces, loss of mussel beds, etc.).

Within the HH/WI/P sub-area, transects in the Little Letete Passage area (including the MCN site) encountered silty mixed sediments, with sporadic occurrence of bedrock and mud, largely aligning with previous substrate and geological interpretations (Greenlaw and Harvey 2022; Philibert et al. 2024). Previous imagery surveys from 2016 to 2017 showed diverse echinoderms here, including green sea urchins, and scallops, along with *B. ovifera* prevalence (Lawton et al. 2026). Taxa occurrences from the current survey were consistent with this pattern, with *B. ovifera* commonly observed (though generally at low abundance), alongside horse mussels, numerous sea stars, and encrusting sponges. Observations were similar when considering transects within the MCN site (CON080-082) and those just north of it (CON042-045), though most *C. frondosa*, *B. ovifera* and *M. modiolus* observations occurred north of the site. This is likely because these transects occur in deeper areas (>40 m), where there is more consistent preferred substrates for adult sea cucumbers (e.g., pebbles - Hamel and Mercier 1996), and where *M. modiolus* commonly form beds in the HH/WI/P EBSA (Mireault et al. 2025).

To the east, in the Simpsons and Whitehorse Island MCN site, muddy mixed sediments dominated, with scattered occurrences of bedrock outcrops and significant instances of shell hash. This partially aligns with previous interpretations that indicate the area is predominately comprised of discontinuous bedrock, that are subject to persistent hydrodynamic activity (Shaw et al. 2012; Greenlaw and Harvey 2022; Philibert et al. 2024). In terms of taxonomic composition, the 2016 to 2017 imagery surveys in this area documented moderate taxa diversity (6-10 taxa of the 41

analyzed), with anemones and ascidians being prevalent (Lawton et al. 2026). Our survey observed numerous encrusting and massive sponges across bedrock and boulder substrates, along with instances of various algae, scallops, crabs, lobsters, cerianthids and anemones. Our results support the general consensus that this region is highly diverse. The complex geomorphology of the clustered islands in these shallow areas is conducive to higher species richness, likely due to hydrodynamic conditions associated with increased flushing and reduced turbidity (Buzeta 2008). As such, this area along with Head Harbour and the southeast coast of Deer Island are thought to contain the highest species richness in the region (Buzeta 2008).

In the Head Harbour Passage area (including the MCN site), mixed sediments were highly heterogeneous, transitioning from fine sediments to boulder fields and bedrock outcrops, back to fine sediments over linear extents of tens of meters. Shell hash was also common, and in some cases, acted as the primary substrate observed, as shells were so compacted and formed a matrix, making underlying substrates indistinguishable. This somewhat contradicts prior sediment classifications that predicted the passage to be comprised of mud surrounded by discontinuous bedrock (Greenlaw and Harvey 2022). Instead our results better align with older geological interpretations that describe tidal scour troughs in the passage with mixed, highly mobile (from tidal influences) sediments that are actively eroded (Shaw et al. 2012). As with the Simpsons and Whitehorse Island MCN site, this seafloor complexity surrounding the islands and channels in Head Harbour is supportive of a higher species richness (Buzeta 2008). The 2016 to 2017 imagery transects highlighted this area as having the highest number of taxa, as well as containing the most abundant horse mussel bed and tunicate field across the entire area surveyed (Mireault et al. 2025; Lawton et al. 2026). This included areas within the passage, as well as to the south, surrounding Indian Island (Lawton et al. 2026). We also observed dense mussel beds in this area, along with high occurrences of numerous arthropods, ascidians, anemones, echinoderms, algae, and sponges, similar to the diversity of taxa encountered in 2016 to 2017 (Lawton et al. 2026). Of the five transects located within the Head Harbour MCN site, a taxa count of 47 was observed across the 104 analyzed images, and when combined with the remaining 190 analyzed images surrounding the MCN site, only an additional 4 taxa were observed (including mackerel, brittle stars, and the sponges *Polymastia bartletti* and *S. ficus*). This suggests good coverage of diverse and important taxa within the MCN site (discussed further in section 4.3).

On the southwest side of Deer Island is Western Passage, containing both a northern and a southern MCN site. Generally, transects conducted here were similar to those of Head Harbour, encountering highly heterogeneous mixed sediments with shell hash, quickly transitioning over tens of meters. This is in agreement with previous substrate classifications and geological interpretations of tidal scour complexities with mixed, highly mobile sediments that are actively eroded (Shaw et al. 2012; Greenlaw and Harvey 2022). The 2016 to 2017 imagery surveys found moderate taxa counts from transects conducted in between the newly-defined Western Passage MCN sites, primarily composed of various echinoderms, anemones and some high abundances of *B. ovifera* on hard substrates (Lawton et al. 2026), forming tunicate fields (Mireault et al. 2025). In the current survey, Western Passage was particularly diverse, with many image taxa counts >10. While some observations did fall within the Western Passage North MCN site, most transects (and affiliated high taxa counts) extended between the MCN sites. This area contained expansive horse mussel beds along with dense homogeneous *D. vexillum* tunicate mats, other tunicates (including low abundances of *B. ovifera*), various arthropods, sculpins, anemones, sea stars, scallops, and highly diverse massive and encrusting sponges. Cumulatively, the area between Western Passage MCN sites observed a taxa count of 49 across 190 analyzed images, compared to lower counts of 37 and 23 taxa (across 58 and 12 images) in the North and South MCN sites, respectively. Such a contrast in taxa counts within and between MCN sites could be due to the difference in sample sizes, or demonstrate that MCN sites may need to be reconsidered or shifted (see section 4.3 for further discussion).

4.1.3 THE WOLVES AND DEADMANS HARBOUR

In the current survey, we collected almost 5 hours of continuous video coverage of the seafloor across The Wolves/Wolves Bank and Deadmans Harbour MCN sites, covering a distance of ~4.9 km and an area of ~3050 m². To our knowledge, no prior benthic imagery surveys have been previously conducted on Wolves Bank, and we are the first to characterize its benthic features. High-resolution bathymetry data was made available surrounding The Wolves in recent years, which highlighted Wolves Bank as a distinct topographical feature of the seafloor, describing the bank as likely bedrock interspersed with mixed sediments, surrounded by glaciomarine mud (Philibert et al. 2024). Our findings generally align with recent interpretations, demonstrating that the integration of high-resolution bathymetry data with our survey data enables improved characterization of The Wolves Bank benthic fauna. With respect to specific fauna, transects

encountered numerous massive and encrusting sponges, and dense anemone fields on steep rock walls along the bank edges. *Mycale lingua* and *P. uberrima* were commonly observed along the bank, consistent with Murillo et al. (2024), who identified the outer Bay of Fundy as distinct from surrounding areas in the SS-BoF bioregion due to a variety of sponges, including these two species.

North of Wolves Bank, off the coast of Southern Wolf Island (within the same Wolves/Wolves Bank MCN site), three transects included multiple observations of fishes, dominated by herring. Mixed substrates were common, with some instances of dense shell hash, contrary to surficial geological and substrate classifications which suggest the area is dominated by glaciomarine mud with sand (Todd et al. 2010; Greenlaw and Harvey 2022; Philibert et al. 2024). Taxa occurrences here resembled those observed in the 2016 to 2017 surveys (Lawton et al. 2026). Recent dive surveys (Cooper et al. *in prep*) around Southern Wolf Island corroborate these findings, documenting cerianthids, anemones, tunicates (namely *D. albidum* in the present study), and encrusting sponges. In coastal SWNB, knowledge on cerianthid distribution is principally from SCUBA surveys, and as such, our deep-water benthic observations provide the first substantive information on cerianthid densities in deeper sites within the region. Considering that their densities reached 24 ind. m⁻², cerianthids likely contribute to biogenic habitat consistent with descriptions from the Gulf of Maine (Langton and Robinson 1990; E. Kenchington 2014). Given that cerianthids are vulnerable to bottom-contact gear, densities may increase under spatial conservation measures that eliminate or reduce bottom-contact fishing disturbance.

A total of five transects were conducted within the Deadmans Harbour MCN site at depths ranging from 25 to 40 m, and showed low taxa occurrences (average of 0-1 per image), likely reflecting the predominance of muddy seafloor housing with only sporadic occurrences of lobster and groundfish. Substrate observations matched geological interpretations and prior substrate classifications (Greenlaw and Harvey 2022; Philibert et al. 2024). Only 4 lobster occurrences were reported across the 57 analyzed images in Deadmans Harbour; however, given the low sampling effort (~730 m² of seafloor surveyed), the result is unlikely to be indicative of overall seasonal habitat use by adult lobster populations along this shoreline. The benthic imagery survey coverage also does not account for the known presence of juvenile lobster habitat along the rocky coastal fringe of the MCN site (Lawton et al. 2024). Long-term lobster settlement monitoring established in the early 1990s in the nearby Beaver Harbour (Lawton et al. 2001; White et al. 2024), together with decadal-scale monitoring of lobster use of coastal habitat in Maces Bay (Dinning et al. 2025),

indicate persistent importance of this stretch of New Brunswick coast for benthic lobster recruitment, despite notable inter-annual and decadal variability. Future studies could prioritize lobster monitoring in shallow MCN areas, suited to SCUBA techniques.

4.1.4 GRAND MANAN

In the waters surrounding Grand Manan, we recorded ~9.5 hours of high-definition video over a compiled distance of 16.9 km, covering an estimated seafloor area of 10602 m². North of Grand Manan, in transect CON118, high-resolution bathymetry data highlighted a small bank feature assumed to be analogous to the nearby Wolves Bank. However, due to tidal currents, the one transect we were able to complete transited across the feature over a gentle slope, with assemblages dissimilar to that of Wolves Bank. Instead, shell hash was common, indicating this area may be exposed to stronger currents and/or fishing activity. Return investigations could attempt to target localized higher-slope features that are present on this small bank.

In the Northwest Grand Manan MCN site, sand was common with high prevalence of *Flustra foliacea* colonies on widespread coarser sediments. *F. foliacea* is known to be characteristic of the lower Bay of Fundy (Staniforth et al. 2023; Murillo et al. 2024), though sites on Grand Manan are the only locations where extensive coverage has been noted in our surveys. *F. foliacea* is documented to be increasing in densities surrounding Grand Manan in recent years (Staniforth et al. 2023). Surficial geological interpretations suggest this area is composed of glacial diamict, *i.e.*, poorly sorted mixes of mud with sand, gravel and cobbles (with a strong glaciogenic origin), commonly overlain by gravel and boulders (Shaw et al. 2012; Greenlaw and Harvey 2022; Philibert et al. 2024), which our findings corroborate.

On the eastern side of Grand Manan, in the Long Island Bay-Great Duck Island MCN site, 11 transects covered a depth range from 21 to 92 m, with the shallower transects covering silty mixed sediments with few small bedrock outcrops. Deeper transects were dominated by mud and characterized by high turbidity conditions which limited the acquisition of good benthic imagery. This correlates with geological interpretations and substrate classifications that suggest this area is dominated by mud with some shallower areas of exposed bedrock (Shaw et al. 2012; Greenlaw and Harvey 2022; Philibert et al. 2024). Shell hash was common along transects at this MCN site, along with crabs, barnacles, lobsters, and various sponges observed on or surrounding scattered boulders and cobbles, or on the rare bedrock outcrop. Lobsters are known to occur here,

particularly in the north-western part of this polygon in Flagg Cove. Historically, from the early 1980s through to the mid 2010s, repeat dive monitoring surveys have described summer aggregations of large mature individuals, positively skewed towards large (egg-bearing) females in the nearby Whale Cove (Lawton et al. 2001, 2024). Recent dive surveys conducted by DFO divers in the 2020s have not found continued shallow water habitat usage (V. Howse and P. Lawton, unpublished data), and high densities have not yet been documented in deeper water areas of benthic imaging surveys to date. Redfish (*Sebastes* spp., most likely *S. fasciatus*) were commonly observed between boulders, while groundfish were more prominent on deeper/muddier bottoms. Redfish commonly occur in the lower Bay of Fundy, accounting for a large proportion (up to 78% in 2022) of redfish landings across the bioregion, likely driven by high food availability (amphipods, copepods and euphausiids) in the area (DFO 2023c). The redfish abundances noted at this MCN site are the highest observed across the 2022 to 2024 benthic imagery surveys.

The proposed Old Proprietor Shoal/The Prong MCN site off the southeast coast of Grand Manan is a large site of ~266 km², and we provide initial characterization of benthic habitats that occur here, based on the survey coverage obtained during a limited survey time period. This area is largely unsampled due to its complex topography, within many deep incised channels, resulting in strong rip currents, as well as distance from available staging ports. In the current survey, we were not able to base the CCGS *Viola M. Davidson* on Grand Manan, and so undertook daily transits from mainland NB (~60 km to Letete and ~73 km to St. Andrews). Some limited grab-sampling and benthic imagery has been conducted adjacent to this site using the offshore CCGS *Hudson* during extended offshore research missions that did not require port visits (Todd et al. 2010). The persistent hydrodynamic activity in this area has also restricted high-resolution multibeam surveys, resulting in lower-resolution bathymetry data (predominately ≥100-m horizontal resolution). Substrate classifications and geological interpretations indicate that this area is primarily composed of bedrock with interspersed sand and gravel deposits (Greenlaw and Harvey 2022; Philibert et al 2024). These interpretations are consistent with our observations of common bedrock outcrops along slopes and deep channels, surrounded by mixed sediments and shell hash deposits. Sponges were common along gentle to steep slopes, supporting previous studies that have found increased sponge cover to be correlated with complex, sloped substrates (Ginn et al. 2000; Goodwin et al. 2025). As with transects along the east coast of Grand Manan, redfish were abundant here (though less frequently encountered than in the Long Island Bay-Great Duck Island MCN), and were commonly observed in close proximity to cobbles and boulders, likely using these

features to shelter from strong bottom currents. Redfish have been shown to have positive associations with sponge grounds, using these habitats as refuge from strong currents and predators (De Clippele et al. 2025). Further work is required to substantially characterize this proposed site.

4.1.5 SUBSTRATES

From the ~28 hours of underwater video analyzed from the 2022 to 2024 benthic imagery transects, we documented high heterogeneity in substrates across transects, particularly those occurring in the HH/WI/P sub-area. Across the SWNB study area, our video substrate observations generally agreed with prior geological interpretations and substrate classifications (Shaw et al. 2012; Greenlaw and Harvey 2022; Philibert et al. 2024). However, the coarse spatial scale of prior interpretations (up to 100-m horizontal resolution), provide limited insight into fine-scale substrate patchiness or the distribution of specific habitats, including biogenic features such as horse mussel beds or tunicate fields. Given the high resolution nature of the substrate data of the current study, our results could provide additional ground-truth imagery to re-evaluate prior benthic habitat classifications, by providing much-needed detail on the high heterogeneity observed. Our study did not detail sediment based strictly on grain size (*i.e.*, directly using the Wentworth scale; Wentworth 1922), instead opting to use more general categories to ease annotator burden. Future analysis of the DFO benthic imagery archive could aim to document percent cover of grain sizes across still images or video frames. Prior approaches to convert elements of broad benthic habitat classifications into categories suitable for analysis from still or video imagery (such as Sameoto et al. 2008), could be adapted and extended using modern automated image-analysis techniques.

Our substrate analysis extended beyond describing the general underlying substrate, to also document unique biological and physical characteristics. This included recording extensive coverage of the invasive *D. vexillum* on various substrates, the occurrence of algae, cerianthids, *F. foliacea*, horse mussel beds, and the surficial featuring of bedrock types (silt-covered, smooth, pitted). Biophysical aspects of benthic habitat description are important for interpreting specific geographic attributes within general benthic habitat classification schemes (*e.g.*, Valentine et al. 2005). They also represent a key element within the benthoscape approach, which aims to classify the seafloor into discrete areas based on the combination of substrate, biological structures, and general topography, often from acoustic techniques (Brown et al. 2011). Though not currently

underway, the extensive benthic imagery results from the present survey, together with imagery from the 2016 to 2017 surveys, could be incorporated into a SWNB benthoscape analysis by systematically reviewing all survey imagery and identifying unique substrates and biophysical features (as in Brown et al. 2011; Lacharité et al. 2018).

The applicability of the benthoscape approach for highly complex coastal marine habitats should be approached with caution. Previous studies have employed the use of benthoscapes to inform conservation boundaries and pinpoint key areas where biogenic habitat-forming species are expected to occur (e.g., Lacharité and Brown 2019; Wilson et al. 2021). However, benthoscapes are often classified at broad scales (*i.e.*, 10s to 100s of meters) which may fail to resolve transitions across boundaries, heterogeneity within boundaries, and fine-scale patterns relevant to local stakeholders. A similar benthic imagery survey we conducted in the St. Anns Bank Marine Protected Area found that the degree to which specific geomorphometry is resolved in a benthoscape analysis did not adequately capture fine-scale ridge features or local-scale patchiness across heterogeneous sediments (Teed et al. 2025a). In SWNB, higher-resolution multibeam and LiDAR data (e.g., at a 1-m scale) would better inform geological and general substrate classifications, capturing fine-scale features that are currently too inconspicuous to be representative at 10 to 100-m scales. However, providing higher-resolution data could still leave difficulties for interpretation, especially across putative boundaries. Additionally, there may be factors driving fine-scale substrate and associated benthic attribute distributions that may remain unresolved, such as the spatial footprint of bottom-contact fishing, because these pressures are not currently mapped at fine enough scales sufficient for localized spatial modelling (Murphy et al. 2024; Mireault et al. 2025).

4.2 BENTHIC IMAGERY ANALYSIS CONSIDERATIONS

Certain species or taxa of interest were the primary focus of this study, undertaken to provide efficiency in analyst time, including ability to analyze a large subset ($n=1699$) of still images, and also to acquire abundance estimates of species that are of commercial and conservation priority. Conducting a full species assemblage annotation of all visible taxa in this subset of imagery would likely have taken months to complete (as in Paulin et al. 2025; Teed et al. 2025b); however, such an analysis would allow for subsequent community assemblage and habitat classification analyses (e.g., Lacharité and Brown 2019; Murillo et al. 2024). An important limitation

to consider is the confidence in species labels, which is limited by the use of imagery alone; sponges in particular often require sampled specimens for microscopic review of their spicule for taxonomic identification (Goodwin 2017; Dinn 2020), and juveniles of many species are difficult to differentiate based solely on morphology (Ziaei et al. 2025). Complete assemblage analysis could be undertaken in the future, as the DFO benthic imagery dataset serves as a databank that can be revisited and reanalyzed.

The selection of 68 taxa allowed for increased certainty of taxa presence and abundance, along with efficient post-processing before being able to present survey results to ocean managers and stakeholders. However, caution should be taken when only considering a subset of species based on management and stakeholder priorities, as rare, cryptic or newly established species could go undetected. The invasive tunicate *D. vexillum* was not a priority species for documentation in local historical benthic surveys conducted prior to the 2010s, nor was it detected when the 2016 to 2017 survey imagery was reanalyzed (L.L. Teed, pers. obs.). Noting its presence and abundance can provide crucial insight into changes in benthic species assemblages, given that it can outcompete native species for food and space (Zhang et al. 2019). Recent and ongoing eDNA surveys could be used in conjunction with benthic imagery surveys to detect rare, cryptic, or newly established species that could be added to the list of taxa for image analyses.

Another aspect of analyzing a subset of still images is that we do not provide a complete representation of each transect surveyed. While it does reduce the burden on the annotator, and may address potential spatial autocorrelation concerns, using a subset of imagery can miss the full breadth of spatial distributions and discrete patchiness (Teed et al. 2024). In the future, to support further baseline characterization of selected MCN sites, or within subsequent ecological monitoring, the distance between images analyzed could be reduced and paired with more extensive annotator analysis of the continuous video, incorporating autocorrelation to derive clusters (as in Teed and Lawton *in review*). Utilizing video data in particular could better detect fine-scale spatial structure of conservation priority and biogenic habitat-forming species such as *M. modiolus* and *B. ovifera*, ensuring MCN sites are inclusive of high-density areas.

To reduce the burden of extensive image and video annotation, Artificial Intelligence (AI) software could be employed to expedite annotations. For example, numerous studies have used trained AI as a ‘first pass’ through imagery datasets to detect all organisms present, with annotators then able to identify and sort organisms to lower classifications more quickly (e.g., Mbani et al.

2023). While automatic detection with machine learning is becoming more widely available, with the potential to expedite future workloads, AI still requires the manual review of training datasets, which are often lacking in complex heterogeneous habitats (Nozères et al. 2025), such as those observed in SWNB. Our dataset of 1699 annotated images could be used to help train automatic detection, increasing confidence in detections in heterogeneous habitats, like the system integrated into BIIGLE (MAIA - Zuroweitz and Nattkemper 2021).

4.3 RELEVANCE TO MARINE CONSERVATION NETWORK PLANNING

Overall, 53 of the 73 transects from 2022 to 2024 SWNB surveys at least partially occurred within 11 MCN sites (Table 5), covering ~19455 m² (of the 27080 m² surveyed overall). Within MCN sites, we analyzed 1070 still images and over 21 hours of continuous seafloor video, for taxa occurrences and dominant substrate, respectively. The current survey coverage demonstrates high heterogeneity of benthic habitats within and across MCN sites. Although surveys were conducted at multiple locations over three years (15 survey days, with several months of planning and analysis), the total seafloor area covered within the 11 MCN sites (0.019 km²) represents only about 0.005% of their combined area (~382 km²). Even when integrating prior surveys from the well-studied SWNB coastal areas, including 2016 to 2017 imagery data, as well as recent and historical dive surveys, etc. (Table 6), the spatial extent of empirical observations across the MCN sites remains quite limited. This is not unusual and is expected, reflecting general experience in surveying and documenting benthic species assemblages and habitat characteristics across marine coastal habitats (Lacharité and Brown 2019; Wei et al. 2019; Noble-James et al. 2023). It would be logistically infeasible to sample benthic habitats across these 11 MCN sites in their entirety, let alone across the total 20 MCN sites in SWNB. Moreover, achieving sufficient coverage outside MCN sites to enable robust comparisons would be equally impractical. Scientists frequently deal with the issue of not being able to sample everywhere by applying various statistical analysis and modelling approaches to integrate empirical biological observations with physical environmental factors to develop predictive spatial representations of species associations (e.g., Beazley et al. 2017; Murillo et al. 2024; Cutcliffe et al. 2025; Mireault et al. 2025). Such techniques could be employed using the current survey data to predict occurrence and abundance of benthic fauna across SWNB.

The primary objective of the current survey was to provide additional baseline characterization of several proposed MCN sites; accordingly, the survey was not designed to explicitly compare taxa occurrence inside versus outside MCN boundaries. However, there were a few exceptions, isolated to the HH/WI/P sub-area where transects were conducted outside of (but nearby) the Little Letete, Head Harbour, and Western Passages MCN sites. Taxa counts within and outside of the Little Letete Passage MCN site were similar, indicating good coverage of taxa within the site, though prevalence of certain taxa (e.g., *C. frondosa*, *B. ovifera*) was higher outside of the site, where transects predominately occurred in deeper habitats.

Transect coverage within the Head Harbour Passage MCN site revealed high taxonomic diversity compared to adjacent transects; however, *B. ovifera* was notably absent, the invasive *D. vexillum* was widely established, and extensive shell hash accumulations were observed throughout. Considering this, the Head Harbour Passage MCN site could be a good candidate for a spatial closure and subsequent monitoring to protect horse mussel beds, helping to limit further spread of *D. vexillum* from fishing vectors, and allowing for the possible recovery and re-establishment of *B. ovifera* fields and sponges. Previous studies documented that long-term bottom-fishing closures in Georges Bank (to try and limit *D. vexillum* spread) assisted in the recovery of a near-collapsed scallop fishery, resulting in lower *D. vexillum* cover and higher scallop densities in closed versus adjacent open areas (Valentine et al. 2007; Kaplan et al. 2017). While a similar closure in Head Harbour may provide for increases in scallop densities within the MCN site, the currently proposed site (~5 km²) may not be of adequate size to facilitate major change, considering Georges Bank sites (Kaplan et al. 2017) were >100 km². Nevertheless, the Head Harbour MCN site is a good candidate area where an experimental spatial closure, combined with ecological monitoring of benthic habitat and species (specifically scallops and horse mussel beds) both within and outside the MCN could provide insight into the effects of spatial closures on benthic fishery species and biogenic habitat. One principal caveat for such an endeavor is the relatively small sizes of the proposed MCN sites and their spatial distribution across SWNB, which may limit localized responses to site-level protection, relative to broader-scale dynamic forces affecting the lower Bay of Fundy marine environment.

In contrast, the current Western Passage North and South MCN sites do not appear to adequately capture the taxa diversity observed in the area between proposed MCN sites. This could be due to the small sample size of transects occurring within the proposed MCN sites, or could

reflect differences in local physical environmental factors. In particular, horse mussel beds were abundant in the area between the North and South Western Passage sites, while previously documented *B. ovifera* fields have disappeared from a shallower sill feature. This sill feature occurs between Western Passage MCN sites ~800 m across (from Deer Island to Maine) and ~400 m wide, with shallow depths (~30 to 45 m) surrounded by the deeper North and South MCN site boundaries (60 to 110-m depths). Direct evaluation of these changes is not possible as current survey transects only overlap with a few 2016 to 2017 locations. Documentation of extensive horse mussel beds and the loss of tunicate fields suggests that a spatial shift or expansion in one or both of the two Western Passage MCN sites could provide for greater overall benthic habitat area known to have been conducive to supporting these biogenic habitat-forming species, including the shallower sill feature. Similar to the Head Harbour MCN site, a spatial shift could allow for protection of known established mussel beds and for the possible recovery of *B. ovifera* fields. An impediment to significant adjustment of the MCN boundaries is the location of a marine finfish aquaculture site within Western Passage, between the two sites (Government of New Brunswick 2026). Future benthic surveys should consider including survey locations beyond proposed SWNB MCN sites, recognizing that site boundaries may change as the network plan is finalized.

The 2022 to 2024 benthic imaging surveys provide new scientific information on 11 SWNB MCN sites (of the 20 proposed); however, decisions on survey locations were responsive to ongoing site proposals and stakeholder consultations, rather than an *a priori* survey design around an established set of sites. Additional survey work should be conducted at MCN sites that were not covered in the current survey. This includes sites such as Bocabec Bay, South Campobello, Grand Harbour, Seal Cove, Southern Head, and Three Islands (Figure 2). Due to the shallow depth profile of most of these sites, dive surveys are likely a better survey approach (e.g., Lawton et al. 2024; Dinning et al. 2025; Cooper et al. *in prep*) complemented by surface-deployed and coastal Remotely Operated Vehicle (ROV)-based benthic imaging systems operable from small surface vessels capable of surveying close to shore.

Future surveys should also prioritize presently under-surveyed locations such as the Western Passage North and South sites, Wolves Bank, as well as the Old Proprietor Shoal/The Prong. The large area of the Old Proprietor Shoal/The Prong MCN site will prove difficult to characterize extensively, especially given the presence of powerful rip currents, multiple locations with deep, steep-walled and extended channels (see for example Figures 3e and 14). Options to

stage survey operations on Grand Manan could be explored, to reduce extended daily transits from the NB mainland (up to 4 h each way). In general, while our benthic survey successfully begins to fill data gaps in benthic habitat characterization across SWNB, additional survey coverage should be obtained, especially given that most scientific surveys to date have largely been focused in coastal waters at <35-m depth. The majority of coastal waters in SWNB are beyond depths >35 m (see Lawton and Teed 2026), conditions under which the FOBIS package has been demonstrated as an effective benthic survey platform.

4.4 BENTHIC HABITAT MONITORING POTENTIAL

The current iteration of the MCN plan for SWNB marine waters, supported by a range of prior regional scientific surveys, as well as previous DFO benthic imagery surveys and the current survey, along with high-resolution bathymetry data, can be used to identify sites that could be used for long-term monitoring efforts to document shifts in community assemblages over time. However, with the exception of recent dive surveys to update the extensive catalog of dives conducted in the 1970s (C. Goodwin pers. comm.), prior surveys have largely been independent studies, with no consistent long-term funding to mount temporal objectives and repeatability. As such, prior work principally represents baseline habitat characterization. For implementation of long-term monitoring protocols required for MCN establishment, some prior surveys may no longer reflect the state of benthic habitats at the time of MCN establishment and should, therefore be considered outdated. This could be troublesome, considering some MCN site boundaries have been informed by prior survey information. For example, the Head Harbour MCN site was delineated, in part, based on habitat suitability models for two biogenic habitat-forming species, *B. ovifera* and *M. modiolus* (Mireault et al. 2025). Although the current survey provided additional observations of high-density *M. modiolus* beds 6 to 8 years following the earlier survey, *B. ovifera* was observed far less frequently and at lower abundances. Results from our 2022 to 2024 survey generates another static sample of taxa occurrences, rather than a true measure of temporal change. While some locations were chosen to ground-truth prior habitat suitability models in the HH/WI/P EBSA, increasing depth coverage and allocation of survey time to previously unexplored MCN sites were prioritized. Direct overlap of transects was not attempted, and for benthic surveys using a drift transect protocol, as is done with FOBIS, is not strictly feasible due to the Bay of Fundy tidal currents. As described in Teed et al. (2025a), FOBIS could undergo alterations in the structure of the frame to permit towed operations, though moving to a towed design may limit its deployment

across complex seafloor topography. Technological advancements in Autonomous Underwater Vehicles (AUVs) and ROVs could allow for specific resampling of imagery survey transects at a high spatial resolution. However, they are also limited in their ability to conduct designated transect track lines against strong tidal currents. Additionally, some technologies (e.g., AUVs) are not able to remain close enough to the seafloor (<1 to 2 m) to capture clear images in turbid benthic environments (Noble-James et al. 2023). Notwithstanding these technical challenges in repeatability, application of the drift transect survey approach used with FOBIS, paired with proximity analysis of acquired imagery (in relation to prior data), could achieve temporal benthic ecological monitoring with observations potentially resolvable to within 10 to 100 m of prior surveys.

Overall, our benthic imagery survey provides further baseline characterization of SWNB coastal benthic habitats. While the sampled seafloor area within MCN sites is relatively small, the breadth of information collected is invaluable for ongoing marine conservation planning in SWNB. Together with the 2016 to 2017 imagery survey, current DFO benthic imagery (digital still and continuous video), documented in open data publications (e.g., Lawton 2022; Mireault et al. 2023; Lawton and Teed 2025) represents a comprehensive data bank for follow-on habitat characterization, investigation of specific benthic species and demersal fish ecology, and future integrated analysis and development of long-term monitoring frameworks. Other prior DFO benthic imagery surveys could be integrated and analyzed to provide additional taxa information, as local surveys employing video and still imagery date back to the 1990s (Strong and Lawton 2004; see Table 6 for select examples). Similar to the current survey comparing transect locations to the 2016 to 2017 surveys, these older datasets could undergo a formal proximity analysis to qualitatively discuss temporal changes in benthic habitats. Previous surveys could also help distinguish habitats observed within and outside of MCN sites. Furthermore, other survey approaches including ecosystem trawl surveys, inshore lobster trawl surveys (e.g., Denton 2020), scallop stock assessment surveys (e.g., Nozères et al. 2024), eDNA, and on-going dive surveys could be integrated with imagery survey characterizations to develop a comprehensive benthic ecosystem overview of SWNB, better informing MCN site locations. Utilizing trawl, scallop stock assessment, and eDNA surveys, along with specimen collections from dive surveys, would provide more clarity on species identification that could lead to a formal species assemblage analysis. Additionally, this would allow for the evaluation of the relationship between taxonomic and functional diversity. Despite the documented usefulness of trawl and eDNA surveys for monitoring select habitat

components, non-invasive imagery surveys should be prioritized as they increase the ability to observe benthic ecosystem structure and assemblages (T.J. Kenchington 2014; Noble-James et al. 2023; Teed and Lawton *in review*). Our survey approach delivers ample information applicable to monitoring ecosystem indicators and could be repeated to observe temporal change and continuously inform SWNB MCN designation.

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6 COMPETING INTERESTS STATEMENT

The authors declare there are no competing interests.

7 AUTHOR CONTRIBUTION STATEMENT

Conceptualization: PL, LLT; Data curation: LLT, PL; Formal analysis: LLT; Funding acquisition: PL; Investigation: PL, LLT; Methodology: LLT, PL; Project administration: LLT, PL; Software: PL, LLT; Resources: PL; Supervision: PL; Validation: LLT; Visualization: LLT; Writing – original draft: LLT, PL; Writing – review and editing: LLT, PL.

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9 DATA AVAILABILITY STATEMENT

Transect, imagery metadata analyzed, and taxa occurrence data generated during this study are available in the Lawton and Teed 2025 repository, <https://open.canada.ca/data/en/dataset/f9098f77-b2e1-423d-8950-eeabd7bba85b> and on OBIS (Ocean Biodiversity Information System) at <https://obis.org/dataset/a49970ed-f310-49c4-86c5-6a3a5418f657>. Still imagery and video files for this study are available from the Coastal Ecosystems Science Division (CESD) data manager upon reasonable request (email: DFO.CESDDataRequest-DSECDemandededonnes.MPO@dfo-mpo.gc.ca). However, imagery files will be uploaded in batches to the open data link provided (Lawton and Teed 2025) at a later date (as current Open Data Portal limits only permit files <20GB).

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11 APPENDIX

Appendix Table 1. Detailed description of seafloor substrates and habitats observed in each near-seafloor imagery transect in SWNB from observations made while viewing the downward- and forward-facing underwater video. Sub-area location is provided and includes: PB – Passamaquoddy Bay, HHWIP - the Head Harbour/West Isles/Passages region, W/DH – The Wolves and Deadman’s Harbour, and GM – Grand Manan. Transects are ordered based on geographic location.

Transect	Location	Seafloor substrate and habitat description
CON029	PB	Mud with pockmarks and/or lobster burrows. Very turbid.
CON047	PB	Mud with the odd boulder/cobble and some sporadic shell hash and massive sponges. Some large pockmarks or lobster burrows. Few crab and lobster throughout.
CON048	PB	Mud with sparse shell hash, massive sponges, cerianthids, few crabs, rare cobble/boulder, and rare fish and skate. Switches to contain more cobbles/boulder housing crabs, lobster, massive sponges, then back to mud with a few skates. Lobster burrows and tail tracks visible.
CON049	PB	Mud with pockmarks or lobster burrows, groundfish throughout. Some drift algae and other fish throughout. Difficulty focusing downward video camera, several minutes of no video.
CON042	HHWIP	Silty mud with gravel/pebbles, shell hash, shrimp, drifting algae (red algae, kelp, <i>A. nodosum</i>), fish, crabs, and sea cucumbers.
CON043	HHWIP	Silty boulders/cobbles interspersed with non-silty gravel, encrusting sponges, some silty bedrock patches, scallops, <i>Didemnum</i> spp., and fish. Then a few small porous bedrock patches with crabs, small <i>B. ovifera</i> , and <i>A. nodosum</i> . Later, some larger silty bedrock patches with more encrusting sponges, then back to mixed sediments with <i>Didemnum</i> spp., sponges, shell hash, sea cucumbers, few lobster and crabs, eventually switching to just pebbles/gravel with the odd boulder, shell hash, <i>Didemnum</i> spp., <i>A. nodosum</i> , lobster, crabs, cucumbers, encrusting sponges, and scallops. Transitions to just gravel and shell hash, few lobster and skates, drifting kelp. Transect ends with gravel/pebbles containing lots of shell hash, drifting kelp, <i>D. vexillum</i> , fish, and scallops.
CON044	HHWIP	Silty pebbles/cobbles/gravel with shell hash, sea cucumbers, fish, <i>A. nodosum</i> , encrusting sponges, lobster, scallops, few big boulders. Then switches to just gravel (less silty) with lots of shell hash, sea cucumbers, few lobster, fish, and <i>D. albidum</i> . Then encounter a steep bedrock wall containing cucumbers, sponges, fish, <i>D. albidum</i> , then sand/gravel with shell hash, odd cobble, and scallops, and then a mix of bedrock and very large boulders with few fish, crabs, and lobster. Some small bedrock patches interspersed with gravel, odd boulder/cobble, and containing cucumbers, encrusting sponges, shell hash, and <i>D. albidum</i> . Quite a few <i>B. ovifera</i> and horse mussels on boulders/bedrock forming turf. Transect ends with mixed sediments housing sea cucumbers, mussels, urchins, lots of shell hash, and encrusting sponges.
CON045	HHWIP	Transect starts along a silty bedrock wall, containing anemones, encrusting sponges, fish, crabs, and lobster. Then gravel with cobbles/pebbles, shell hash, sponges, <i>D. albidum</i> , crabs, sponges, scallops, fish with some bedrock patches. Then silty bedrock/boulders/cobbles interspersed with shell hash and gravel, <i>D. albidum</i> , <i>A. nodosum</i> , and sponges. Then switches to silty pebbles and non-silty gravel with shell hash, fish, scallops, then just gravel interspersed with bedrock patches housing sea cucumbers, lobster, sponges, shell hash, and <i>D. albidum</i> . Then silty gravel/pebbles with shell hash, scallops, few bedrock patches containing sea cucumbers, <i>A. nodosum</i> , sponges, and shell hash (mostly horse mussel shells). Eventually becomes bedrock with encrusting sponges, cucumbers, <i>D. albidum</i> , shell hash, and some mussel turf. Transect ends with pebbles/gravel containing shell hash, encrusting sponges, cucumbers, lobster, scallops, then small boulder field interspersed with bedrock, then back to gravel/pebbles with some mussel reef.

Transect	Location	Seafloor substrate and habitat description
CON080	HHWIP	Mud with sparse pebbles/cobbles and the rare odd boulder housing massive sponges, fish, some shell hash, drifting kelp, lobster, and few scallops. Then up a silty bedrock wall with sponges before transitioning back to mud with pebbles/gravel, few cobbles shell hash, crabs, and fish. Transect ends with more cobbles/boulders housing shell hash, crabs, fish, and sponges.
CON081	HHWIP	Silty/muddy gravel/pebbles with shell hash, encrusting sponges, scallops, cucumbers, lobster, and drifting algae. Some silty bedrock patches quickly transitioning to muddy gravel/pebbles, shell hash, later with more pebbles/cobbles. Then silty bedrock patches with crabs, drift kelp, coralline algae, encrusting sponges, fish, shell hash, and then mud with sparse gravel/pebbles, shell hash, skate, various fish, and scallops. Eventually switches to bedrock that is silty with lots of cucumbers, few sponges, drift kelp, shell hash, scallops, and some interspersed gravel. Then just gravel with some shell hash, scallops, and some mussel turf patches before going back to gravel/pebbles with shell hash, scallops, encrusting sponges, cucumbers, odd boulder, drifting kelp, and fish. Then mussel reef with lots of dead shells, interspersed with gravel and housing herring, encrusting sponges, lobster, few scallops, some cucumbers, crabs, and drifting <i>A. nodosum</i> .
CON082	HHWIP	Mud with the odd pebble/cobble/boulder with some shell hash, groundfish, drifting algae, crabs, lobster, and massive sponges. Then transitions to predominately mud.
CON046	HHWIP	Silty mixed sediments, shell hash, sponges, few anemones, <i>D. albidum</i> , drifting algae, and lobster. Very turbid (transect aborted).
CON083	HHWIP	Silty gravel/pebbles with shell hash, cerianthids, crabs, drifting kelp and red algae, scallops, fish, <i>D. albidum</i> , encrusting sponges, and lobster. Then up a silty bedrock wall with bedrock/sand at the top containing shell hash, encrusting sponges, lobster, crabs, and scallops before transitioning to gravel/muddy pebbles with shell hash, crabs, fish, cerianthids, and few lobsters.
CON084	HHWIP	Lots of mackerel observed on descent. Silty/muddy gravel/pebbles with lots of shell hash, crabs, fish, cerianthids, drifting kelp, lobster, the odd cobble/boulder, and few scallops. Then switches to silty bedrock patches, crabs, fish, encrusting sponges, interspersed with gravel/pebbles and shell hash, then back to silty/muddy gravel/pebbles, shell hash, scallops, cucumbers, encrusting sponges, crabs, lobsters, drifting kelp, and cerianthids. More mackerel near the end of transect.
CON085	HHWIP	Mud with some lobster burrows. Then muddy bedrock housing massive sponges, then mud with sparse pebbles/cobbles containing lobster, fish, drifting kelp, anemones, crabs, and lots of shell hash. Transitions to mud with lots of shell hash and cerianthids, then quickly back to muddy bedrock with sponges, then to muddy gravel with shell hash, cerianthids, lobsters, and fish. Transect ends with mud housing sparse shell hash, lobster burrows, lobsters, then gravel/pebbles with anemones, crabs, fish, shell hash, and drifting algae.
CON086	HHWIP	Mud with sparse gravel, shell hash, sponges, cerianthids, crabs, and fish. Then more muddy/silty gravel/pebbles/cobbles with shell hash, cerianthids, massive sponges, crabs, anemones, lobster, and fish (mostly mackerel). Transect ends up a silty bedrock wall housing anemones and sponges.
CON093	HHWIP	Muddy gravel/sand with shell hash, the odd pebble/cobble/boulder, cerianthids, crabs, scallops, lobster, fish, anemones and massive sponges. Eventually transitions to mud with sparse gravel, shell hash, cerianthids, crabs, lobster, odd boulder with sponges, anemones, and fish.
CON094	HHWIP	Mackerel on descent. Silty gravel/pebbles with shell hash, cerianthids, scallops, crabs, fish, lobster, and the odd boulder with sponges and anemones (silty). Then more silty cobbles consistently before transitioning to mud with sparse pebbles, shell hash, cerianthids, crabs and massive sponges.
CON039	HHWIP	Gravel and pebbles, with shell hash, fish, <i>D. vexillum</i> , anemones, with some substrates more silty. Few crabs, sponges, and <i>B. ovifera</i> on odd larger cobbles. Lots of <i>D. albidum</i> throughout. Eventually becomes more silty, with what could be mussel turf. More shells, silty gravel, anemones, drifting algae, crabs, <i>Didemnum</i> spp., and the rare boulder. Then switches to bedrock (porous) with boulders, anemones interspersed with gravel patches, shell hash, <i>D. albidum</i> , lobsters, and odd fish. Then compact mussel shells with anemones, before travelling up a sloped bedrock wall (steep at some points) with shell hash, anemones, sponges, and fish.

Transect	Location	Seafloor substrate and habitat description
CON040	HHWIP	Sand/mud with some gravel, lots of shell hash, drifting algae, then just gravel and shell hash, before quickly transitioning to silty bedrock wall covered in sponges, anemones, <i>Didemnum</i> spp., then back to gravel. Another bedrock wall with turf, sponges, <i>Didemnum</i> spp., anemones, then boulder field with sponges, anemones, some <i>B. ovifera</i> , <i>Didemnum</i> spp. interspersed with gravel. Very heterogenous from gravel to bedrock wall to boulder field. Gravel habitats contained anemones, scallops, shell hash, and lobster. Later some porous bedrock with silty boulders, turf, anemones, <i>Didemnum</i> spp., scallops, compact shells, and up a wall with mussel clumps, anemones, sponges, <i>Didemnum</i> spp., <i>B. ovifera</i> , fish, and algae. Transect ends travelling up steep silty bedrock wall with sponges, anemones, and <i>Didemnum</i> spp.
CON041	HHWIP	Starts off on a cage surrounded by silty boulders with interspersed gravel, anemones, shell hash, <i>A. nodosum</i> , <i>D. albidum</i> , lobster, fish, crabs, some drifting kelp, <i>B. ovifera</i> , scallops, and few massive sponges. Later, similar assemblages with boulders/cobbles/pebbles/muddy gravel. Then transitions to muddy gravel with shell hash and the odd boulder/cobble containing <i>D. albidum</i> , lobster, scallops, <i>B. ovifera</i> , fish, crabs, anemones, and then soon back to silty mixed sediments, with cerianthids. Transitions to mud/sand with gravel, then more mixed sediments, <i>A. nodosum</i> , shell hash, anemones, cerianthids, <i>D. albidum</i> , fish, and scallops. Lights go out for a short time as the transect ends.
CON036	HHWIP	Boulders/cobbles/pebbles and bedrock covered in sponges, anemones, interspersed with shell hash, <i>D. albidum</i> , some extensive <i>D. vexillum</i> patches, barnacles, and sea stars. In some spots seafloor was too heterogenous with huge boulders to get close to seafloor. Then possible mussel bed with dead shells, up a little slope, then more mussels with some fish and sea cucumbers. Then an extensive mussel reef with the odd huge boulder or bedrock patch. Fish and crabs throughout. <i>D. vexillum</i> present on mussels. Then compact mussel shells with pebbles/gravel, drifting algae, and anemones. Transitions to gravel with shell hash, crabs, and the odd anemone. Then more anemones, some cucumbers, crabs, fish, and <i>D. albidum</i> . Gravel/pebbles eventually become more silty near the end of transect.
CON037	HHWIP	Silty pebbles/gravel, shell hash, anemones, <i>Didemnum</i> spp., mussel turf with odd boulder covered in encrusting sponges. Then pebbles/cobbles/boulders interspersed with gravel, containing sponges, anemones, extensive <i>D. vexillum</i> , drifting algae, few fish and crabs. Then pebbles/gravel with lots of shell hash/horse mussel shells (possibly some underlying live turf), then back to pebbles/gravel/cobbles with anemones, <i>D. vexillum</i> , sponges, sea stars, and then back to mussel turf/shells with the odd boulder. Transitions to cobbles/boulders with anemones, sponges, <i>D. vexillum</i> , then to more gravel with lots of anemones and shell hash, anemones, mussel turf (mostly just empty shells). Transect ends with some sporadic cobbles/boulders and lots of compacted horse mussel shells.
CON038	HHWIP	Gravel/pebbles with <i>A. nodosum</i> , anemones, shell hash, <i>D. vexillum</i> , crabs, scallops, some drifting kelp, fish, and sea cucumbers. Few lobster around the rare boulder. Then extensive shell hash patches, before ending with gravel with some drifting algae, anemones, crabs, and scallops.
CON109	HHWIP	Gravel/pebbles with mackerel, scallops, anemones, and crabs. Then lots of shell hash, anemones, gravel/pebbles, odd cobbles, <i>D. vexillum</i> , and mussels/turf. Then back to gravel with silty pebbles, anemones, shell hash, drifting algae, <i>D. vexillum</i> , and crabs, then back to turf, anemones, cucumbers with some bedrock patches with sponges, fish, mussel reef, <i>D. vexillum</i> , and drifting kelp. Transitions to large silty boulders/bedrock with lots of sponges, anemones, <i>Didemnum</i> spp., shell hash, crabs, cucumbers, drifting kelp, then back to silty pebbles/gravel/mussel bed, shell hash, anemones, crabs with bedrock patches in between housing sponges, lobster, <i>D. vexillum</i> , and fish. Transitions to turf/mussels with anemones, <i>D. vexillum</i> , and shell hash. Switches to silty pebbles/cobbles/gravel with shell hash/turf, anemones, drifting <i>A. nodosum</i> , <i>D. vexillum</i> , then becomes silty bedrock/boulders containing anemones, sponges, <i>D. albidum</i> , then back to shell hash/turf/mussels. Transect ends as mixed sediments with lots of encrusting sponges, shell hash, <i>D. vexillum</i> , and mussels.
CON110	HHWIP	Densely compacted mussel shells with some live individuals with some sparse boulders/cobbles that are silty with anemones, and crabs. Transitions to silty boulders/cobbles/bedrock with anemones, crabs, cucumbers, sponges, drifting algae, <i>Didemnum</i> spp., and

Transect	Location	Seafloor substrate and habitat description
		lots of krill swimming. Also contains fish, shell hash, rare <i>B. ovifera</i> , and lobster. Lots of anemones observed eating krill. Then turf with mussels and drifting kelp. Switches to gravel (with the odd boulder) with lots of shell hash/mussel shells (some live ones) with turf, anemones, pebbles, drifting algae, anemones, sponges, crabs, and fish. Transect ends with silty pebbles/gravel containing shell hash, anemones, crabs, cucumbers, mussels, <i>Didemnum</i> spp., drifting algae, sponges, lobster, and fish.
CON002	HHWIP	Silty gravel and pebbles covered with extensive <i>Didemnum vexillum</i> . Anemones and shell hash common. Some cobbles/boulders throughout with few sea cucumbers, various fish, drifting algae, few scallops, and <i>Cancer</i> spp. At times, <i>D. vexillum</i> so extensive that substrate is indistinguishable. Some porous bedrock patches halfway through the transect before returning to silty mixed substrates covered in <i>D. vexillum</i> with anemones, various fish, and few cucumbers.
CON004	HHWIP	Transect begins as a silty mussel reef with the odd cobble/boulder containing encrusting sponges. Anemones, crabs, shell hash, and <i>Didemnum</i> spp. are common with few sea cucumbers. Around halfway through the transect, switches to silty boulders/cobbles/pebbles interspersed with mussels, anemones, sea cucumbers, <i>D. vexillum</i> , algae, sponges, few fish, and crabs. Few <i>Boltenia ovifera</i> throughout, and some very extensive <i>D. vexillum</i> patches. Transect ends with gravel/pebbles/cobbles with some shell hash, anemones, crabs, sponges, cucumbers, and few large boulders.
CON035	HHWIP	Silty gravel/pebbles/cobbles interspersed with sandy mud. Shell hash, anemones, drifting algae, crabs, few scallops and fish throughout, <i>D. albidum</i> , and encrusting sponges. Then increasing cobbles/boulders with more fish, drifting algae, sponges, anemones, with some sandy patches, few cucumbers, then patches of <i>D. vexillum</i> . Transitions to sandy gravel/pebbles with lots of mackerel, scallop shells (few live ones), other shell hash, anemones, <i>Didemnum</i> spp., drifting algae, and crabs. Ends with cobbles and lots of drifting <i>A. nodosum</i> .
CON052	HHWIP	Silty mixed sediments with dense shell hash/horse mussel shells, anemones, lobster, crabs, small patches of mussel reef, <i>Didemnum</i> spp., various fish, scallops, drifting algae, cucumbers, and encrusting sponges. Then less silty gravel/sand with pebbles, housing anemones, shell hash, sponges, and <i>Didemnum</i> spp. Transitions to cobble/boulder field with lots of sponges, anemones, then back to turf/gravel/mussel shells containing some very extensive <i>D. vexillum</i> patches, scallops, crabs, and anemones. Then up a bedrock wall around before becoming gravel/sand/pebbles with shell hash (mostly horse mussel shells), fish, crabs, and <i>A. nodosum</i> . Transect ends with compacted mussel shells.
CON003	HHWIP	Silty gravel and pebbles with encrusting sponges, anemones, drifting algae, few fish, <i>D. vexillum</i> , scallops, and crabs. Eventually transitioned to just gravel that is not silty with shell hash, anemones, algae, crabs, <i>D. vexillum</i> , scallops, and few fish. Halfway through the transect more gravel/pebbles/cobbles covered in encrusting sponges, anemones, algae, few cucumbers, scallops, and crabs, eventually becoming silty with lots of shell hash, the rare boulder and possible mussel turf. Then just silty mussel turf with shell hash, anemones, crabs, and some fish. Transect ends with silty pebbles/cobbles/boulders covered in encrusting sponges, anemones, and shell hash with some porous bedrock patches with crabs.
CON005	HHWIP	Silty mussel reef with boulders/cobbles/pebbles, anemones, sponges, and shell hash, then just sandy turf with shell hash, scallops, anemones, lobster, crabs, and sea cucumbers. Then transitions back to silty mussel reef before quickly turning to silty boulders/cobbles/pebbles with encrusting sponges, shell hash, anemones, then more mussel reef with crabs, drifting algae, fish, and then back to boulders/cobbles/pebbles. Halfway through the transect, switches to just silty gravel/pebbles, shell hash, anemones, encrusting sponges, crabs, fish, <i>Didemnum</i> spp., then with more cobbles/boulders. Transitions back to mussel turf/reef with shell hash, sponges, crabs, anemones, and some cobbles. Transect ends with silty gravel/pebbles with shell hash, anemones, fish, scallops, crabs, <i>D. vexillum</i> and some porous bedrock underlying pebbles/cobbles.
CON006	HHWIP	Mixed sediments with lots of shell hash, encrusting sponges, anemones, sea cucumbers (throughout), fish, crabs, and <i>Didemnum</i> spp. Transect then transitions to more silty mixed sediments containing sponges, cucumbers, anemones, shell hash, scallops, <i>D. vexillum</i> , encrusting sponges, fish, and drifting algae, then less silty again around with extensive shell hash, cucumbers, anemones, <i>Didemnum</i> spp., sponges, scallops, and hermit crabs. As the substrate becomes more silty again, there are mussels in between coarser sediments

Transect	Location	Seafloor substrate and habitat description
		along with anemones, scallops, cucumbers, <i>Didemnum</i> spp., hermit crabs, drift algae, encrusting sponges, few fish, and lots of shell hash. Transect ends as a mussel reef/turf around with lots of empty shells, cucumbers, anemones, sponges, <i>Didemnum</i> spp., crabs, scallops, and drifting algae.
CON007	HHWIP	Gravel/pebbles with lots of shell hash (and empty horse mussel shells), anemones, crabs, odd boulder with encrusting sponges, drifting algae, and <i>D. vexillum</i> . Later, mostly silty pebbles/cobbles covered in yellow encrusting sponges, shell hash, <i>D. vexillum</i> (sometimes very extensive), anemones, drifting algae, sea cucumbers, and crabs. Then switches to less silty, more gravel/pebbles with the odd large boulder, anemones, <i>D. vexillum</i> , drifting algae, various fish, scallops, crabs, cucumbers, then more silty cobbles/pebbles interspersed with non-silty gravel, anemones, <i>D. vexillum</i> (extensive at times), scallops, cucumbers, crabs, and fish. Transect ends with porous bedrock patch before returning to mixed sediments.
CON051	HHWIP	Silty mixed sediments covered in <i>D. vexillum</i> with anemones, encrusting sponges, few cucumbers, crabs, scallops, shell hash, fish, and <i>D. albidum</i> . Then switches to mostly gravel (not silty) with empty mussel shells, <i>D. vexillum</i> , anemones, drifting algae, then more mixed sediments with the odd large boulder, sea cucumbers, <i>D. vexillum</i> throughout, fish, encrusting sponges, drift kelp/algae, and dense mussel shells with some turf. Eventually becomes sandy gravel with mussel shells, <i>D. vexillum</i> , anemones, and fish, with some bedrock/boulder patches containing encrusting sponges. Then silty boulder/cobble field covered in sponges, <i>Didemnum</i> spp., anemones, with sparse bedrock patches containing few <i>B. ovifera</i> and redfish. Switches to bedrock (sometimes rippled) interspersed with cobbles/gravel/sand, then back to all silty mixed sediments housing anemones, <i>Didemnum</i> spp., crabs, sponges, cucumbers, and fish. Eventually switches to just gravel with shell hash and sand, then back to boulder field with sponges, anemones, <i>D. albidum</i> , crabs, <i>A. nodosum</i> . Transect ends as sand with gravel/pebbles, shell hash, anemones, and encrusting sponges.
CON050	HHWIP	Mixed sediments covered in <i>D. vexillum</i> , mostly gravel/pebbles with anemones, drifting algae, scallops, crabs, small <i>B. ovifera</i> , fish, and sea cucumbers.
CON008	HHWIP	Muddy gravel/pebbles/cobbles with shell hash, drifting algae, various fish, few anemones, sponges, crabs, some garbage/fishing gear debris, and few cucumbers. After, more mud/sand with sparse gravel/pebbles, lots of shell hash, crabs, scallops, lots of <i>Iophon</i> sponge, various fish, sea cucumbers and the odd boulder.
CON088	W/DH	Mud with rare crab, cerianthid, fish, sponges, shell hash, and lobster under the odd silty boulder. Very turbid. Then some muddy bedrock patches with crabs and sponges, followed by muddy bedrock/cobble field surrounded by mud, lobster, cerianthids, and fish.
CON089	W/DH	Mud with lobster burrows, groundfish, massive sponges, crabs, cerianthids, lobsters, lots of drift kelp and then up a muddy bedrock wall, to more mud housing sponges, lobsters, sparse boulders/cobbles, anemones, fish, cerianthids, <i>D. albidum</i> , and crabs.
CON090	W/DH	Mud with shell hash, cerianthids, fish (some mackerel), drifting kelp, sponges, crabs, and lobsters.
CON091	W/DH	Mud with sparse shell hash, groundfish, scallop, cerianthids, lobster, crabs, and lobster burrows.
CON092	W/DH	Mud with lobster burrows and lobster.
CON111	W/DH	Herring on descent. Muddy gravel with shell hash, cerianthids, groundfish, <i>A. nodosum</i> , drifting red algae, crabs, and some encrusting sponges throughout.
CON112	W/DH	Silty gravel/pebbles/cobbles with the odd large boulder containing shell hash, sponges, crabs, cerianthids, anemones, <i>D. albidum</i> , fish, scallops, drifting <i>A. nodosum</i> , and few small <i>B. ovifera</i> .
CON113	W/DH	Muddy/silty pebbles/cobbles with shell hash, sponges, crabs, anemones, <i>D. albidum</i> , and scallops. Possibly underlying silty bedrock (hard to tell if rock or mud, but scattered pebbles/gravel on top) with lobster, and cerianthids.
CON030	W/DH	Silty gravel/pebbles/cobbles with odd boulder and shell hash, cerianthids, and <i>D. vexillum</i> throughout. Quite turbid in spots with crabs, sponges throughout (lots of Polymastiidae and <i>M. lingua</i>), and anemones. Few scattered scallops, some fish. Eventually switches to more muddy/silty sand and gravel, then finishes with mixed sediments.

Transect	Location	Seafloor substrate and habitat description
CON031	W/DH	Silty gravel/cobbles/boulders with lots of massive sponges, anemones, some fish, then switches to silty bedrock with more sponges, anemones, some <i>B. ovifera</i> , <i>D. vexillum</i> , with sand and shell hash in crevices, then mixed with boulders. Then silty gravel/pebbles with odd boulder/cobble, cerianthids, sponges, shell hash, fish, crabs, anemones, and rare scallop. Then as transect becomes shallower, more cobbles/boulders with sponges, anemones, few <i>B. ovifera</i> , cerianthids, and fish. Then back to sandy/muddy/silty mixed sediments and shell hash with the odd bedrock with cobble patch. Transect ends with mixed sediments with more boulders, anemones, sponges, and fish.
CON032	W/DH	Silty gravel/sand/pebbles, shell hash, with cerianthids, massive sponges, lobster, fish, anemones, then boulder/cobble field interspersed with sand/shell hash with sponges, anemones, and redfish. Then up a bedrock wall with lots of sponges, anemones, some <i>B. ovifera</i> . Then silty gravel with lots of shell hash, sponges, cerianthids, crabs, anemones, then with more cobbles/boulders, and up another bedrock wall covered in sponges and anemones, before quickly transitioning to bedrock with cobbles, interspersed with sand/shell hash. Then switches to sandy gravel with shell hash and cerianthids, then back to bedrock with sponges, anemones, and eventually up another bedrock wall before leveling out on silty bedrock (interspersed with gravel/shell hash) with lots of anemones, and sponges.
CON033	W/DH	Silty gravel/pebbles with shell hash, cerianthids, crabs, encrusting sponges, and few scallops throughout. Later has the rare cobble/boulder. Sea stars and shrimps throughout, few fish.
CON034	W/DH	Silty gravel/pebbles, shell hash, encrusting sponges, few fish, sporadic boulders, and few scallops throughout. Lots of cerianthids throughout whole transect. Lots of fish halfway through the transect. Then has more cobbles, anemones, cerianthids, shell hash, fish, and sponges, before transitioning back to gravel/pebbles, with the odd cobbles/boulders, more anemones, <i>D. vexillum</i> , sea stars, crabs and fish. Up a steep bedrock/boulder wall at the end of the transect, covered in sponges and anemones.
CON118	GM	Sandy gravel/cobbles with shell hash, crabs, scallops, sparse silty boulders, cerianthids, herring, lobster, anemones, and krill.
CON095	GM	Sand with silty pebbles and cobbles, lots of shell hash, <i>F. foliacea</i> , anemones, encrusting and sponges. Then more boulders interspersed with sand, fish, and algae. Transitions back to mostly sand/gravel/pebbles with shell hash and lots of <i>F. foliacea</i> , sponges, anemones, fish, drifting algae and the odd silty boulders.
CON096	GM	Boulder/cobbles interspersed with sand and lots of shell hash, anemones, sea stars, barnacles, crabs, sponges, and few lobsters.
CON097	GM	Gravel/pebbles interspersed with sand, shell hash, <i>F. foliacea</i> , anemones, sponges, fish, crabs, odd boulder/cobbles (often silty), scallops and drifting algae. Then more cobbles/boulders before transitioning back to more gravel/pebbles housing shell hash, scallops, anemones, crabs, <i>F. foliacea</i> , encrusting sponges, fish, and sea stars.
CON098	GM	Sand with gravel/pebbles/cobbles and shell hash. The cobbles are covered in <i>F. foliacea</i> . Anemones, fish, drifting algae, scallops, crabs, sponges, and lobsters also present.
CON087	GM	Slightly silty gravel with shell hash, crabs, cerianthids, and sponges. Then silty bedrock patch with some boulders and sponges attached, interspersed with gravel, shell hash, fish, and crabs. Then back to gravel housing scallops, drifting algae, cerianthids, lobster, some silty bedrock patches/boulders, sponges, lots of crabs, and anemones. Eventually switches to muddy gravel/pebbles with shell hash, crabs, cerianthids, odd boulder with sponges, scallops, and fish. Then boulders interspersed with gravel/sand containing shell hash, sponges, fish, crabs, cerianthids, and lobster, then mostly gravel/sand with shell hash, crabs, cerianthids, lobster, scallops, sponges, and drifting algae. Transect ends with mud containing pebbles/gravel, shell hash, cerianthids, crabs, and later with sparse boulders/cobbles.
CON099	GM	Mud with cerianthids, sparse shell hash, crabs, massive sponges, rare boulder, and lobster. Then transitions to more gravel/pebbles (and odd boulder) in mud with shell hash, cerianthids, massive sponges, crabs, and groundfish.
CON100	GM	Silty mud covered bedrock containing crabs, encrusting sponges, shell hash, fish, and massive sponges. Then encounter steep silty rock walls interspersed with muddy gravel/shell hash, and another rock wall on the other side with massive sponges. Transitions to muddy gravel/pebbles with lots of shell hash, crabs, cerianthids, then up another rock wall patch housing sponges, groundfish, and lobster. Transect ends as muddy gravel/pebbles with shell hash, cerianthids, crabs, fish, and lobster.

Transect	Location	Seafloor substrate and habitat description
CON101	GM	Mud with crabs. Very turbid and playing with video camera settings, blocking some video.
CON102	GM	Muddy/silty bedrock/boulders with crabs, sponges, shell hash, fish, and lobster. Very turbid. Then boulders/bedrock interspersed with muddy gravel and shell hash, drifting kelp, and quite a few redfish. Switches to muddy gravel and shell hash with sparse boulders, crabs, sponges, and cerianthids. Transitions to silty bedrock patches with crabs, sponges, scallops before going back to muddy gravel/pebbles, shell hash, crabs, and scallops. Then another bedrock patch, fish, sponges, crabs, interspersed with muddy gravel/shell hash, lobster, anemones, less muddy and more sandy as transect ends with more silty boulders/steep bedrock patches, sponges, fish (lots of redfish), crabs, shell hash, and lobster.
CON103	GM	Missing the first 10 minutes of downward video. When video begins, silty boulders/bedrock interspersed with sand/gravel, shell hash, sponges, crabs, lobster, redfish, anemones, scallops, few horse mussels, drifting kelp, cunners, and groundfish. Then switches to muddy/sandy gravel, shell hash with some silty bedrock patches with sponges, crabs, fish, lobster, and drifting <i>A. nodosum</i> .
CON104	GM	Mud with few fish, crabs and lobster. Very turbid.
CON105	GM	Muddy gravel/pebbles with shell hash, cerianthids, encrusting sponges, crabs, herring, and anemones. Then small bedrock patch with drifting <i>A. nodosum</i> , scallops, lobster, and fish. Odd boulder with anemones.
CON106	GM	Silty bedrock patches interspersed with sandy gravel, shell hash, sponges, crabs, redfish, <i>D. albidum</i> , then shifts to more prominent gravel/sandy with shell hash, sparse bedrock patches with sponges, crabs, <i>D. albidum</i> , anemones, cerianthids, fish, and lobster. Then muddy/sandy with gravel, shell hash, crabs, lobster, scallops, and cerianthids. Then up a silty bedrock wall housing sponges, anemones, fish, and lobster. Then back to muddy gravel with shell hash and some bedrock patches similar to above. Transitions to boulder field with lots of encrusting sponges, crabs, fish, lobster, interspersed with gravel/shell hash. Transect ends with bedrock.
CON107	GM	Very turbid, playing with camera focus settings. Mud with crabs, drifting algae, and lobster burrows.
CON108	GM	Pebbles/gravel with large silty bedrock patches housing red algae, sponges, crabs, lobster, cunners, and drifting kelp. Then silty/muddy gravel/pebbles patches with cerianthids then back to bedrock, <i>A. nodosum</i> , and lots of scallop shells. Then muddy gravel/pebbles with shell hash, cerianthids, ending with silty boulders, crabs, and scallops.
CON119	GM	Gravel/sand with lots of shell hash, herring, mackerel, and <i>F. foliacea</i> . Then some pebbles/boulders with encrusting sponges, scallops, drifting <i>A. nodosum</i> , lobster, crabs, anemones and a possible <i>D. vexillum</i> patch.
CON114	GM	Sandy gravel with shell hash, <i>F. foliacea</i> , drifting <i>A. nodosum</i> , crabs, and scallops. Then sandy cobbles/boulders interspersed with gravel containing shell hash, sponges, <i>F. foliacea</i> , drifting <i>A. nodosum</i> , crabs, then back to more gravel with sparse cobbles among rippled sand housing fish.
CON120	GM	Gravel/pebbles with shell hash, sponges, <i>F. foliacea</i> , anemones, drifting algae, crabs, fish, and scallops. Then just gravel with shell hash before switching to cobble/boulder field and bedrock wall (steep) housing crabs, anemones, sponges, and barnacles, then back to cobble/boulder field interspersed with gravel, shell hash (some patches of densely compacted shells), sponges, and anemones. Encounters another steep rock wall before another boulder/cobble field (less silty) with anemones, sponges, crabs, few sparse <i>B. ovifera</i> on boulders, redfish, and shell hash. Then another rock wall to leading to cobble/pebble/boulder fields with more gravel/sand and some bedrock patches. Transect ends with gravel/pebbles containing shell hash, crabs, sponges, and various fish.
CON121	GM	Gravel/pebbles with shell hash, <i>F. foliacea</i> , drifting <i>A. nodosum</i> , anemones, sponges, and lobster. Then up a bedrock wall that is silty, covered in sponges with redfish. Transitions to a silty cobble/boulder/bedrock field covered in sponges with redfish, crabs, and anemones. Then gravel/pebbles between silty boulders/cobbles containing sponges, anemones, shell hash, redfish, crabs, and <i>F. foliacea</i> . Then up another silty bedrock wall to a cobble/boulder field housing sponges, redfish, crabs, barnacles and interspersed with less silty gravel. Switches to another silty boulder/cobble field with sponges, crabs, redfish, interspersed with less silty gravel containing shell hash, and drifting algae. Then pebbles/cobbles with lots of shell hash, <i>F. foliacea</i> , sponges, crabs, fish, and the odd silty boulder. Transect ends with gravel, shell hash, <i>F. foliacea</i> , scallops, and crabs.

Transect	Location	Seafloor substrate and habitat description
CON115	GM	Silty gravel/pebbles with shell hash, sponges, crabs, cerianthids, fish, scallops, drifting <i>A. nodosum</i> , and anemones on the odd cobble, underlying sand, and mackerel.
CON116	GM	Silty gravel/pebbles with the odd cobble containing encrusting sponges, shell hash, crabs, fish, drifting algae, anemones, and cerianthids. Then silty bedrock patch (steep at parts) with cobbles/boulders housing sponges, crabs, anemones, and redfish. Transitions to silty gravel/pebbles with shell hash, lobster, crabs, sponges, drifting algae, fish, and scallops (maybe just shells). Then boulder/cobble field interspersed with gravel, containing shell hash, sponges, anemones, crabs, and redfish, then bedrock wall with sponges, anemones, and crabs. Switches back to silty gravel/pebbles, shell hash, crabs, fish, sponges, anemones, drifting <i>A. nodosum</i> . Encounters a rock wall with sponges, crabs, anemones, and barnacles. Then sand with shell hash, crabs, sparse pebbles and more gravel as it continues. Some patches of densely compacted shells among gravel. Rippled bedrock covered in shell hash ending with pebbles.
CON117	GM	Silty gravel/pebbles housing shell hash, sponges, crabs, cerianthids, anemones and some scattered cobbles (which contained more sponges) with fish, <i>D. albidum</i> , redfish, and scallops.

Appendix Table 1 cont.

Appendix Table 2. Details on the selected still images for annotation ($n = 1699$) per transect including average altitude, field of view (FOV), depth of image, and the distance between annotated stills. Transects are in order of sub-area from north to south (*i.e.*, from Passamaquoddy Bay to Grand Manan). For complete imagery dataset ($n = 5081$) and associated metadata, see Lawton and Teed 2025.

Transect	Number of images analyzed	% of images analyzed	Average altitude (m $\pm$ SD)	Average FOV (m ² $\pm$ SD)	Average depth (m $\pm$ SD)	Average distance to next image (m $\pm$ SD)
CON029	12	33	0.73 ($\pm$ 0.24)	0.87 ($\pm$ 0.09)	49.6 ($\pm$ 1.0)	25.3 ($\pm$ 3.5)
CON047	35	43	0.85 ($\pm$ 0.16)	0.94 ($\pm$ 0.17)	43.9 ($\pm$ 8.2)	25.3 ($\pm$ 4.2)
CON048	28	31	0.84 ($\pm$ 0.21)	0.94 ($\pm$ 0.21)	36.1 ($\pm$ 5.0)	25.3 ($\pm$ 3.3)
CON049	25	28	0.86 ($\pm$ 0.22)	0.97 ($\pm$ 0.22)	46.6 ($\pm$ 7.7)	25.4 ($\pm$ 3.0)
CON042	9	16	0.82 ($\pm$ 0.18)	0.92 ($\pm$ 0.17)	40.9 ($\pm$ 0.5)	23.3 ($\pm$ 1.9)
CON043	21	30	0.83 ($\pm$ 0.19)	0.93 ($\pm$ 0.20)	71.7 ($\pm$ 2.0)	24.6 ($\pm$ 3.1)
CON044	31	39	0.92 ($\pm$ 0.19)	0.92 ($\pm$ 0.19)	62.8 ($\pm$ 12.7)	28.0 ($\pm$ 7.0)
CON045	36	34	0.88 ($\pm$ 0.17)	0.97 ($\pm$ 0.17)	62.0 ($\pm$ 6.3)	28.7 ($\pm$ 13.8)
CON080	20	41	0.87 ($\pm$ 0.12)	0.89 ($\pm$ 0.10)	27.6 ($\pm$ 3.6)	30.9 ($\pm$ 11.2)
CON081	36	37	0.93 ($\pm$ 0.14)	0.93 ($\pm$ 0.11)	22.3 ($\pm$ 3.4)	27.7 ($\pm$ 4.1)
CON082	25	34	0.87 ($\pm$ 0.15)	0.88 ($\pm$ 0.12)	32.4 ($\pm$ 1.6)	24.8 ($\pm$ 5.4)
CON046	0	0	NA	NA	NA	NA
CON083	17	29	0.91 ($\pm$ 0.15)	0.91 ($\pm$ 0.12)	38.2 ($\pm$ 4.2)	24.0 ($\pm$ 4.3)
CON084	19	41	0.95 ($\pm$ 0.11)	0.95 ($\pm$ 0.09)	37.6 ($\pm$ 6.3)	24.6 ($\pm$ 2.0)
CON085	18	38	1.13 ($\pm$ 0.31)	1.07 ($\pm$ 0.21)	67.2 ($\pm$ 7.9)	28.0 ($\pm$ 4.2)
CON086	21	36	1.07 ($\pm$ 0.28)	1.05 ($\pm$ 0.22)	51.7 ($\pm$ 8.3)	28.8 ($\pm$ 7.3)
CON093	15	31	0.98 ($\pm$ 0.22)	0.98 ($\pm$ 0.17)	36.2 ($\pm$ 8.2)	22.4 ($\pm$ 3.0)
CON094	11	28	0.87 ($\pm$ 0.20)	0.89 ($\pm$ 0.16)	45.2 ($\pm$ 5.5)	27.7 ($\pm$ 3.9)
CON039	21	26	0.81 ($\pm$ 0.23)	0.92 ($\pm$ 0.21)	114.8 ($\pm$ 5.0)	27.3 ($\pm$ 5.1)
CON040	20	36	0.87 ($\pm$ 0.20)	0.96 ($\pm$ 0.21)	121.7 ($\pm$ 16.8)	28.8 ($\pm$ 11.8)
CON041	43	24	0.74 ($\pm$ 0.15)	0.84 ($\pm$ 0.13)	104.9 ($\pm$ 5.3)	24.0 ($\pm$ 2.8)
CON036	34	59	0.95 ($\pm$ 0.28)	1.07 ($\pm$ 0.28)	47.0 ($\pm$ 6.1)	29.1 ($\pm$ 8.6)
CON037	42	47	0.88 ($\pm$ 0.15)	0.97 ($\pm$ 0.15)	76.1 ($\pm$ 5.9)	28.3 ($\pm$ 6.2)
CON038	24	30	0.73 ($\pm$ 0.17)	0.84 ($\pm$ 0.14)	118.0 ($\pm$ 2.2)	24.4 ($\pm$ 3.4)
CON109	35	26	0.81 ($\pm$ 0.20)	0.84 ($\pm$ 0.15)	25.9 ($\pm$ 4.2)	26.2 ($\pm$ 5.6)
CON110	26	28	0.75 ($\pm$ 0.15)	0.79 ($\pm$ 0.11)	81.3 ($\pm$ 6.9)	22.2 ($\pm$ 6.2)
CON002	15	19	0.92 ($\pm$ 0.15)	1.28 ($\pm$ 0.25)	39.3 ($\pm$ 4.5)	23.3 ($\pm$ 3.7)
CON004	15	31	1.10 ($\pm$ 0.20)	1.63 ($\pm$ 0.42)	76.5 ($\pm$ 3.6)	17.5 ($\pm$ 5.9)
CON035	19	35	0.81 ($\pm$ 0.16)	0.90 ($\pm$ 0.16)	36.1 ($\pm$ 1.3)	25.1 ($\pm$ 5.0)
CON052	47	54	0.86 ($\pm$ 0.19)	0.92 ($\pm$ 0.14)	52.9 ($\pm$ 7.6)	33.1 ($\pm$ 9.7)
CON003	34	50	1.02 ($\pm$ 0.15)	1.45 ($\pm$ 0.33)	65.0 ($\pm$ 9.6)	27.8 ($\pm$ 6.5)
CON005	23	47	1.15 ($\pm$ 0.19)	1.77 ($\pm$ 0.49)	47.5 ($\pm$ 8.0)	28.1 ($\pm$ 4.7)
CON006	14	25	0.99 ($\pm$ 0.16)	1.40 ($\pm$ 0.32)	40.8 ($\pm$ 2.4)	20.6 ($\pm$ 5.9)
CON007	20	36	1.04 ($\pm$ 0.20)	1.54 ($\pm$ 0.47)	99.0 ($\pm$ 9.2)	20.7 ($\pm$ 6.2)
CON051	95	41	0.77 ($\pm$ 0.13)	0.85 ($\pm$ 0.12)	87.6 ($\pm$ 23.9)	27.0 ($\pm$ 5.3)
CON050	14	29	0.66 ($\pm$ 0.10)	0.76 ($\pm$ 0.07)	78.1 ($\pm$ 1.1)	23.7 ($\pm$ 3.3)
CON008	13	29	0.89 ($\pm$ 0.21)	1.30 ($\pm$ 0.35)	50.3 ($\pm$ 0.5)	18.0 ($\pm$ 3.2)
CON088	13	22	0.88 ($\pm$ 0.21)	0.89 ($\pm$ 0.15)	29.6 ($\pm$ 0.6)	24.0 ($\pm$ 3.3)
CON089	12	21	0.91 ($\pm$ 0.17)	0.92 ($\pm$ 0.14)	27.6 ($\pm$ 1.4)	24.1 ($\pm$ 1.7)
CON090	8	22	0.92 ($\pm$ 0.12)	0.93 ($\pm$ 0.10)	35.7 ($\pm$ 3.0)	22.6 ($\pm$ 5.8)
CON091	11	27	0.90 ($\pm$ 0.30)	0.92 ($\pm$ 0.13)	37.6 ($\pm$ 2.1)	25.1 ($\pm$ 2.3)
CON092	13	33	0.84 ($\pm$ 0.35)	0.95 ($\pm$ 0.13)	35.7 ($\pm$ 0.1)	24.3 ($\pm$ 3.7)
CON111	16	43	0.82 ($\pm$ 0.15)	0.85 ($\pm$ 0.12)	49.1 ($\pm$ 2.0)	27.8 ($\pm$ 7.2)

Transect	Number of images analyzed	% of images analyzed	Average altitude (m $\pm$ SD)	Average FOV (m ² $\pm$ SD)	Average depth (m $\pm$ SD)	Average distance to next image (m $\pm$ SD)
CON112	13	23	0.72 ($\pm$ 0.19)	0.78 ($\pm$ 0.14)	68.9 ($\pm$ 1.8)	22.3 ($\pm$ 3.4)
CON113	15	28	0.82 ($\pm$ 0.08)	0.84 ($\pm$ 0.07)	90.6 ($\pm$ 1.2)	23.9 ($\pm$ 3.1)
CON030	14	22	1.09 ($\pm$ 0.31)	1.16 ($\pm$ 0.29)	45.4 ($\pm$ 1.2)	25.5 ($\pm$ 2.6)
CON031	17	21	1.13 ($\pm$ 0.33)	1.28 ($\pm$ 0.27)	38.4 ($\pm$ 1.2)	23.5 ($\pm$ 2.3)
CON032	12	26	1.27 ($\pm$ 0.44)	1.32 ($\pm$ 0.31)	31.0 ($\pm$ 3.6)	27.4 ($\pm$ 11.9)
CON033	11	26	1.15 ($\pm$ 0.26)	1.28 ($\pm$ 0.26)	66.7 ($\pm$ 0.5)	22.3 ($\pm$ 1.6)
CON034	21	32	1.02 ($\pm$ 0.38)	1.14 ($\pm$ 0.35)	73.5 ($\pm$ 21.1)	29.9 ($\pm$ 10.2)
CON118	18	29	0.90 ($\pm$ 0.15)	0.90 ($\pm$ 0.11)	78.5 ($\pm$ 11.9)	26.0 ($\pm$ 6.2)
CON095	32	56	0.97 ($\pm$ 0.17)	0.96 ($\pm$ 0.14)	71.9 ($\pm$ 2.9)	31.1 ($\pm$ 7.1)
CON096	28	47	1.05 ($\pm$ 0.20)	1.02 ($\pm$ 0.15)	46.8 ($\pm$ 1.4)	30.9 ($\pm$ 7.9)
CON097	38	46	0.93 ($\pm$ 0.19)	0.93 ($\pm$ 0.15)	59.3 ($\pm$ 1.2)	29.6 ($\pm$ 6.6)
CON098	41	50	0.89 ($\pm$ 0.20)	0.90 ($\pm$ 0.16)	73.2 ($\pm$ 21.0)	33.3 ($\pm$ 12.6)
CON087	42	21	0.97 ($\pm$ 0.18)	0.97 ($\pm$ 0.14)	47.5 ($\pm$ 9.9)	24.2 ($\pm$ 4.5)
CON099	8	23	0.79 ($\pm$ 0.12)	0.82 ($\pm$ 0.09)	41.2 ($\pm$ 0.1)	24.1 ($\pm$ 2.7)
CON100	11	28	0.89 ($\pm$ 0.22)	0.91 ($\pm$ 0.16)	32.2 ($\pm$ 0.8)	25.2 ($\pm$ 3.6)
CON101	8	30	0.56 ($\pm$ 0.09)	0.67 ($\pm$ 0.07)	83.8 ($\pm$ 0.6)	44.2 ($\pm$ 16.2)
CON102	20	25	0.96 ($\pm$ 0.22)	0.96 ($\pm$ 0.17)	38.9 ($\pm$ 1.5)	28.9 ($\pm$ 8.4)
CON103	24	38	0.92 ($\pm$ 0.16)	0.93 ($\pm$ 0.13)	29.0 ($\pm$ 2.4)	26.4 ($\pm$ 3.3)
CON104	20	33	0.59 ($\pm$ 0.19)	0.71 ($\pm$ 0.07)	90.3 ($\pm$ 0.2)	31.9 ($\pm$ 9.2)
CON105	18	36	0.91 ($\pm$ 0.13)	0.92 ($\pm$ 0.10)	53.5 ($\pm$ 2.8)	25.0 ($\pm$ 4.9)
CON106	18	25	0.95 ($\pm$ 0.27)	0.95 ($\pm$ 0.21)	32.7 ($\pm$ 1.5)	24.9 ($\pm$ 2.8)
CON107	7	26	0.48 ($\pm$ 0.20)	0.64 ($\pm$ 0.07)	90.6 ($\pm$ 0.5)	34.2 ($\pm$ 9.9)
CON108	14	28	0.79 ($\pm$ 0.19)	0.83 ($\pm$ 0.13)	24.6 ($\pm$ 2.0)	23.4 ($\pm$ 2.4)
CON119	14	31	1.07 ($\pm$ 0.22)	1.04 ($\pm$ 0.17)	83.9 ($\pm$ 2.1)	26.6 ($\pm$ 4.6)
CON114	18	40	0.93 ($\pm$ 0.21)	0.93 ($\pm$ 0.16)	92.8 ($\pm$ 1.6)	27.5 ($\pm$ 3.9)
CON120	35	32	1.14 ($\pm$ 0.26)	1.09 ($\pm$ 0.19)	93.6 ($\pm$ 15.9)	26.3 ($\pm$ 5.1)
CON121	64	35	1.21 ($\pm$ 0.27)	1.24 ($\pm$ 0.20)	84.8 ($\pm$ 26.1)	27.4 ($\pm$ 6.3)
CON115	17	35	1.10 ($\pm$ 0.21)	1.06 ($\pm$ 0.16)	81.2 ($\pm$ 2.1)	24.0 ($\pm$ 3.5)
CON116	66	49	1.29 ($\pm$ 0.34)	1.18 ($\pm$ 0.21)	132.4 ($\pm$ 22.6)	26.0 ($\pm$ 6.6)
CON117	29	38	1.29 ($\pm$ 0.27)	1.20 ($\pm$ 0.19)	111.1 ($\pm$ 6.9)	28.6 ($\pm$ 4.8)

Appendix Table 2 cont.