A Drop Camera Survey of Port Joli, Nova Scotia

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ABSTRACT

Vandermeulen, H. 2017. A drop camera survey of Port Joli, Nova Scotia. Can. Tech. Rep. Fish. Aquat. Sci. 3215: viii + 59 p.

An underwater HD video camera on a fiber-optic umbilical was adapted into a drop camera frame with laser scale and light. The video feed was run through an overlay receiving GPS coordinates and time / date stamps from a chart plotter. Video output from the overlay was recorded direct to hard drive. The resulting drop camera system was used to survey bottom type and macrophyte cover in Port Joli, Nova Scotia. The more sheltered head of the bay consisted primarily of a sandy bottom with patchy eelgrass cover. The mouth of the bay was exposed with rocky outcrops and cobble / boulder areas covered in Irish moss and kelps. Lobsters were found scattered throughout the bay in a variety of habitats from depths of approximately 3 m to 20 m (the depth limit of the survey).

RÉSUMÉ

Vandermeulen, H. 2017. Relevé sous-marin de Port Joli, Nouvelle-Écosse. Can. Tech. Rep. Fish. Aquat. Sci. 3215: viii + 59 p.

Une caméra vidéo sous-marine à haute définition sur câble ombilical de fibre optique a été adaptée à un bâti de caméra sous-marine avec échelle laser et lampe. La vidéo était retransmise grâce à une superposition recevant les coordonnées du système de positionnement global ainsi que l'heure et le timbre dateur à partir d'un traceur de cartes. La vidéo provenant de la superposition était ensuite enregistrée directement sur le lecteur de disque dur. Le système de caméra sous-marine ainsi obtenu a permis d'étudier le type de fond et l'étendue des macrophytes à Port Joli, en Nouvelle-Écosse. La partie la plus abritée de la baie était principalement constituée d'un fond sablonneux avec une zone éparse de zostère. À l'embouchure de la baie se trouvaient des zones d'affleurements rocheux ainsi que de blocs rocheux/galets couverts de mousse perlée et de varechs. Les homards vivaient dispersés dans la baie, dans différents habitats situés entre 3 et 20 m (limite du relevé) de profondeur environ.

INTRODUCTION

In June 2016, the Oceans and Coastal Management Division (OCMD) of Maritimes Region's Ecosystem Management Branch outlined research needs for coastal Ecologically and Biologically Significant Areas (EBSAs) in Nova Scotia, including Port Joli on the Province's southwest shore (Figs. 1 & 2). OCMD stated that they would need benthic habitat characterization; fish, invertebrate and marine plant surveys to better understand the biota of the areas; and information on use by key species. The information was required to see if these areas actually fit the Oceans Act criteria and aid in defining boundaries for management.

The research needs for Port Joli included:

a. Characterize marine fauna outside eelgrass areas;
b. Need a better idea of what the fish and invert communities look like in the subtidal components of this EBSA;
c. Dive or video transects (in small boat) and habitat classifications are the priorities. Analysis needs to be done quickly.

OCMD also commented on the potential for Science Branch to do surveys in Port Joli in summer 2016, and if video transects were to be done, the analysis would need to be done quickly. As dive or video transects and habitat classifications were expressed as key priorities in the list, Science Branch needed to mobilize quickly with readily available equipment.

Dive transects to develop habitat classifications at bay-scales are impractical in general, so video transects with a transponder positioned camera were recommended for Port Joli (see Vandermeulen 2014a & b). However, a nearshore transponder based video camera was not available for use. To meet OCMD's deadline, Science Branch revamped an existing HD-SDI underwater video camera for drop camera deployment.

Drop camera surveys have some limitations in their ability to discern benthic habitat features at larger scales as compared to transponder positioned towed camera surveys (Vandermeulen 2014a). That being said, a drop camera survey in Port Joli was deemed capable of classifying benthic habitat features at the bay-scale with a proper sampling grid.

The Port Joli drop camera survey was performed in September and October 2016. A GIS package was created from the survey results and is also described here.

2.0 MATERIALS AND METHODS

2.1 GIS and Survey Design

The GIS platform was ArcGIS (ver. 10.2.2). Drop camera targets were inserted into the GIS with a hydrographic chart background[1]. The intention was to survey the entire Port Joli bay from Wreck Point to Port Joli Head down to the 20 m contour line, not including the very shallow (<0.5 m) head of the bay where the draft of the survey vessel limited deployment. The survey area (approximately 40,000,000 m^2) included a range of wave exposures (sheltered mud flats; exposed head lands), and a range of depths (shoreline to 20 m). Drop camera locations were chosen in the GIS at 2 (or 3 depending upon site), 5, 10 and 20 m depths arranged along sight lines perpendicular to shore which were about 500 m apart. Additional targets were added in the GIS to fill in gaps at various depths (Fig. 3, Table 1, a total of 106 drop targets). With this sampling grid, the shallower subtidal portions of the bay had a higher density of drop camera sampling points compared to the deeper sites. This ensured that the more heterogeneous habitat patches in the nearshore were properly captured. The 500 m sight line separation was chosen from previous experience in similar bays. With this drop camera grid survey design, the following benthic habitat features were potentially identifiable at bay-scales:

- Mud or sand flats;
- Gravel beds;
- Cobble and boulder fields;
- Bedrock ledges or reefs;
- Larger sedentary benthic invertebrate aggregations, reefs or bioherms (e.g. urchins, oysters, tunicates, scallops, etc.);
- Macrophyte beds including eelgrass and kelps.

Note that these habitat features include locations that could be used by fish or mobile invertebrates (e.g. lobsters) for spawning, foraging or safe passage. However, the drop camera system and survey could not properly assess the presence / densities of mobile invertebrates or fish. There are a variety of reasons for this limitation, including the downward view of the camera, inability to tow, and limitations on bay-scale sampling grid size due to deployment issues. These drawbacks are corrected via shallow water transponder positioned towed camera systems – which are not available at BIO at the present time.

2.2 Equipment

A 22' Cape Sable style Rosborough custom wheelhouse research vessel was used as described in Vandermeulen (2007). The electronics were powered by a deep cycle

[1] The GIS project described in this report is being maintained by OCMD and is accessible for further analysis and exploration.

battery run in parallel with two power inverters[2]. Navigation was provided by a Garmin 1020 chart plotter with CHS charts. An external GPS antenna was mounted on the working deck davit post and fed back to the chart plotter using an NMEA 2000 cable. WAAS correction was applied by the chart plotter to provide a precision of approximately 3 m. Drop camera targets from the GIS were labeled and embedded into the chart plotter.

The chart plotter was connected to the remaining electronics as shown in Figure 4. The SDI feed from the HD video camera (SV-HD SDI; Shark Marine Technologies Inc., St. Catharines, Ontario) went to the video overlay (Proteus II; VideoLogix Inc., Irvine, California) where it received positional and time / date stamp data from the chart plotter. The overlay then sent the completed video feed to a direct to disk HD recorder (Atomos Samurai; Atomos Global Pty. Ltd., Port Melbourne, Australia) and a standard low power 19" LED TV.

Figure 5 shows a clutch block mounted on the vessels davit post holding the camera's 45 m long fibre-op umbilical cable. Note how the block is mounted just below the GPS antenna, ensuring that the camera will be within the 3 m precision 'envelope' of the GPS when the cable is vertical during drop camera deployment. The clutch block is described in Vandermeulen (2011).

The HD video camera was deployed as a drop camera by the construction of a tubular stainless steel frame (Fig. 6). The frame measured 42 cm in diameter by 38 cm in height and was attached to the umbilical Kellem grip via a tall V-shaped yoke measuring 74 cm in height with a terminating eye and large shackle. The total weight of the frame and the yoke less electronics was 17.5 kg, ensuring adequate mass for vertical deployment in moderate current and waves.The main components of the drop camera system in the frame were camera, 10 cm laser scale[3], and light[4] – all mounted in a downward looking vertical view (Fig. 7).

The configuration of the electronics within the wheelhouse is shown in Fig. 8. The camera control box provided power to the umbilical and received the fiber optical video feed from the camera which was converted into a standard SDI signal for the video overlay. The chart plotter at the wheel guided the helmsman to targets, while the LED TV allowed the deck hand to view the video in real time.

2.3 Survey Methods

All field work was completed with a crew of two - helmsperson and a drop camera operator (deck hand). The helmsperson was responsible for reaching the drop targets, turning on the camera and light, and controlling the video recording device. The drop camera operator held the umbilical cable and raised or lowered the drop camera frame as required. The clutch block held some of the strain from the cable but the operator still required a great deal of skill and stamina to keep the camera frame approximately 30 cm off the bottom while watching the LED TV while standing in the wheelhouse door.

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[2] Moto Master Eliminator™ 700W.
[3] Semiconductor lasers, 650nm, 7.5 mW (Shark Marine Technologies Inc.)
[4] SV-Q10K halogen light, 250W (Shark Marine Technologies Inc.)

Approximately 3 minutes of video was recorded at each drop camera location. The vessel was allowed to drift in the wind and current while recording as long as the umbilical cable remained in a vertical position off of the clutch block. The engines were engaged if the cable angled significantly off vertical, but this was rare. In this manner, the shallow water targets were held within an accuracy radius of approximately 3 m on the Garmin based GPS position. However, the accuracy radius on deeper targets with poor cable angle was approximately 10 m on GPS position. These differences in accuracy were not accounted for in subsequent video analyses or in the GIS.

Due to a lack of boat access sites in Port Joli, we launched at Port Mouton each day, with a travel time of approximately one hour to reach Port Joli (a distance of approximately 20 km, see Fig. 1). The route traversed an exposed series of headlands which prevented bay access during poor weather.

The survey was conducted on September 24, 25, and 26, 2016. A period of foul weather then prevented access and the survey was completed on October 6, 2016.

2.4 Historical Surveys

The author was informed of several past surveys in Port Joli:

- Moore and Miller (1983) provided numerous transect-based SCUBA observations along the Atlantic coast of Nova Scotia. They describe one transect on the eastern shore of Port Joli.
- Brothers (1997) ran 32 transects for a SCUBA survey within Port Joli during the summer of 1996.
- The Canadian Parks and Wilderness Society (CPAWS) undertook a number of SCUBA transects in Port Joli in the summer of 2009 (Ashley Sprague, pers. comm.).

The exact location of some of these transects were not clear, and they were not included in our analysis. However, the remaining transect coordinates that were logically consistent were embedded into the GIS (Figs. 9 – 14).

2.5 Video Analysis

The video clips were embedded into the GIS at the drop camera locations. They were then analyzed for bottom type, macrophyte cover and the presence of lobsters. Example screen shots are shown in figures 15 – 24. The typical ‘field of view’ for these downward perspective images is approximately 1 m across. The video analysis was presence / absence rather than quantitative.

3.0 RESULTS

3.1 Benthic Classification

The benthic classification arising from the video analysis is summarized in Table 2.

Substrates

A sandy substrate predominated throughout the bay from the shallows right to 20 m (Fig. 25). The sand was particularly clean looking and well sorted, with prominent wave induced sand ripples in the shallows (depths less than 10 m). Gravel deposits were common in the lower half of the bay and its mouth (Fig. 26). This is consistent with stronger currents and wave strength observed in this region during the survey. Cobble and boulder deposits quite closely matched gravel locations, and for similar reasons (Fig. 27). Massive formations of solid rock occurred as ledges along the western side of the mouth of the bay, a region of very exposed shoreline (Fig. 28).

Macrophytes

Zostera marina was found on sandy or gravel substrates in the upper shallower portions of the bay (Fig. 29). No consistent large bed of eelgrass was discovered, it always occurred as small patches. The leaves were quite clear of epiphytes, although clumps of filamentous algae were seen consistently at the base of the leaves.

Irish moss (*Chondrus*) was found on harder substrates to depths of 10 m (Fig. 30). The thalli occurred as large bushy clumps, and some tip bleaching was seen. The plants were a dominant cover on suitable substrates and an active commercial harvest of Irish moss does occur in this bay.

Fucus was present on rocky substrates along the more sheltered eastern side of the bay (Fig. 31). Interestingly, *Chaetomorpha* partially shared the same locations as *Fucus* but also occurred on the western side of the bay (Fig. 32). This local green alga is increasing in abundance along the Atlantic coast of Nova Scotia in recent years.

“Green turf” is a collection of green seaweeds commonly found in Nova Scotia (Table 2). These seaweeds were also predominantly found along the more sheltered eastern side of the mouth of the bay (Fig. 33).

“Red turf” are members of the Rhodophyta encompassing a wide range of species (Table 2). They could be found at almost any depth on any hard surface in the bay (Fig. 34). The kelp species associated with *Saccharina* had a similar distribution (Fig. 35).

The other kelp genus seen in the bay, *Laminaria*, had a slightly more restricted distribution than *Saccharina* (Fig. 36). *Laminaria* tends to be restricted to areas with strong currents or wave action. The brown alga *Desmarestia* had a somewhat similar distribution to *Laminaria* (Fig. 37). In the author’s experience, *Desmarestia aculeata* tends to occur on rocks in slightly deeper waters which are occasionally scoured by sand movement. *Desmarestia viridis* tends to occur in shallower areas. Figure 38 shows the distribution of the third kelp genus in the bay, *Agarum*. This alga prefers deeper water and was always found at depths of 5 m or greater.

The coralline algae found in the bay represented a variety of species (Table 2). They were widely distributed on hard substrates within the bay (Fig. 39).

Benthic Invertebrates

Invertebrates were difficult to discern in the video as many are quite small, and cryptic. Also, larger accumulations of invertebrates such as mussel beds or aggregations of sea urchins were not found. The only larger macro invertebrate commonly observed was the American lobster (Fig. 40). It was seen on almost any substrate at depths of 3 m or greater. Some rock crabs were observed on sandy substrates in the shallows in less than 3 m of water.

3.2 Correspondence with Historical Surveys

Some of the drop camera locations were quite close to previous observations in the bay (Figs. 41 - 44). For example, drop location 17@3m was placed very close to Brothers (1997) transect number 11 (Fig. 41). In our drop camera analysis this site was dominated by sand with patches of *Zostera*. Brothers (1997) described exactly the same in his observations at the site during the summer of 1996, including the presence of filamentous algae. This suggests the presence of a population of eelgrass at the site for at least 20 years.

There were four other Brothers (1997) transects in this area of the bay which were within 200 m of our drop camera locations (Fig. 41):

- Transect #27 near 31@2m – our observation indicated bare sand at this location, while Brothers (1997) found sand with patches of eelgrass.
- Transect #28 near 32@2m - our observations at the site include a sand and gravel mix with kelps and Irish moss and *Zostera.* Brothers (1997) recorded a very similar type of bottom at that depth, including the presence of *Zostera*. He did not find seaweeds on the gravel.
- Transect #29 near 33@3m - this drop camera location indicated sand with *Zostera* cover and Brothers (1997) record the same.
- Transect #10 near 15@3m - Brothers (1997) recorded a sand bottom in this area but no eelgrass. The drop camera video showed sand with patches of *Zostera.*

Transect PJ_7 from the 2009 CPAWS survey was within 250 m of 16@3m at similar depth (Fig. 41). The drop camera video showed sand with patches of *Zostera*, and the seven year old transect observations were the same (Table 3).

Moore and Miller (1983) transect #67 was close to drop camera locations 37@3m and 37@5m (Fig. 42). They describe a boulder bottom with *Saccharina*, *Laminaria* and filamentous algae at a depth of approximately 5 m. This is consistent with our observations at the two drop camera sites, plus the presence of *Chondrus*. Brothers (1997) transect 31 is in the same area, and he also noted a boulder bottom with *Saccharina*, *Laminaria* and *Chondrus* to a depth of 4 m with gravel predominating at greater depths. These observations indicate a consistent macrophyte community at this site for over 30 years.

Brothers (1997) transect # 30 was close to drop camera location 35@5m (Fig. 42). His description of the transect was almost identical to transect #31, although we only found sand at this drop camera location. In the same region of the bay but on the west side, Brothers (1997) transect #6 is described as a bedrock and boulder bottom with *Laminaria*, *Saccharina* and *Chondrus* to a depth of about 8 m. Adjacent to this transect are drop camera locations 11@3m and 11@5m (Fig. 42). Bottom type and macrophyte cover at these drop sites match the transect observations.

Another Brothers (1997) transect matching a drop camera location was #2 beside 8@3m (Fig. 43). Both sets of observations are consistent in terms of substrate; a mix of boulders, cobble and sand. However, Brothers (1997) saw *Zostera* at this site while we did not; and we observed *Chondrus*, *Laminaria* and *Chaetomorpha* while he did not.

Finally, drop camera locations 39@3m and 39@5m occurred near two CPAWS transects and Brothers (1997) #32 (Fig. 44). Both drop camera sites indicate a cobble or boulder bottom with varying amounts of gravel and sand. This matches the CPAWS observations (Table 3) and is consistent with Brothers (1997) designation of a boulder and gravel bottom in this area. We noted *Chondrus*, *Laminaria* and *Saccharina* in the drop camera video; which is also consistent with the observations from the other two studies.

DISCUSSION

The drop camera survey of Port Joli did capture major habitat features at the bay-scale[5]. The shallower upper half of the bay held a sandy substrate with patchy *Zostera* growth[6], while the deeper more exposed lower half of the bay consisted of a more complex set of substrates dominated by cobble or boulder fields. All hard surfaces in the bay were covered by seaweeds, with *Chondrus* dominating in shallower waters. The kelps were also well represented, with species of *Laminaria*, *Saccharina* and *Agarum*.

The green alga *Chaetomorpha* is very striking in appearance and easily noticed by SCUBA divers (see Fig. 20). However, neither Moore and Miller (1983) nor Brothers (1997) comment upon this alga. The CPAWS divers noted something they called ‘green grass’ which was a separate entity from *Zostera* (Table 3). Green grass is certainly an apt description of *Chaetomorpha*, and if the CPAWS divers truly saw this genus in 2009 it fits a pattern the author has noted – this local green seaweed is becoming more abundant along the Atlantic coast of Nova Scotia in recent years.

[5] While our observations did not include the smaller macro-invertebrates, Brothers (1997) and CPAWS (Table 3) observations do provide some information on this group of organisms.

[6] The patchy growth pattern is normal when currents and sand movement may prevent the establishment of continuous beds (Vandermeulen 2005). The only location in Port Joli with dense eelgrass beds appears to be in the very shallow area at the head of the bay, reaching down along the western shore – this is a region not covered by our survey but described in a draft report by the Nova Scotia Department of Natural Resources in 2010 (Derek Fenton, pers. comm.).

Overall, the macrophytes observed in the bay were clean, vibrant and abundant. Past SCUBA based observations near our present drop camera sites indicate little change in the situation over the past 30 years. This is an important observation, as the author has seen disturbance in macrophyte communities in other Nova Scotia bays over the last decade:

- earlier seasonal decline of kelp populations (thallus deterioration in the early summer rather than late summer) possibly due to elevated surface temperatures driven by climate change;
- localized evidence of eutrophication (personal observations and local residents complaining of nuisance blooms of algae – filamentous red algae, *Pilayella* and *Ulva*);
- mats of Beggiatoa in the shallows where none were seen in recent memory (an indicator of anoxia, and eutrophication);
- heavily epiphytized blades of *Zostera* (an indicator of eutrophication, Vandermeulen 2005; 2014b);
- an increasing in abundance of some algal genera which are normally relatively rare (*Colpomenia*, *Chaetomorpha*) – possibly driven by climate change.

The very fact that Port Joli does not seem to show any of these signs of deterioration to any great extent is encouraging. The bay may be naturally resilient to the effects of climate change due to the lack of major river inputs and offshore influences in its water column[7]. These same influences may also reduce the bays susceptibility to eutrophication.

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Max Westhead at the Oceans and Coastal Management Division (OCMD) provided financial support for equipment development and the survey. Claudio DiBacco (Science Branch) provided financial support and staff time to complete the survey. Derek Fenton (OCMD) offered background information on other historical survey activities in the bay. WeldPro Ltd. (Dartmouth, Nova Scotia) assembled the camera frame. The field assistance of Mat Lawson is appreciated.

[7] Gregory et al. (1993) note that the tidal volume to freshwater discharge volume ratio for Port Joli is 499, this is a high end ratio indicating a low influence of riverine discharge. Compare this to ratios for more estuarine bays such as Ecum Secum (93) or Sheet Harbour (35). Also, the salt water tidal flushing time for Port Joli is only 47 h, further evidence of marine influences in the water column (Gregory et al. 1993). There is frequent upwelling in the area which moderates extreme water temperatures (Adam Drozdowski, pers. comm.). Greenlaw et al. (2011) classified Port Joli as a ‘complex intermediate bay’; meaning a complex bay structure in terms of a range of depths and exposures, productivity intermediate between benthic and pelagic sources, and a bay form (rather than an estuary or small cove).

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Table 1. Geographic coordinates of drop camera locations.

latitude	longitude	name
43.79736373	-64.88518544	1@3m
43.79717999	-64.88432296	1@5m
43.79687375	-64.88268258	1@10m
43.79541606	-64.87630704	1@20m
43.80058519	-64.88435679	2@3m
43.80015649	-64.88244582	2@5m
43.79983802	-64.88124512	2@10m
43.79825792	-64.87512326	2@20m
43.80371795	-64.88348062	3@3m
43.80342453	-64.88242727	3@5m
43.80259121	-64.87897551	3@10m
43.79973905	-64.86725898	3@20m
43.80707457	-64.88411263	4@3m
43.80688679	-64.88336718	4@5m
43.80565448	-64.87748461	4@10m
43.80334026	-64.86635099	4@20m
43.81017401	-64.8860019	5@3m
43.81013383	-64.88558574	5@5m
43.80942059	-64.87284574	5@10m
43.81312113	-64.88835771	6@3m
43.81300572	-64.88741281	6@5m
43.81214836	-64.88091237	6@10m
43.81619449	-64.89000061	7@3m
43.81600816	-64.88802219	7@5m
43.81943292	-64.89074659	8@3m
43.81840035	-64.88768052	8@5m
43.81295324	-64.87345539	8@10m
43.82160126	-64.8871814	9@3m

43.82041385	-64.88586227	9@5m
43.8146055	-64.87930231	9@10m
43.8177808	-64.87748406	10@3m
43.81741939	-64.87705624	10@5m
43.81592211	-64.87481017	10@10m
43.82402764	-64.87712754	11@3m
43.82358884	-64.87655711	11@5m
43.81695472	-64.86910585	11@10m
43.81550995	-64.8838345	7@X1
43.82045126	-64.87252229	11@X1
43.82743773	-64.87642024	12@3m
43.82602673	-64.87123882	12@5m
43.83034371	-64.87415337	13@3m
43.82907904	-64.87176469	13@5m
43.83331171	-64.87547249	14@3m
43.83209872	-64.87247773	14@5m
43.83633117	-64.87611423	15@3m
43.83455048	-64.87105165	15@5m
43.83960853	-64.87686292	16@3m
43.8385505	-64.87276294	16@X1
43.84244704	-64.8765064	17@3m
43.84169872	-64.87212121	17@X1
43.84536282	-64.87522293	18@3m
43.84482096	-64.87165773	18@X1
43.84814945	-64.87693422	19@3m
43.84760762	-64.87201425	19@X1
43.85137456	-64.87729074	20@3m
43.85091016	-64.87283425	20@X1
43.8543157	-64.878289	21@3m
43.85656016	-64.8811055	22@2m
43.85756627	-64.88495591	23@2m

43.86040392	-64.88720199	24@2m
43.85976104	-64.8811915	25@2m
43.85863287	-64.87695129	26@2m
43.85735332	-64.87225474	27@2m
43.85472536	-64.86963076	28@2m
43.85533076	-64.8733956	28@X1
43.85187367	-64.8669426	29@2m
43.848812	-64.8664197	30@2m
43.84545774	-64.86734665	31@2m
43.842757	-64.86504116	32@2m
43.83888629	-64.86458957	33@3m
43.83850781	-64.86808346	33@X1
43.83635729	-64.8626406	34@3m
43.83499812	-64.8656829	34@5m
43.83298512	-64.86197509	35@3m
43.83255498	-64.86352001	35@5m
43.83143661	-64.8675368	35@X1
43.83061072	-64.86154727	36@3m
43.83036984	-64.86240292	36@5m
43.82928584	-64.86677622	36@X1
43.82827064	-64.86073916	37@3m
43.82799533	-64.86176118	37@5m
43.82685967	-64.86611072	37@X1
43.82503137	-64.85944083	38@3m
43.82460118	-64.86030242	38@5m
43.82229958	-64.86585818	38@X1
43.82148217	-64.85869808	39@3m
43.82096591	-64.85950025	39@5m
43.8196322	-64.86149082	39@10m
43.81802741	-64.85739679	40@3m
43.81756274	-64.85775331	40@5m

43.81694318	-64.85818113	40@10m
43.8101276	-64.86331501	40@X1
43.81797578	-64.8530116	41@3m
43.81430998	-64.85393855	41@5m
43.81118613	-64.85458028	41@10m
43.80090982	-64.85689766	41@20m
43.81831137	-64.84876901	42@3m
43.81598802	-64.84869771	42@5m
43.80937887	-64.84812728	42@10m
43.8024333	-64.84734293	42@20m
43.81461117	-64.84412237	43@3m
43.81354409	-64.84388469	43@5m
43.81120334	-64.84340933	43@10m
43.812477	-64.83927371	44@3m
43.81123777	-64.8386082	44@5m
43.80896577	-64.83751488	44@10m

Table 2. Benthic classification.

Category	**details**
Substrate	
sand	
gravel	
cobble / boulder	10 cm and larger
ledge	larger blocks of rock
Macrophyte	
coralline[8]	*Corallina officinalis* L.; *Lithothamnion glaciale* Kjellman; *Clathromorphum circumscriptum* (Strömfelt) Foslie; *Phymatolithon* spp.
red turf[8]	*Phycodrys rubens* (L.) Batters; *Palmaria palmata* (L.) F. Weber & D. Mohr; *Ptilota serrata* Kützing; *Phyllophora pseudoceranoides* (S.G. Gmelin) Newroth & A.R.A. Taylor; *Bonnemaisonia hamifera* Hariot; *Ceramium* spp.; *Antithamnion* spp.; *Polysiphonia* spp.; and similar
Chondrus	*Chondrus crispus* Stackhouse
Saccharina	*Saccharina latissima* (L.) C.E. Lane, C. Mayes, Druehl & G.W. Saunders; *S. nigripes* (J. Agardh) Lontin & G.W. Saunders
Laminaria	*Laminaria digitata* (Hudson) J.V. Lamouroux
Agarum	*Agarum clathratum* Dumortier
Desmarestia	*Desmarestia viridis* (O.F. Müller) J.V. Lamouroux; *D. aculeata* (L.) J.V. Lamouroux
Chaetomorpha	*Chaetomorpha melagonium* (F. Weber & D. Mohr) Kützing
green turf[8]	*Cladophora* spp.; *Acrosiphonia arcta* (Dillwyn) Gain; *Ulothrix flacca* (Dillwyn) Thuret; *Codium fragile* ssp. *fragile* (Suringar) Hariot; *Rhizoclonium tortuosum* (Dillwyn) Kützing; *Ulva* spp.; and similar
Fucus[8]	*Fucus distichus* Linnaeus; *F. vesiculosus* Linnaeus
Zostera	*Zostera marina* Linnaeus
Invertebrate	
lobster	*Homarus americanus* H. Milne Edwards

[8] Grab samples required to confirm species listed in 'details'.

Table 3. Summary of CPAWS 2009 transects.

name	mud	sand	gravel	cobble	boulder	eelgrass	Irish moss	Rockweed[9]	kelp	sea colander[10]	fine sour weed[11]	encrusting alga[12]	branched coralline[13]	other red algae	green grass[14]	rock crab	green crab	hermit crab	lobster	sand shrimp	copepod	periwinkle	dog whelk	mussel	tube worm
PJ_7		X				X										X		X	X	X					
PJ_9		X				X										X		X	X	X					X
PJ_10	X					X											X			X	X	X		X	X
PJ_11		X														X	X								X
PJ_13		X				X										X	X			X		X			
PJ_14		X				X											X			X	X	X	X		
PJ_16		X				X										X	X		X	X					
PJ_18		X														X			X						
PJ_19		X		X	X		X	X	X	X	X	X	X	X	X	X			X			X	X	X	
PJ_20		X	X	X	X		X	X	X		X	X	X	X	X	X		X	X			X			
PJ_22		X		X	X		X		X	X		X	X		X				X				X		

[9] Most likely *Fucus* spp.
[10] *Agarum*
[11] Most likely *Desmarestia viridis*
[12] Most likely crustose coralline algae such as *Lithothamnion*
[13] *Corallina* sp.
[14] Possibly *Chaetomorpha* spp.

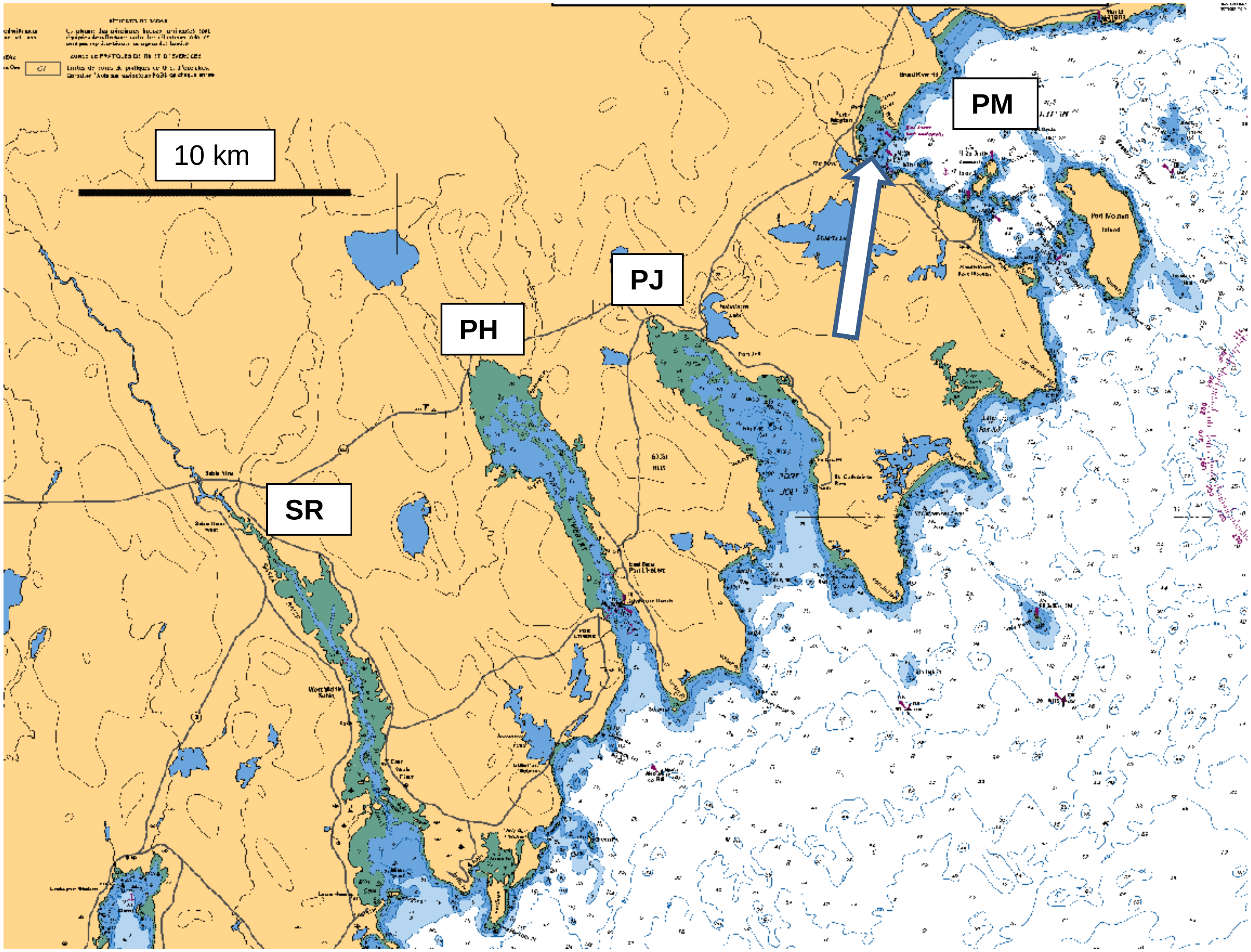

Figure 1: Port Joli area. **PM** – Port Mouton, **PJ** – Port Joli, **PH** – Port L' Hebert, **SR** – Sable River Bay. Boat launch (arrow)

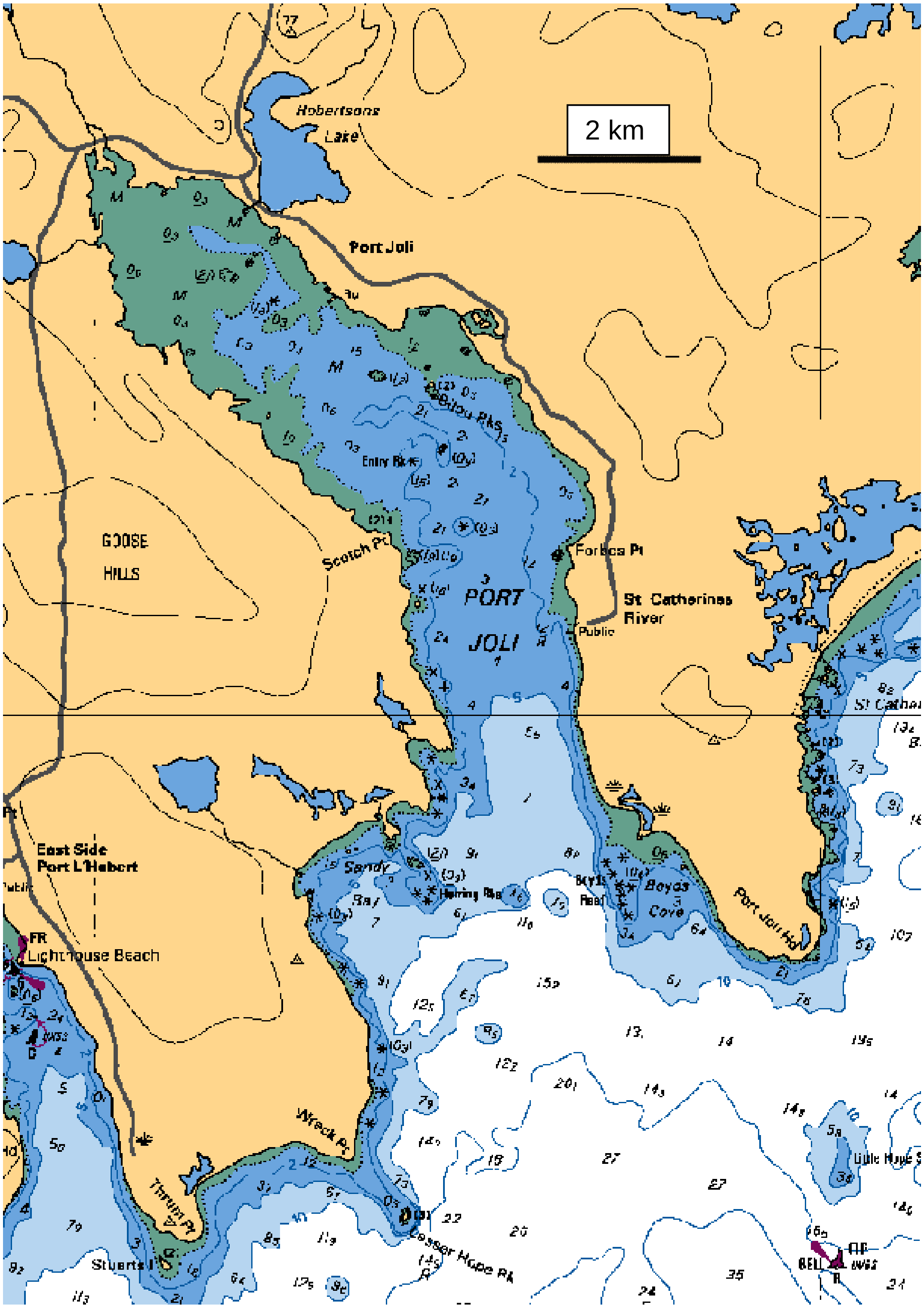

Figure 2: Bathymetry for Port Joli (depth in meters, from Canadian Hydrographic Service chart imagery).

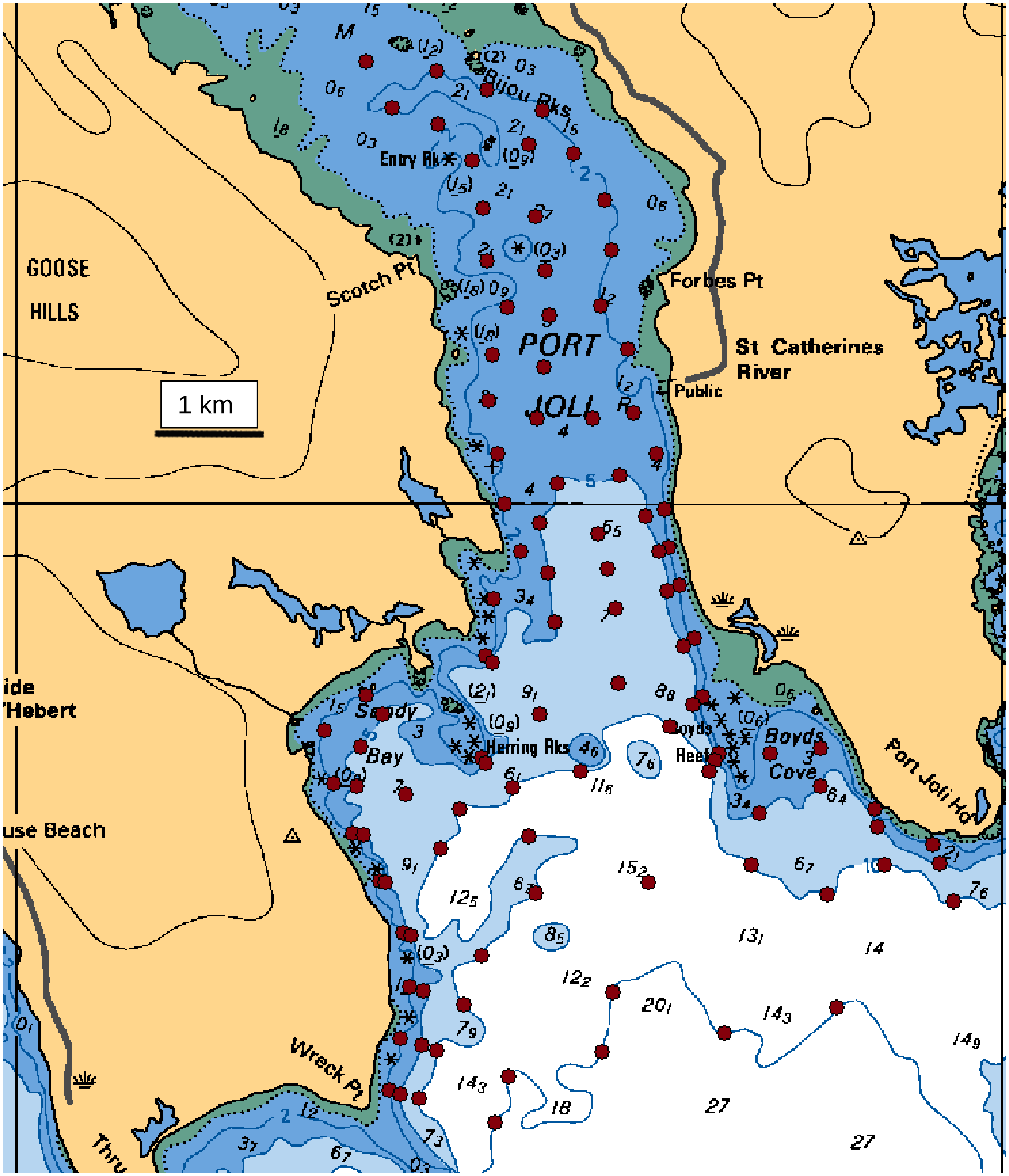

Figure 3: Port Joli drop camera locations (red dots).

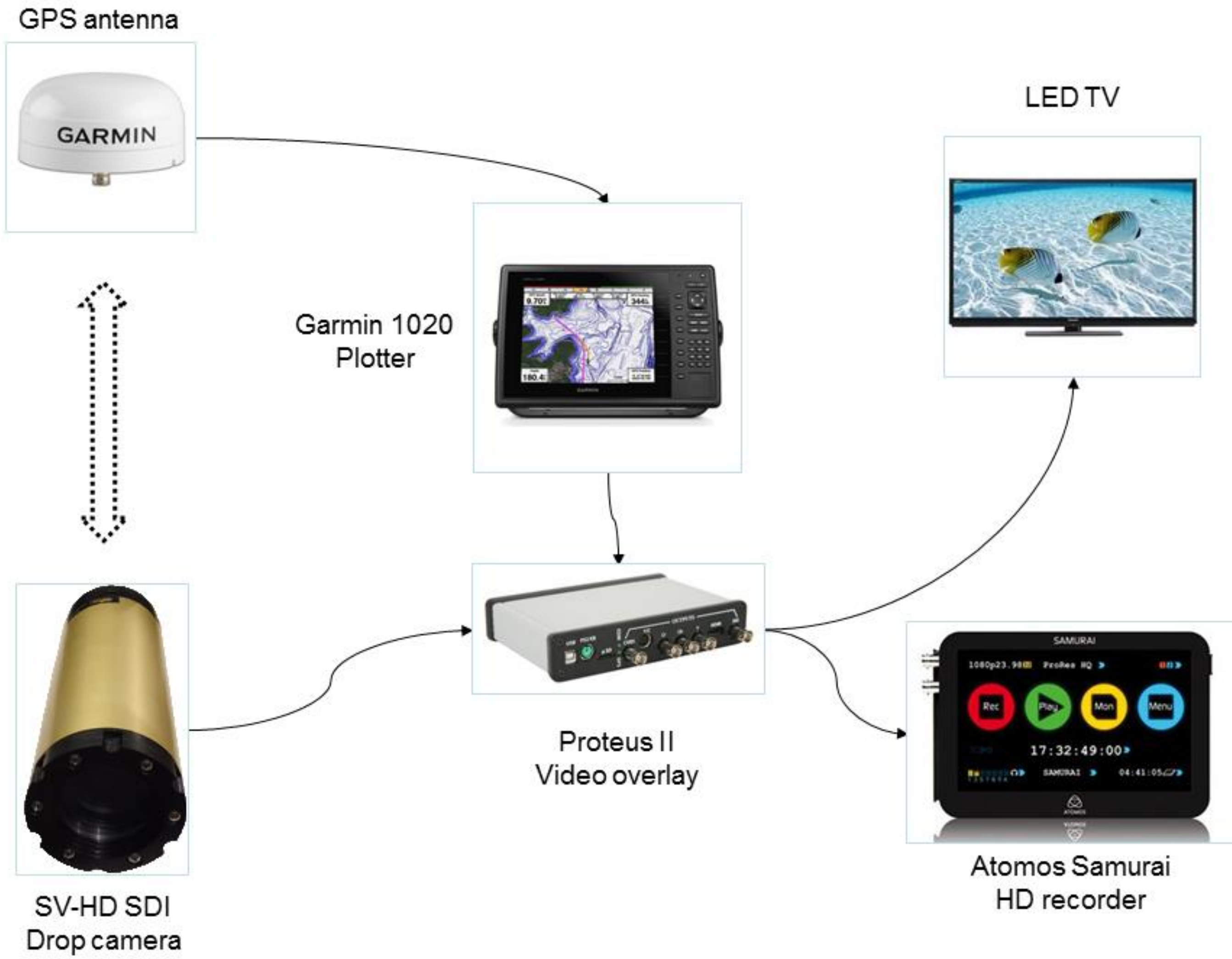

Figure 4: Electronics wiring. Dotted arrow bar indicates vertical alignment of drop camera and GPS antenna.

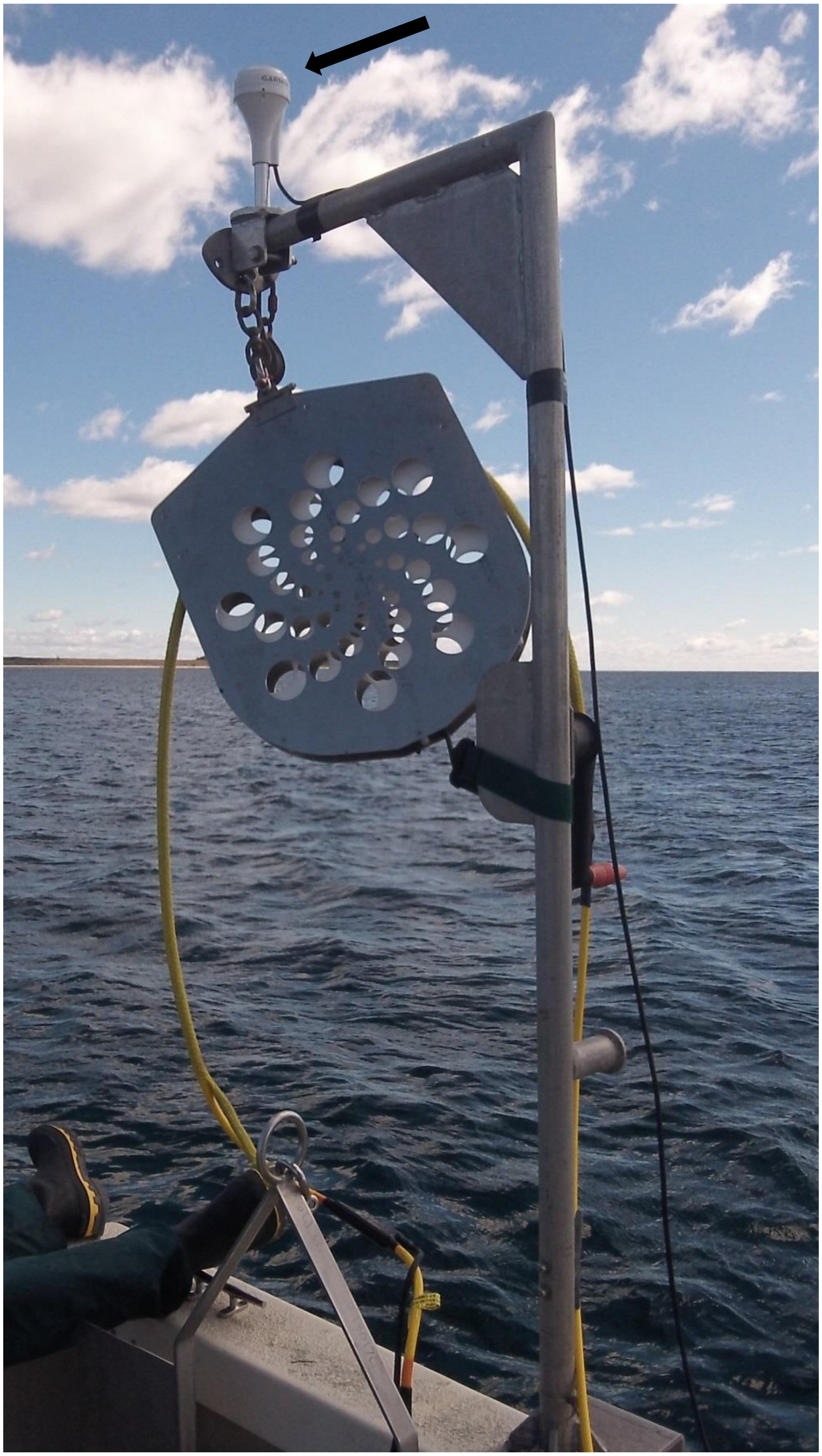

Figure 5: Davit post swung in for steaming. Custom clutch block holding yellow drop camera cable. GPS antenna (arrow) on davit post at connection with clutch block.

Figure 6: Camera frame.

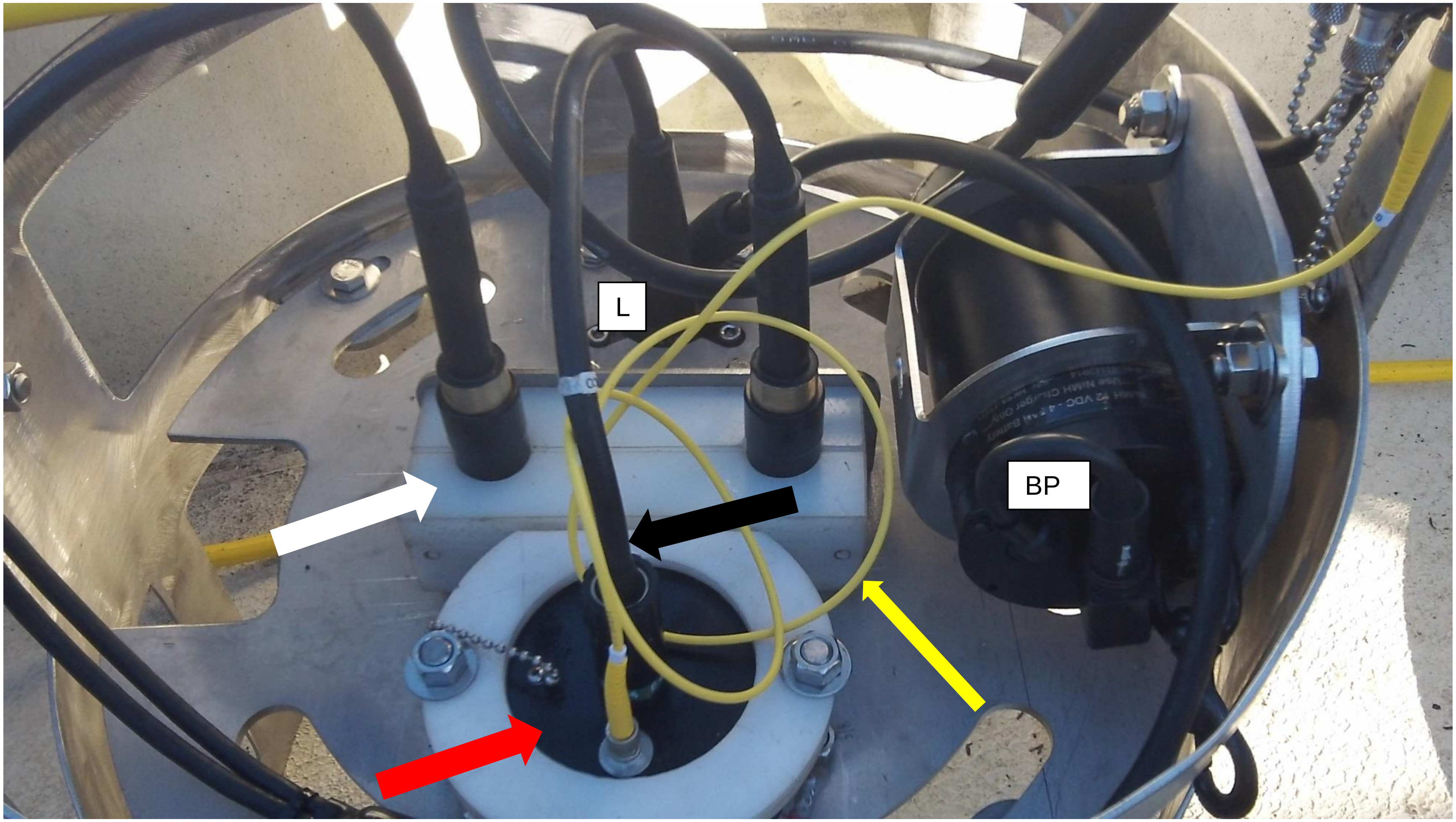

Figure 7: Detail on top of camera frame. Camera bolted into tube holder (red arrow); camera power and control line (black arrow); fibre-op line from camera to umbilical cable (yellow arrow); scale block with lasers (white arrow); light (L); laser battery pack (BP).

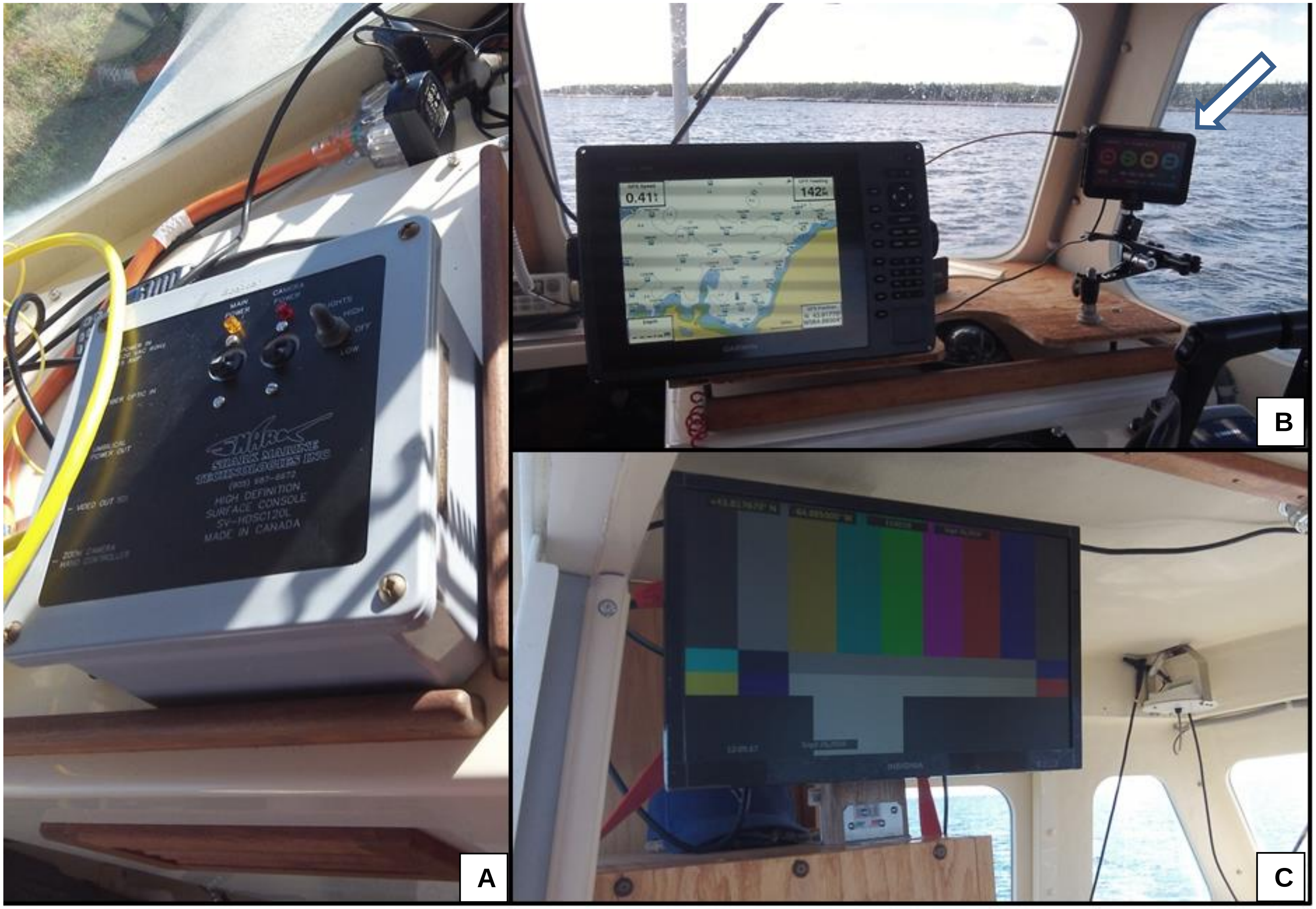

Figure 8: Electronics in wheelhouse. **A** – Camera control box; **B** – Garmin chart plotter with drop camera target points and Atomos HD recorder (arrow); **C** – LED TV.

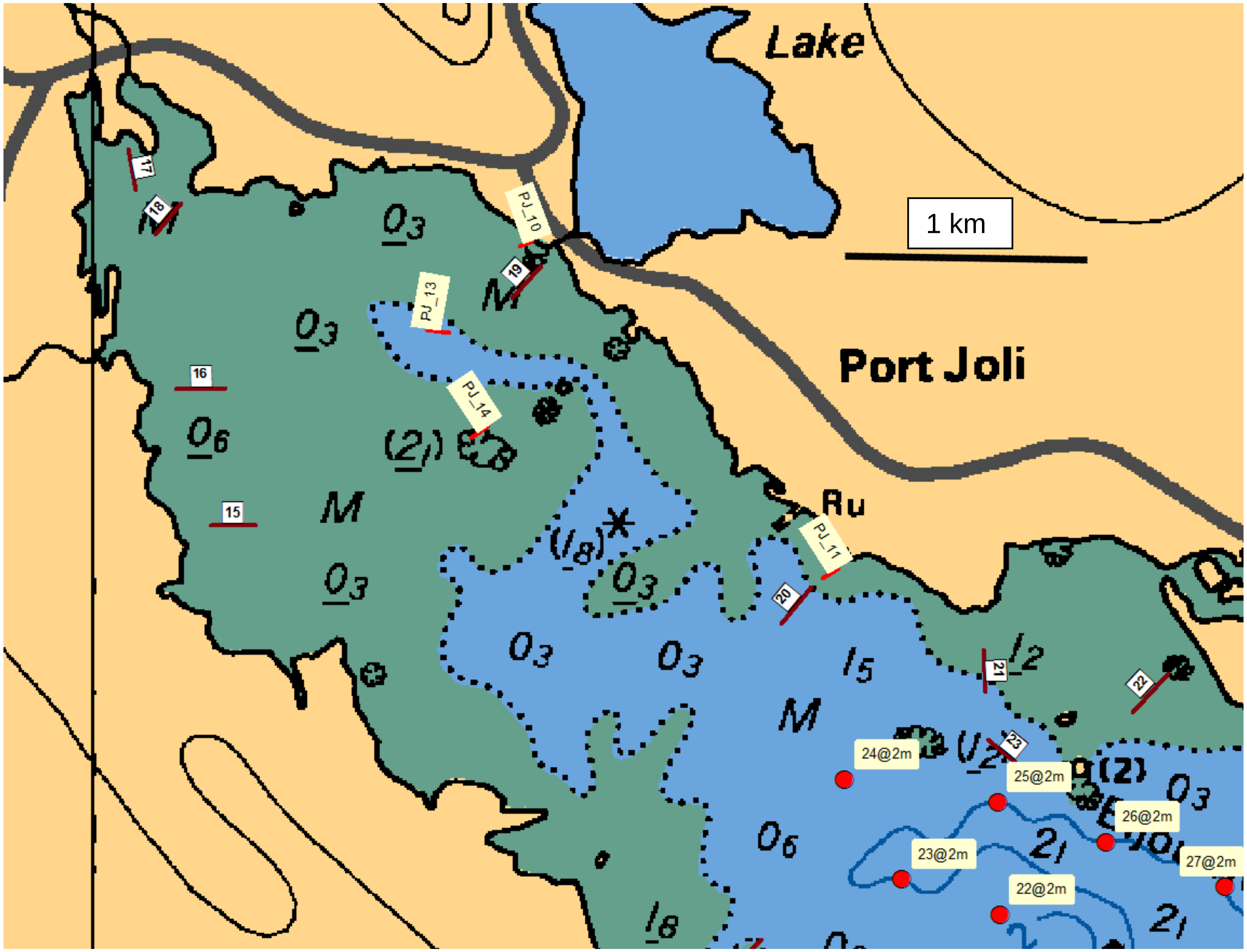

Figure 9: Detail for upper (north) end of bay. Drop camera locations as labeled light red dots (see Table 1). Approximate locations of transects from Brothers 1997 as labeled brown lines. Approximate locations of transects from CPAWS 2009 as labeled light red lines.

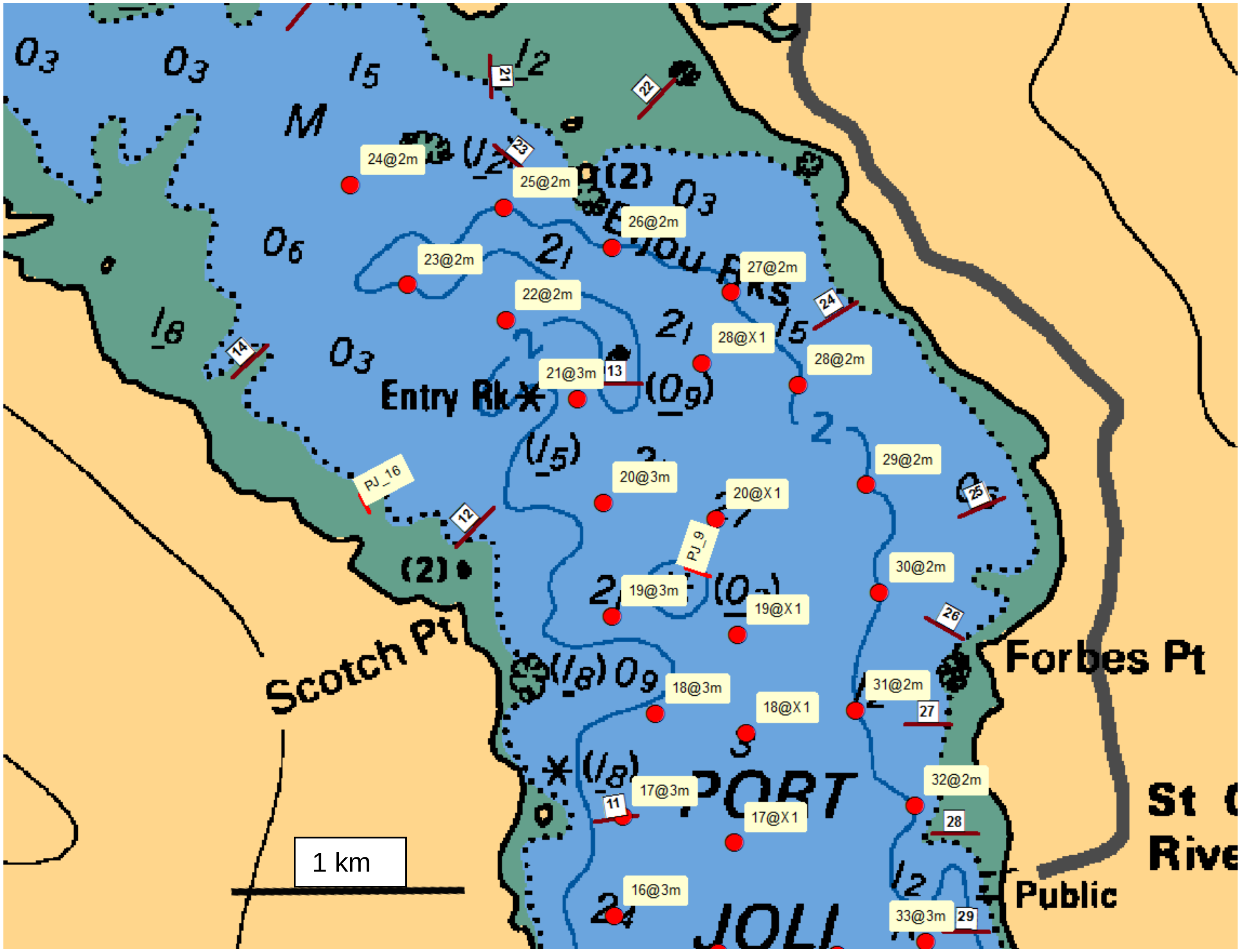

Figure 10: Detail for shallow mid-section of bay. Marks and labels as in Fig. 9.

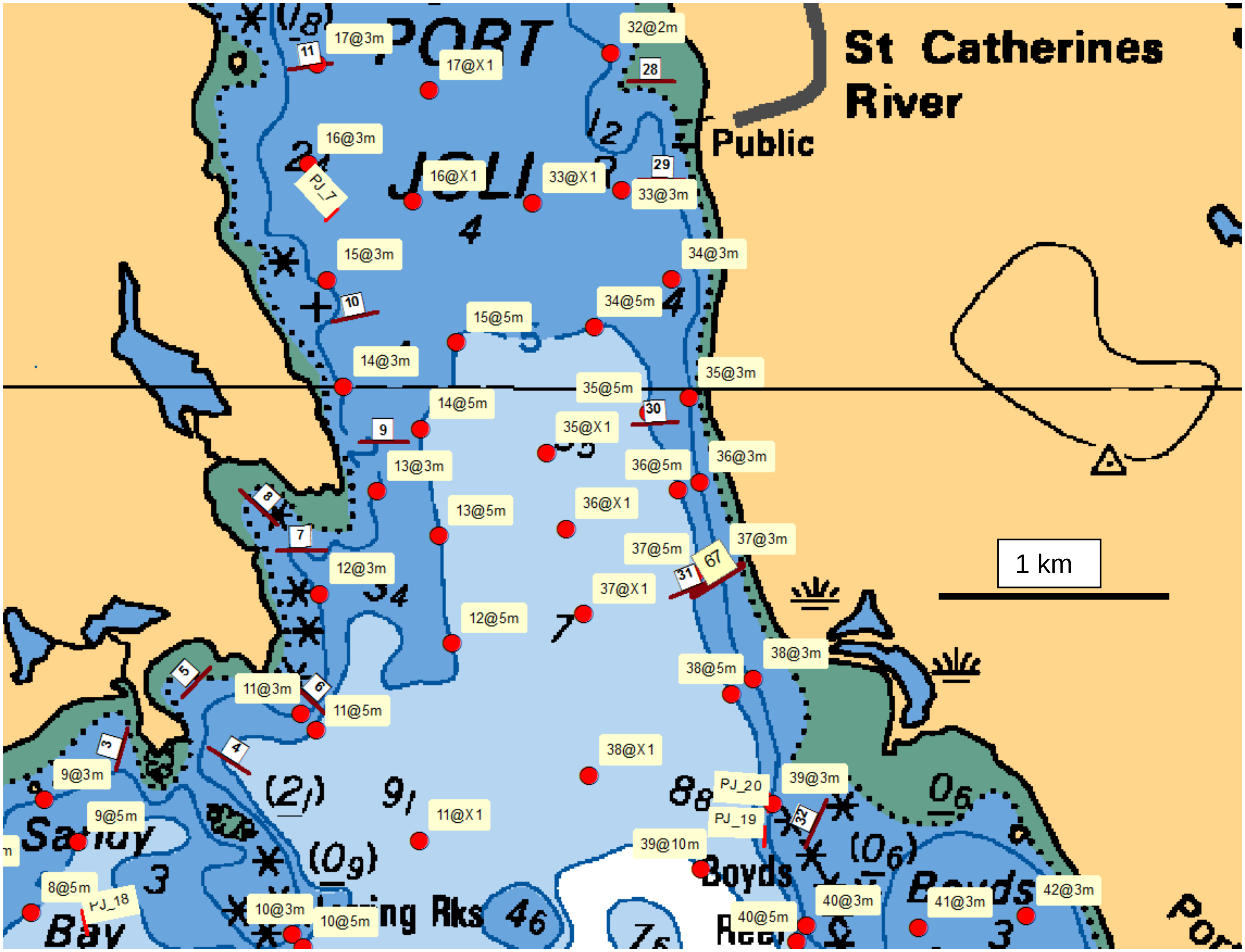

Figure 11: Detail for deeper mid-section of bay. Marks and labels as in Fig. 9. Transect #67 refers to Moore and Miller 1983.

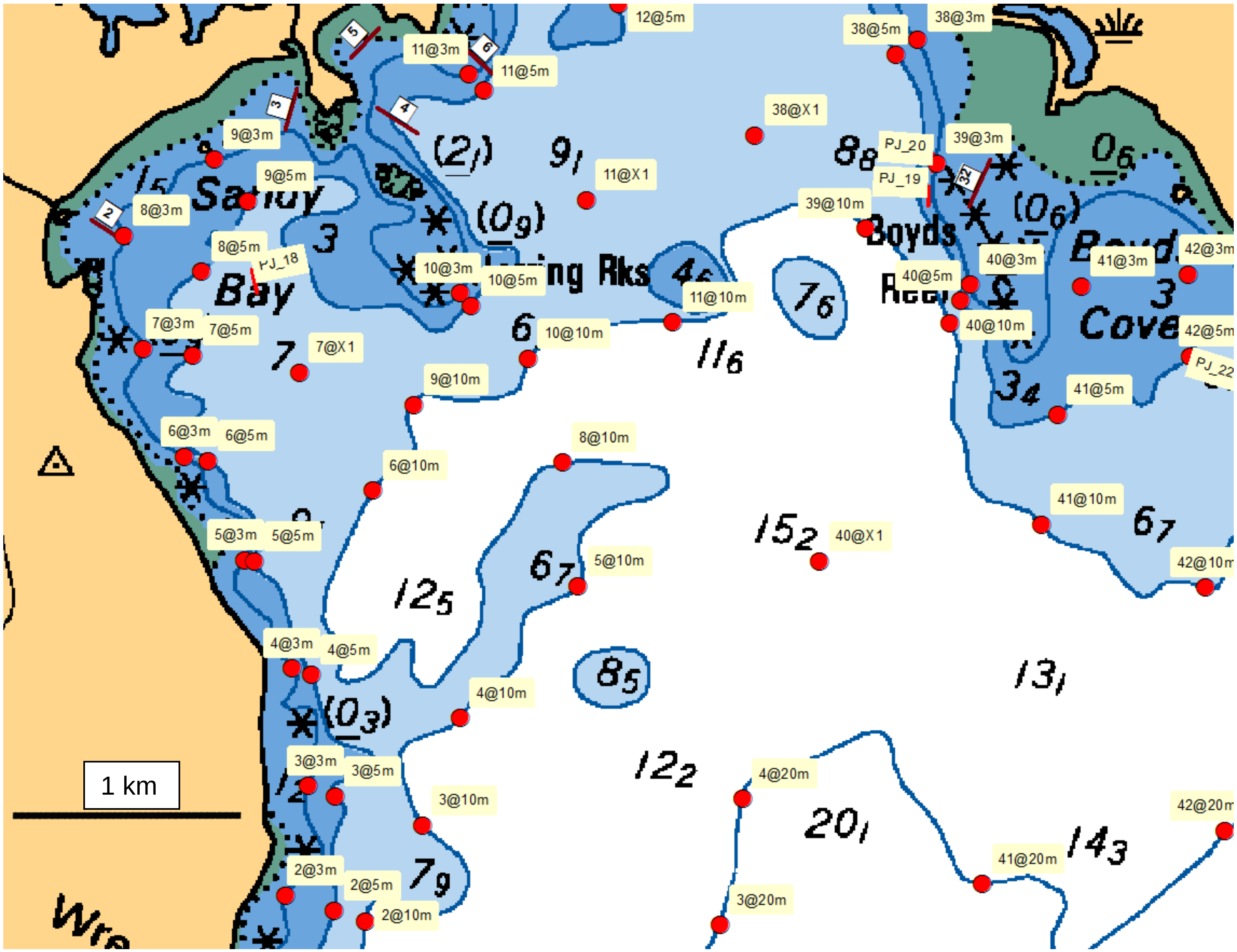

Figure 12: Detail for lower (south) section of bay. Marks and labels as in Fig. 9.

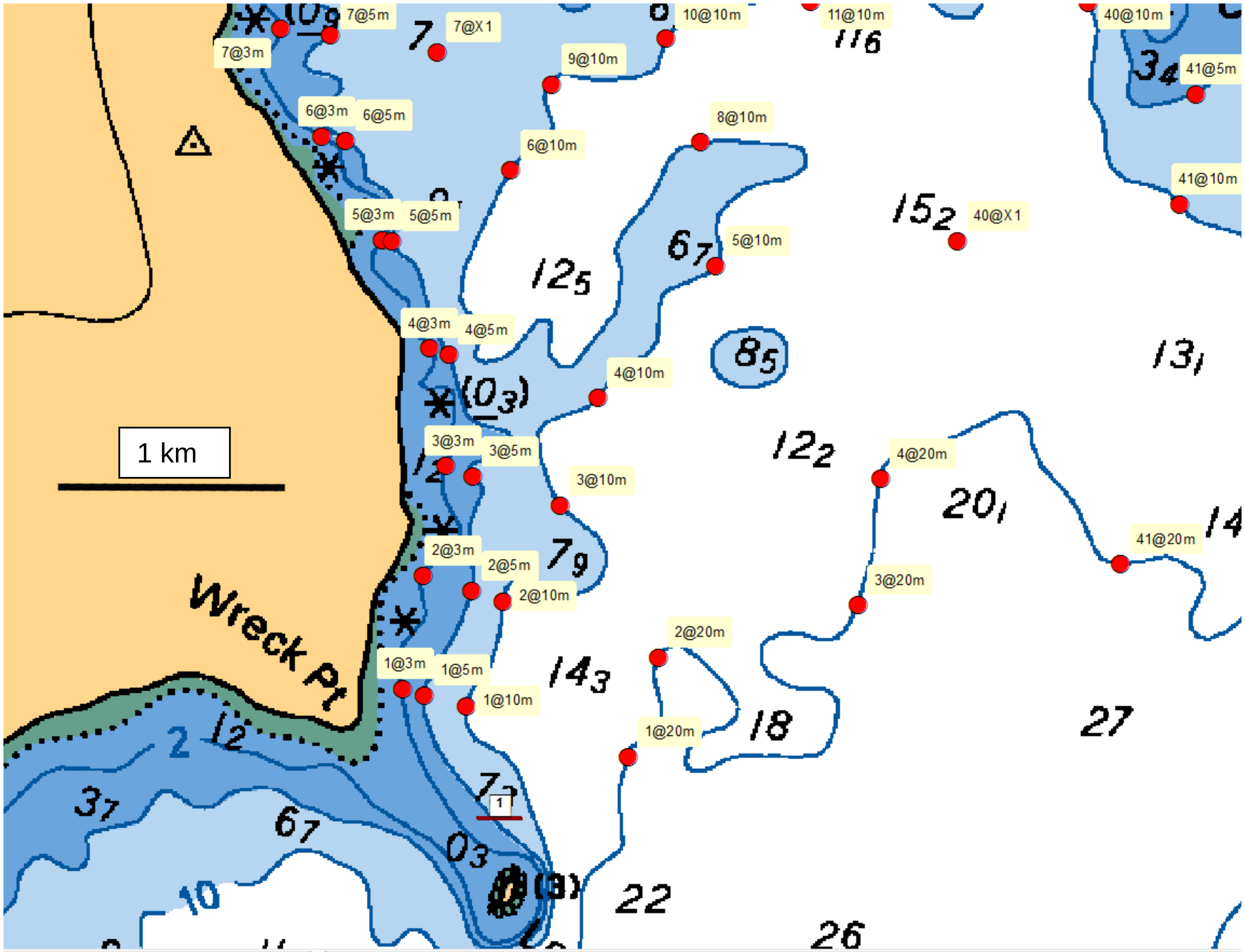

Figure 13: Detail for bay mouth on west side. Marks and labels as in Fig. 9.

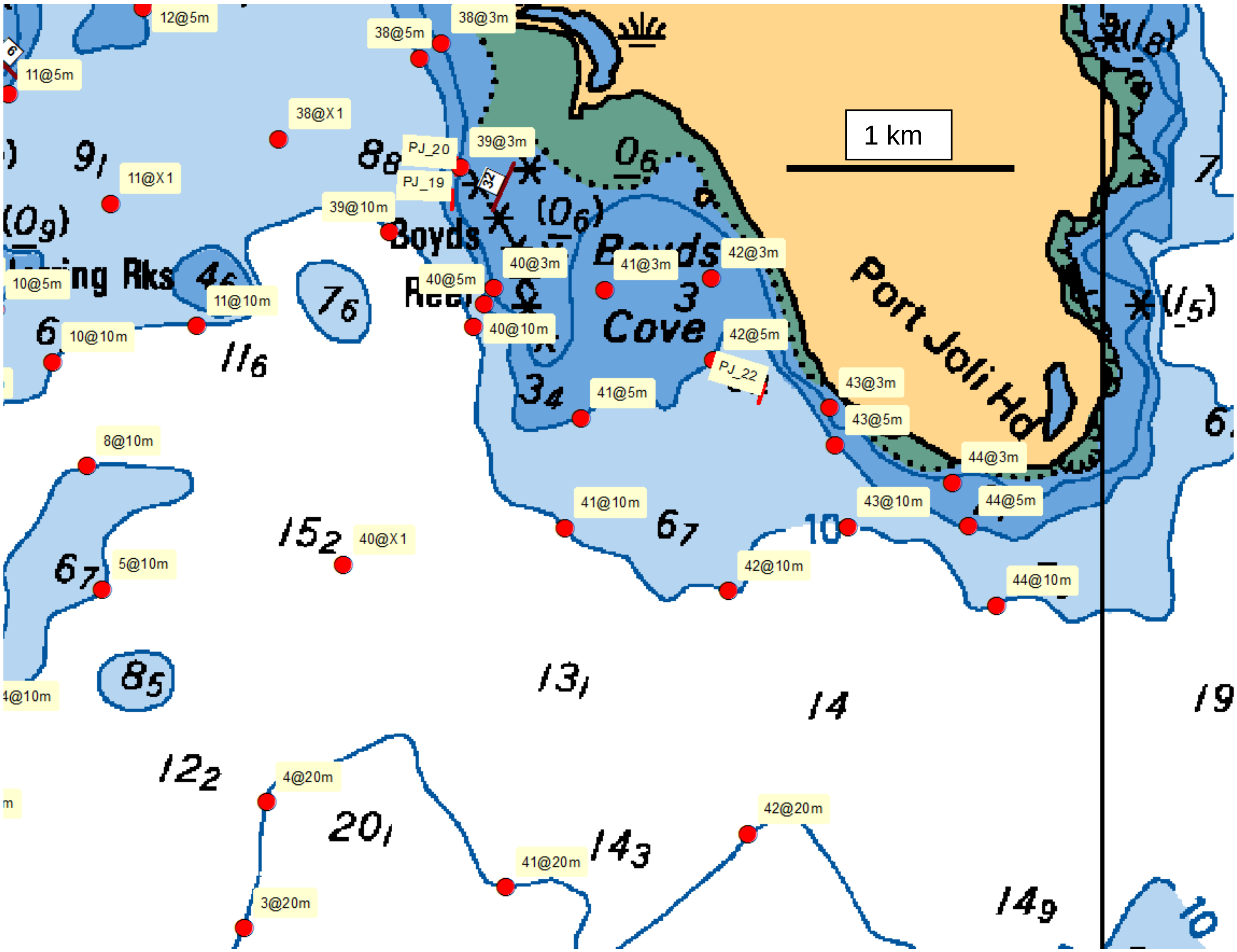

Figure 14: Detail for bay mouth on east side. Marks and labels as in Fig. 9.

Figure 15: Screen shot from video at 20@3m; sand with ripples on left, patch of eelgrass with ‘trapped’ filamentous algae at base of leaves on right. Overlay shows latitude / longitude of camera position on upper left in yellow; GMT time and date stamp on upper right in white; local time (approximate) and date on lower left in white.

Figure 16: Screen shot from video at 20@3m; slightly denser patch of eelgrass with 'trapped' filamentous algae at base of leaves. Overlay as in Fig. 15.

Figure 17: Screen shot from video at 32@2m; eelgrass in gravel / cobble. Overlay as in Fig. 15.

Figure 18: Screen shot from video at 32@2m; *Chondrus* (red arrows), *Fucus* (blue arrows), and *Laminaria* (yellow arrow) on gravel / cobble. 10cm laser scale visible (black circles). Overlay as in Fig. 15.

Figure 19: Screen shot from video at 38@3m; *Chondrus* (red arrows), *Fucus* (blue arrows), and *Codium* (green arrow) on gravel / cobble. Overlay as in Fig. 15.

Figure 20: Screen shot from video at 43@3m; *Chondrus* (red arrows), *Chaetomorpha* (green arrows), and red turf (pink arrows) on gravel / cobble. Overlay as in Fig. 15.

Figure 21: Screen shot from video at 43@3m; *Chondrus* (red arrows), *Chaetomorpha* (green arrows), *Desmarestia* (orange arrow) and *Saccharina* (brown arrows) on gravel / cobble. Overlay as in Fig. 15.

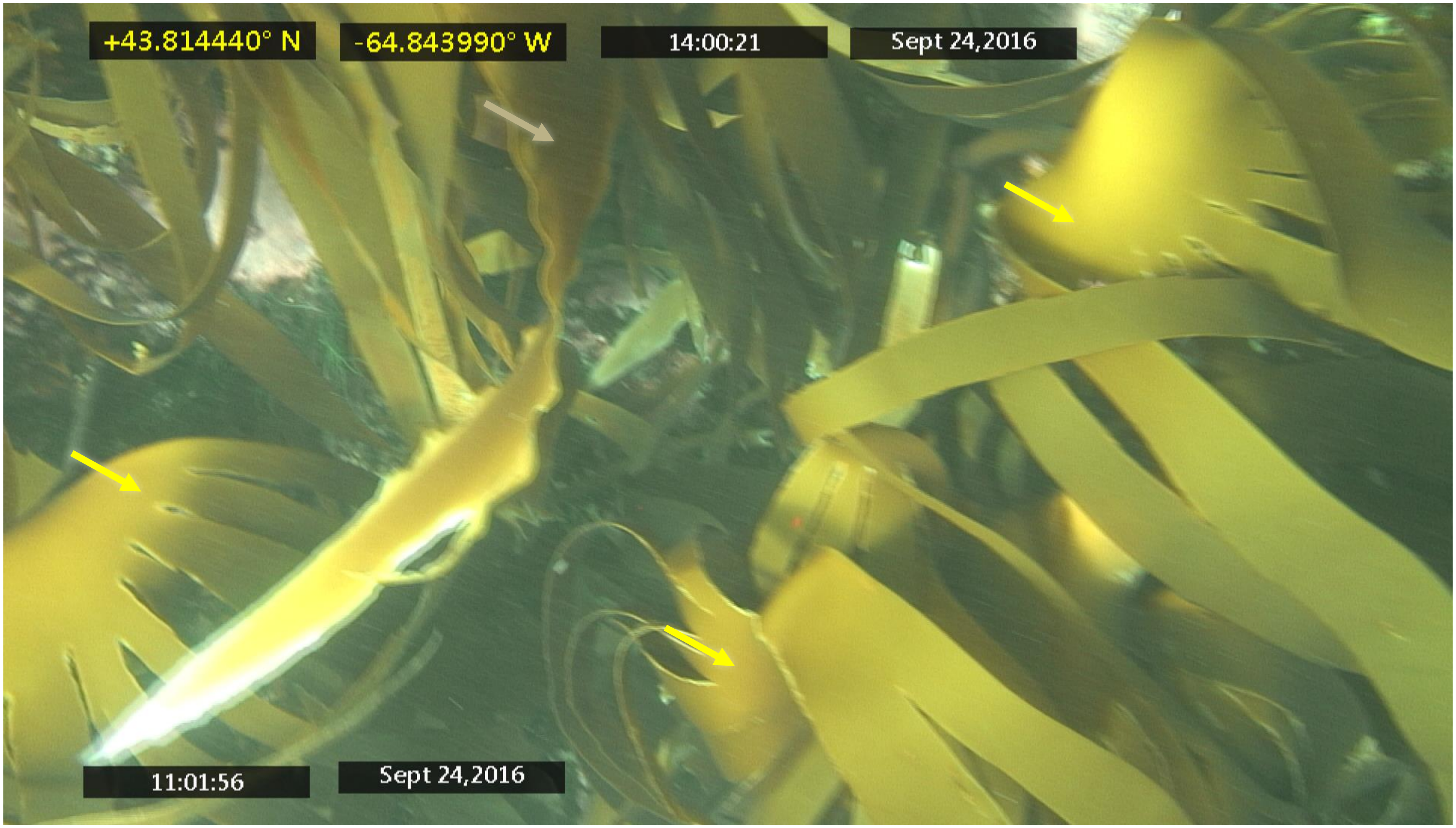

Figure 22: Screen shot from video at 43@3m; a dense stand of *Saccharina* (brown arrow) and *Laminaria* (yellow arrows) with coralline algae on cobble / ledge. Overlay as in Fig. 15.

Figure 23: Screen shot from video at 1@10m; *Desmarestia* (orange arrows) on cobble. Overlay as in Fig. 15.

Figure 24: Screen shot from video at 5@10m; *Agarum* (black arrows) and coralline algae (purple arrows) on cobble. Overlay as in Fig. 15.

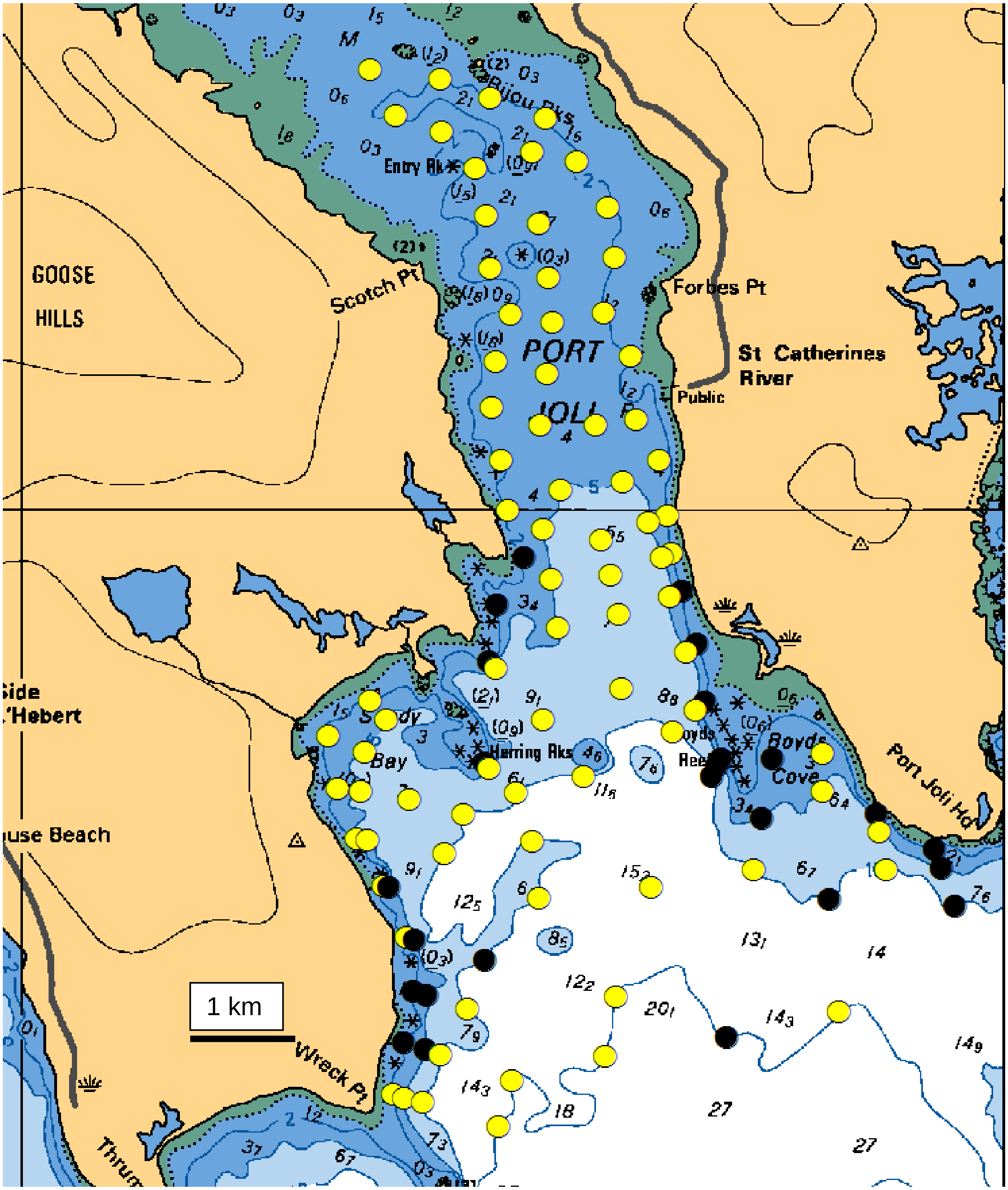

Figure 25: Drop camera locations with a sand substrate seen in video (yellow dots; black=absent).

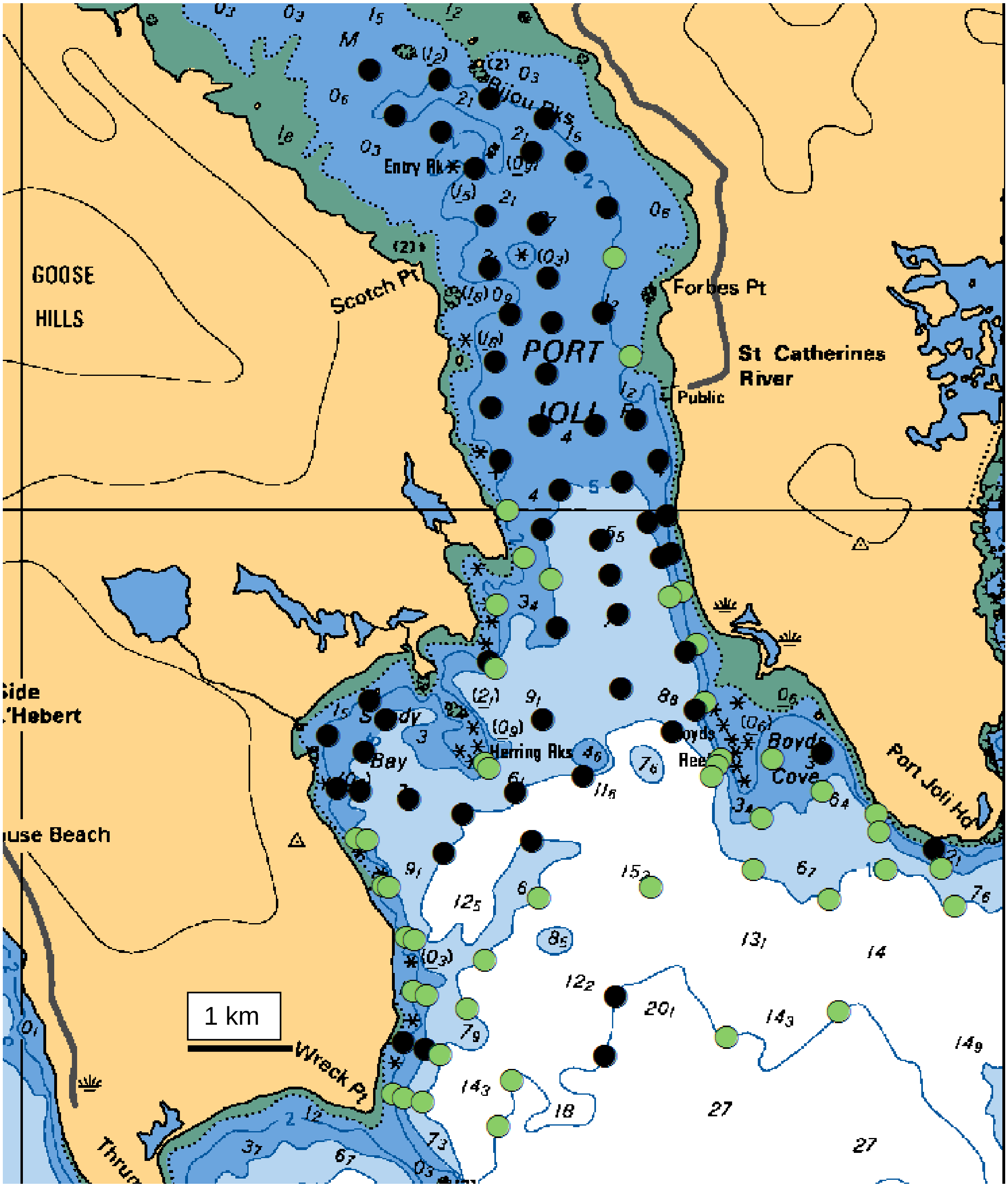

Figure 26: Drop camera locations with a gravel substrate seen in video (green dots; black=absent).

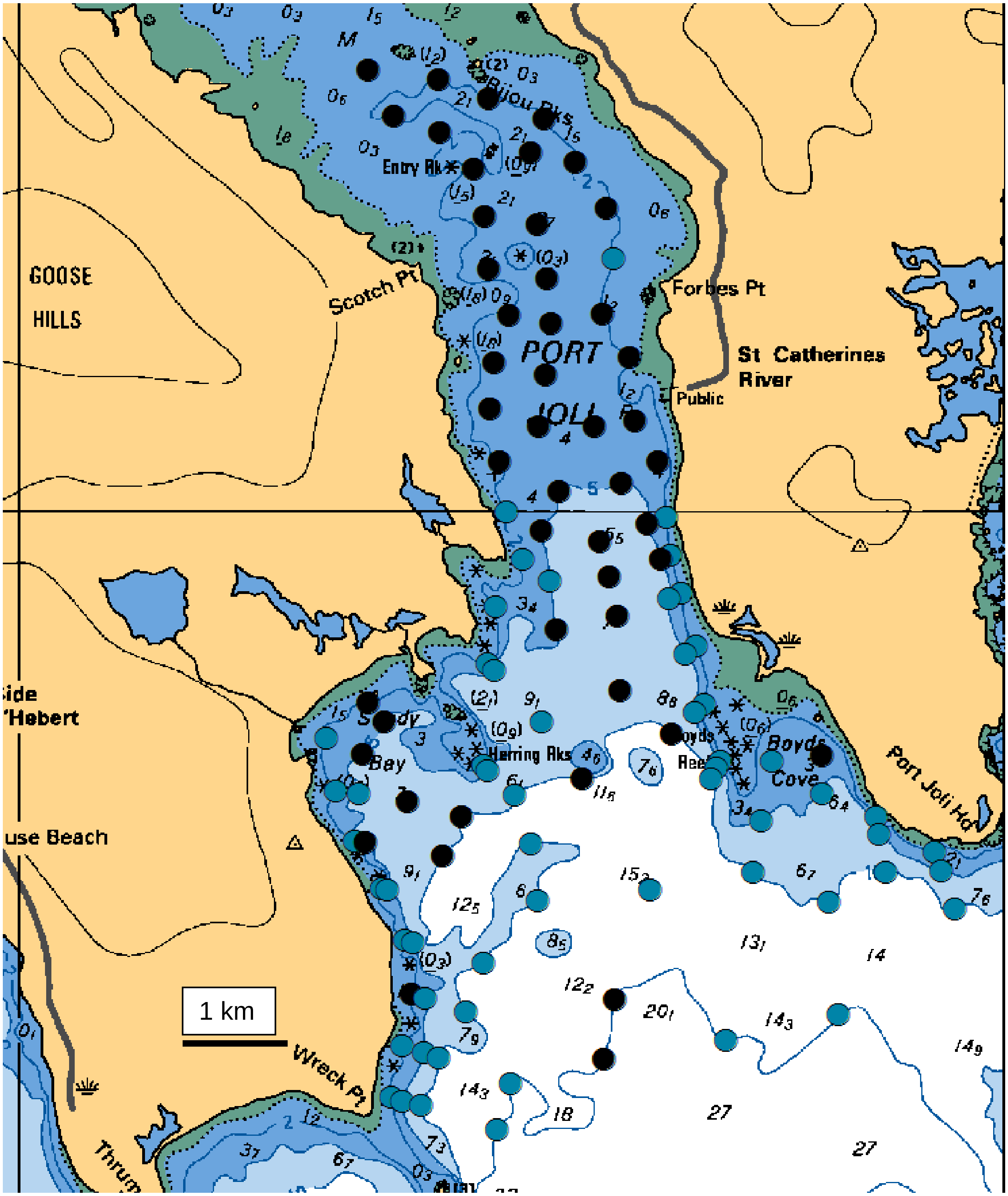

Figure 27: Drop camera locations with a cobble / boulder substrate seen in video (blue dots; black=absent).

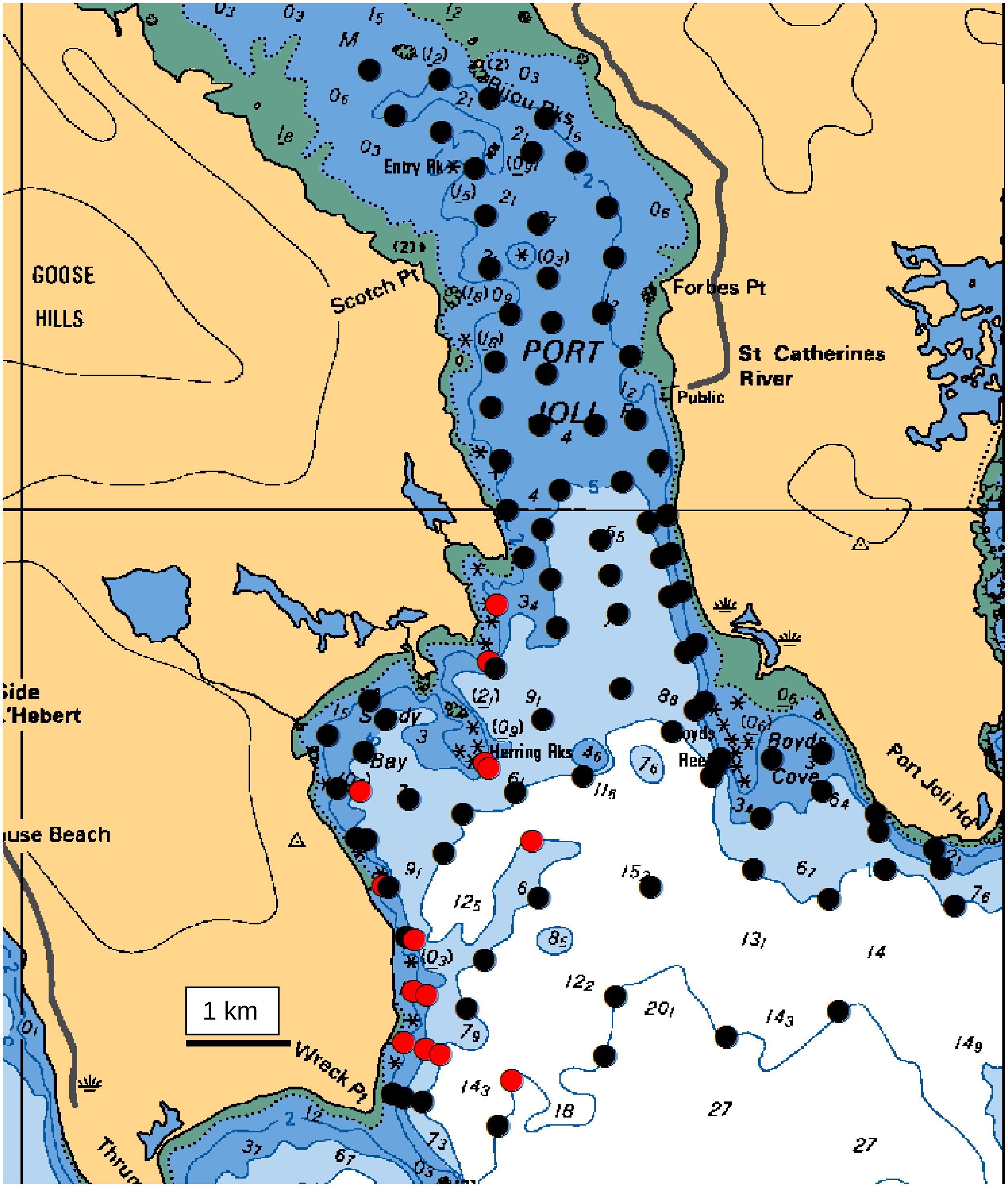

Figure 28: Drop camera locations with a ledge substrate seen in video (red dots; black=absent).

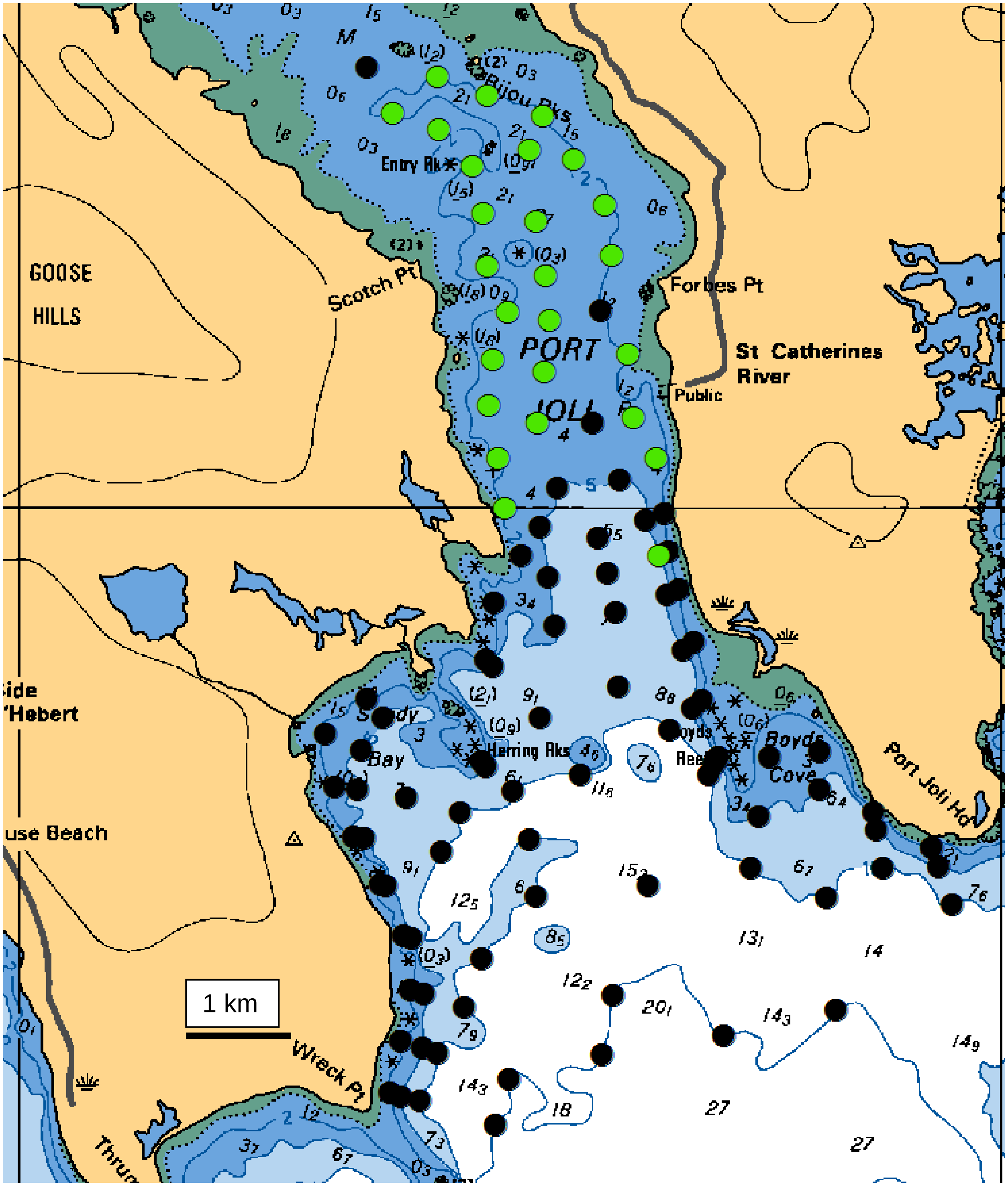

Figure 29: Drop camera locations with *Zostera* seen in video (green dots; black=absent).

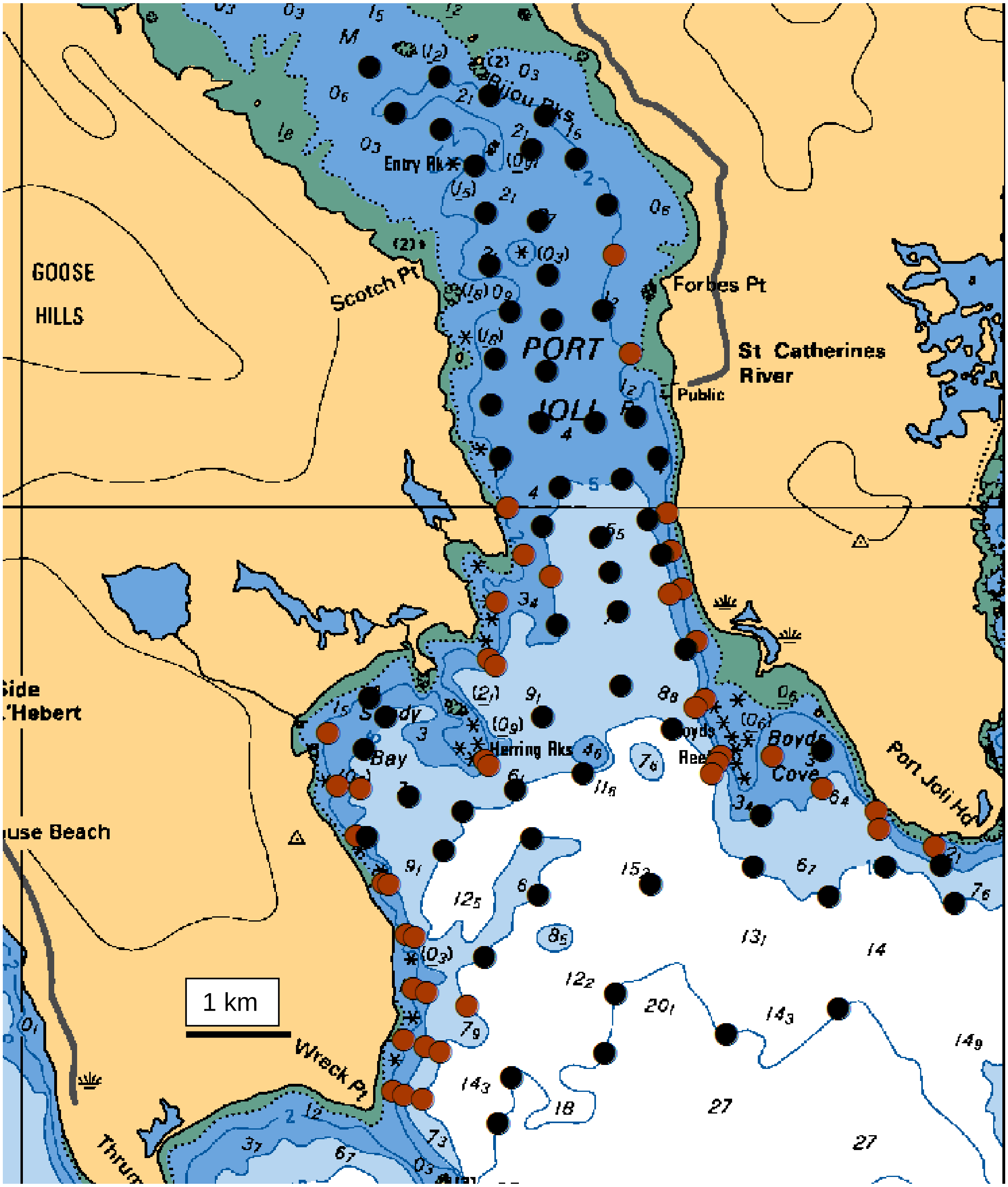

Figure 30: Drop camera locations with *Chondrus* seen in video (red dots; black=absent).

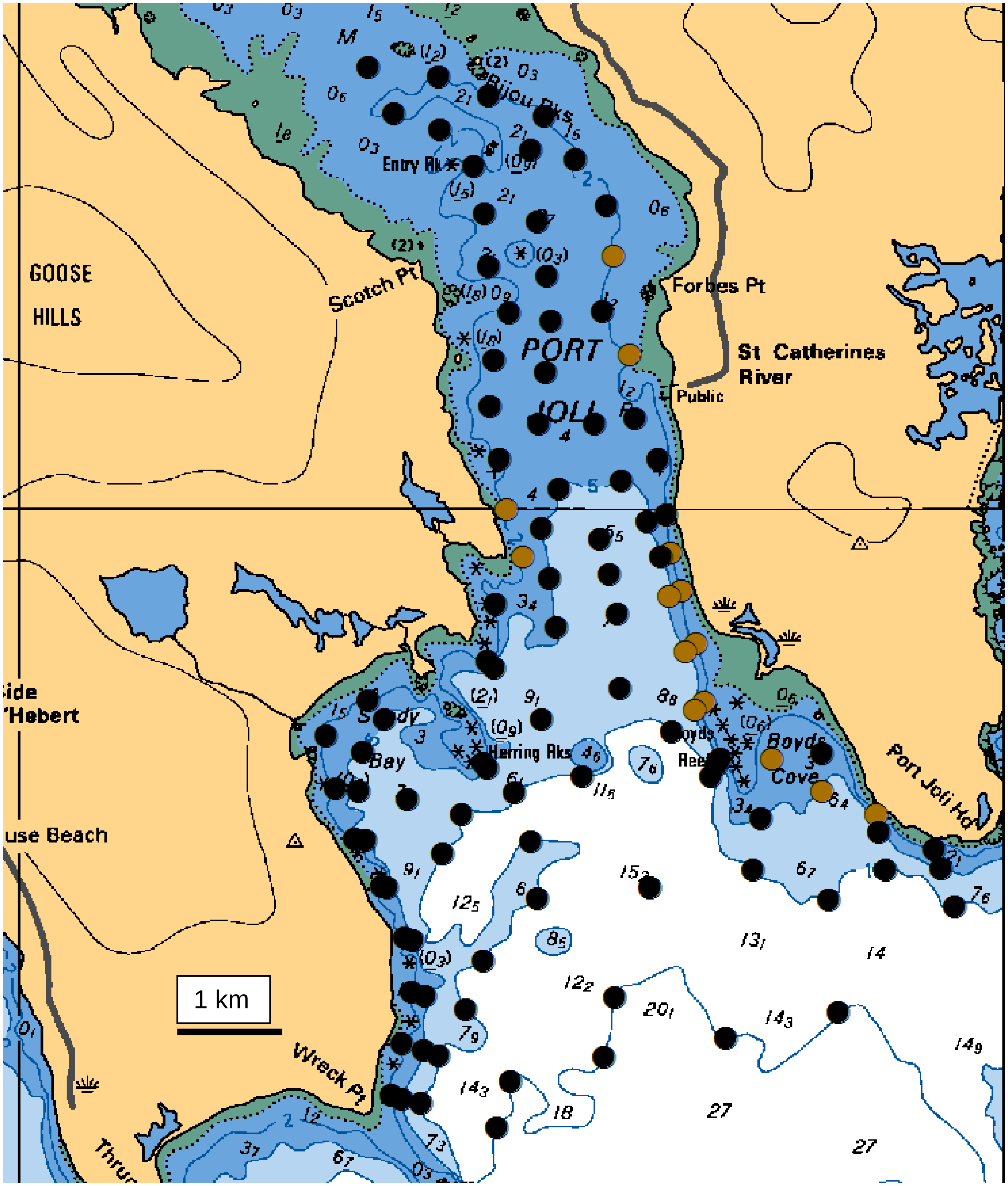

Figure 31: Drop camera locations with *Fucus* seen in video (brown dots; black=absent).

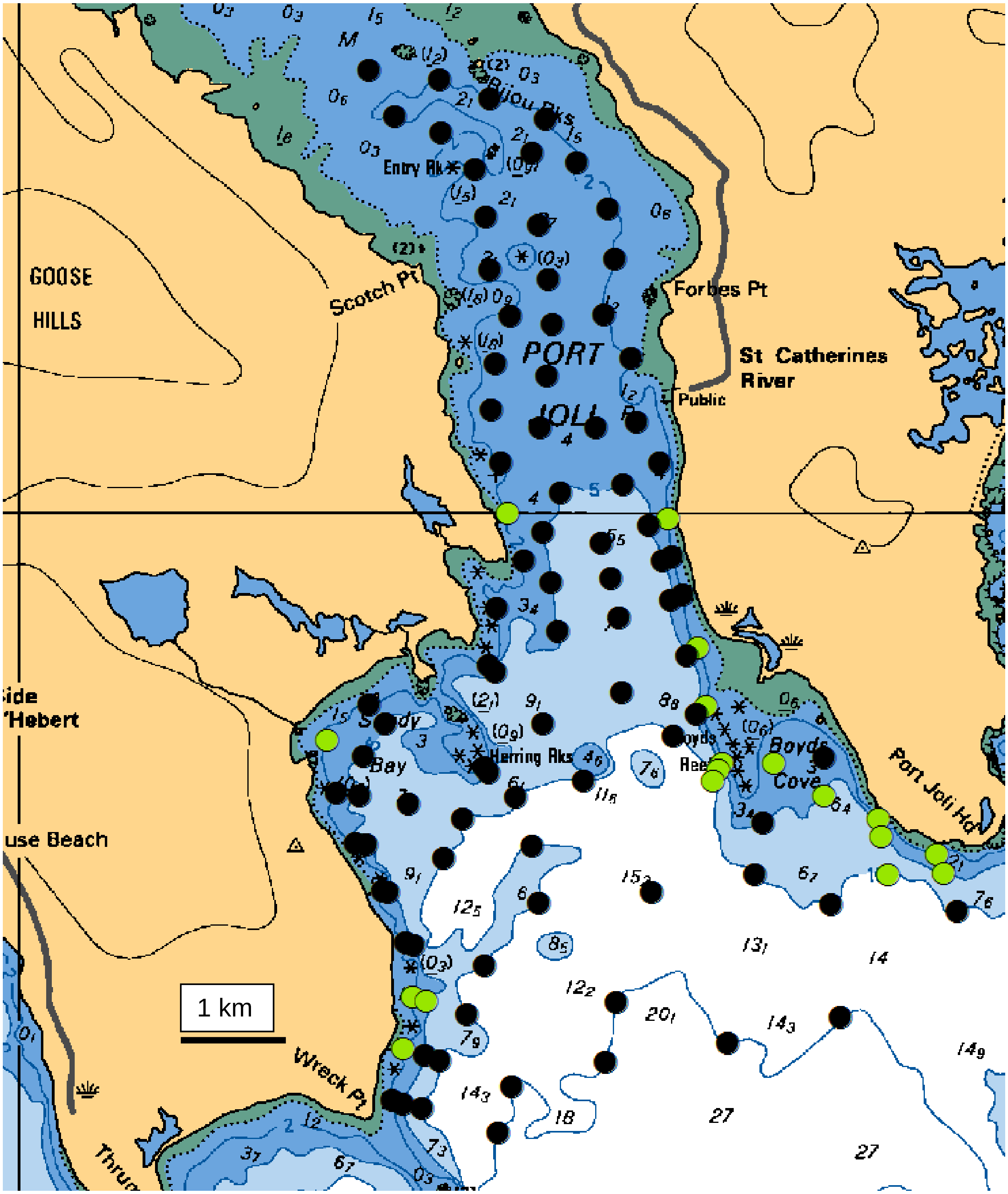

Figure 32: Drop camera locations with *Chaetomorpha* seen in video (green dots; black=absent).

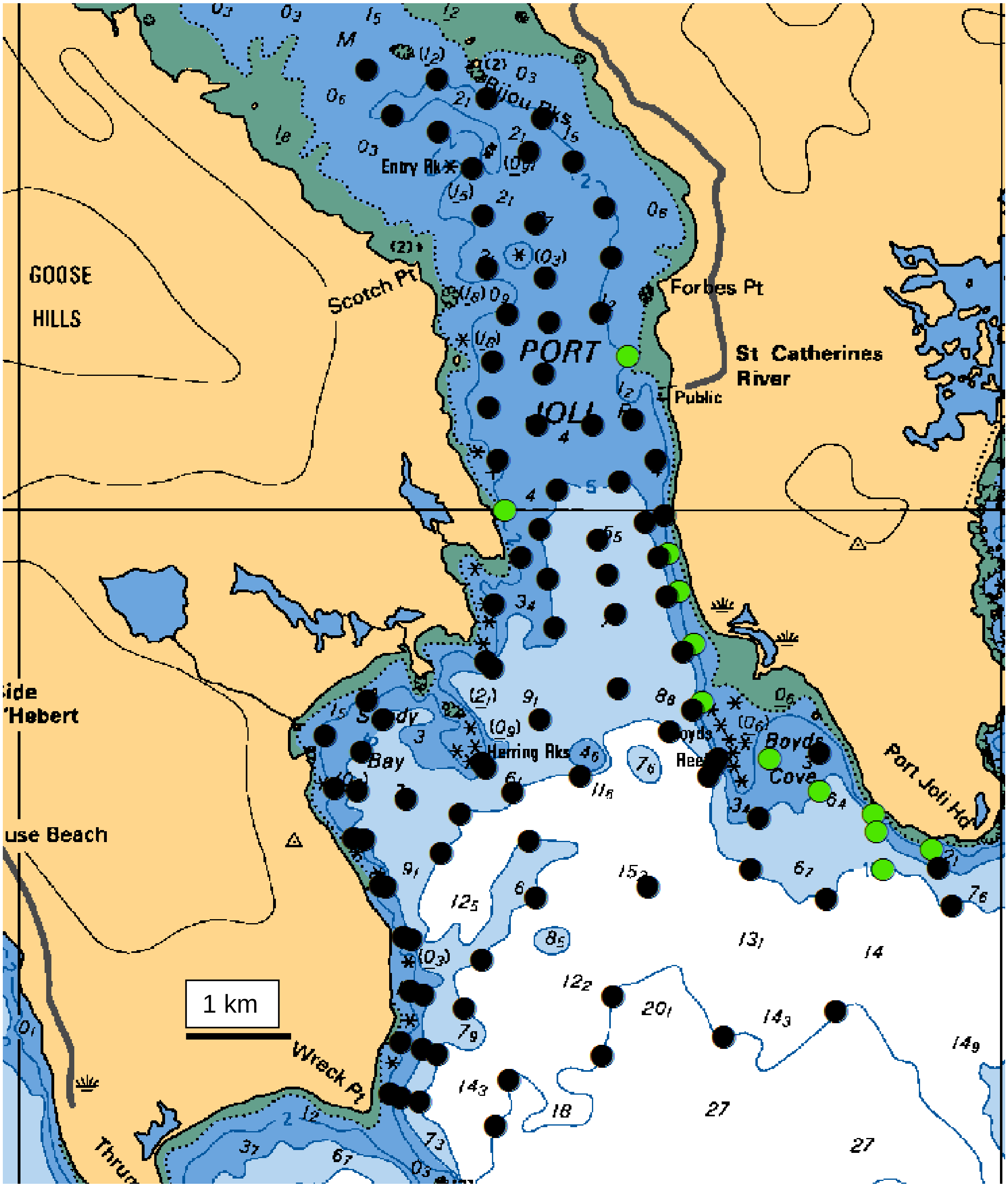

Figure 33: Drop camera locations with 'green turf' seen in video (green dots; black=absent).

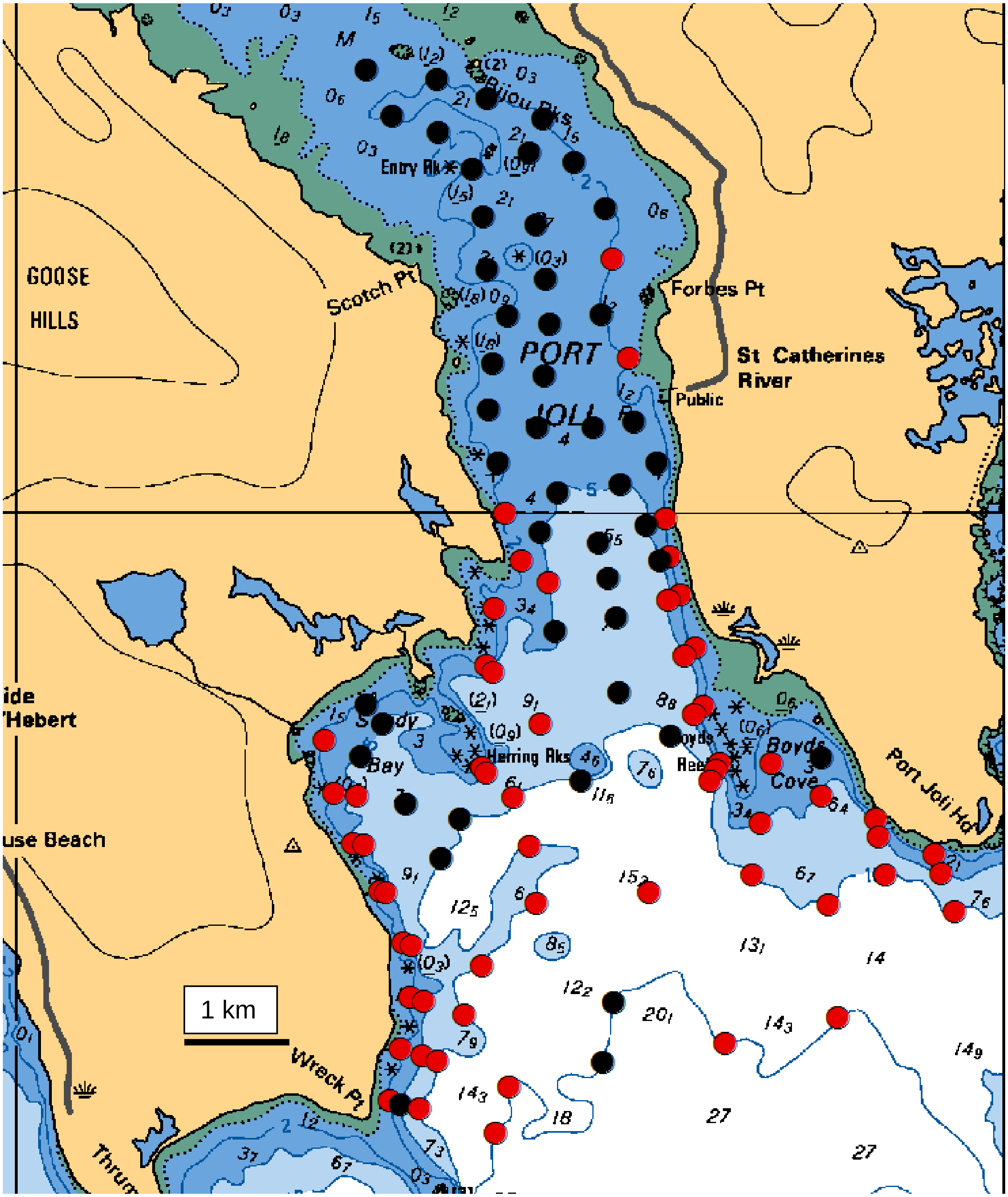

Figure 34: Drop camera locations with ‘red turf’ seen in video (red dots; black=absent).

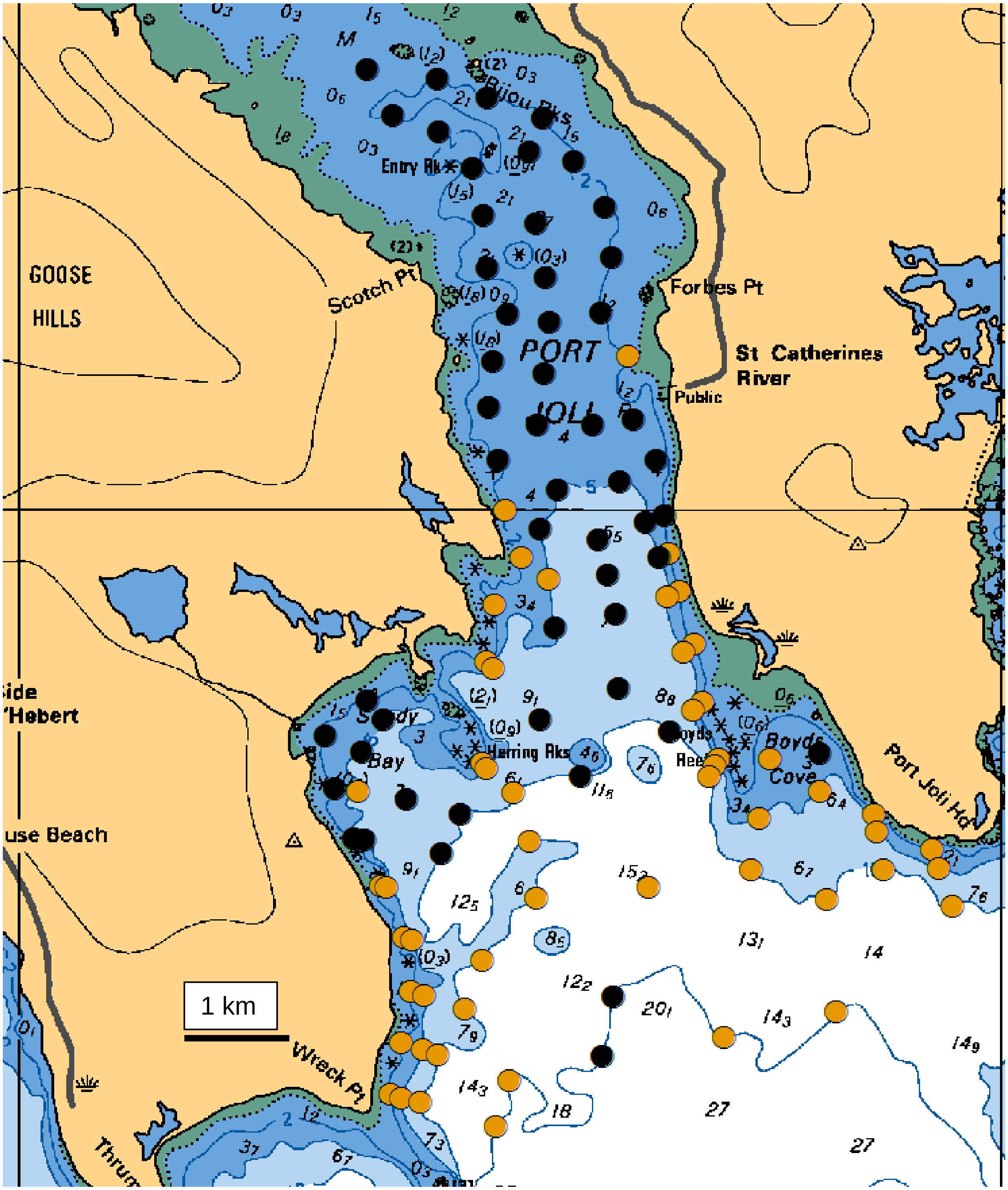

Figure 35: Drop camera locations with *Saccharina* seen in video (brown dots; black=absent).

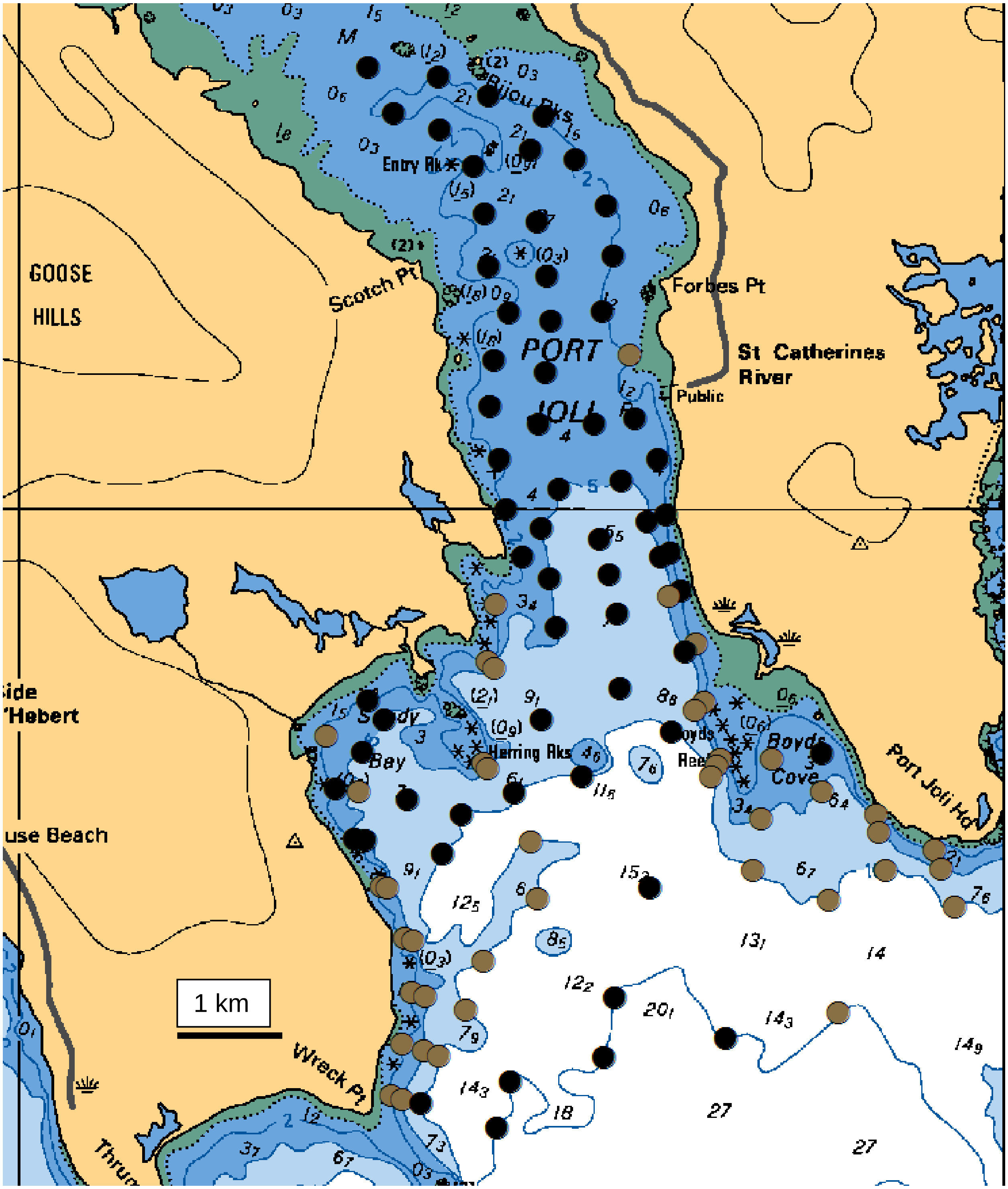

Figure 36: Drop camera locations with *Laminaria* seen in video (brown dots; black=absent).

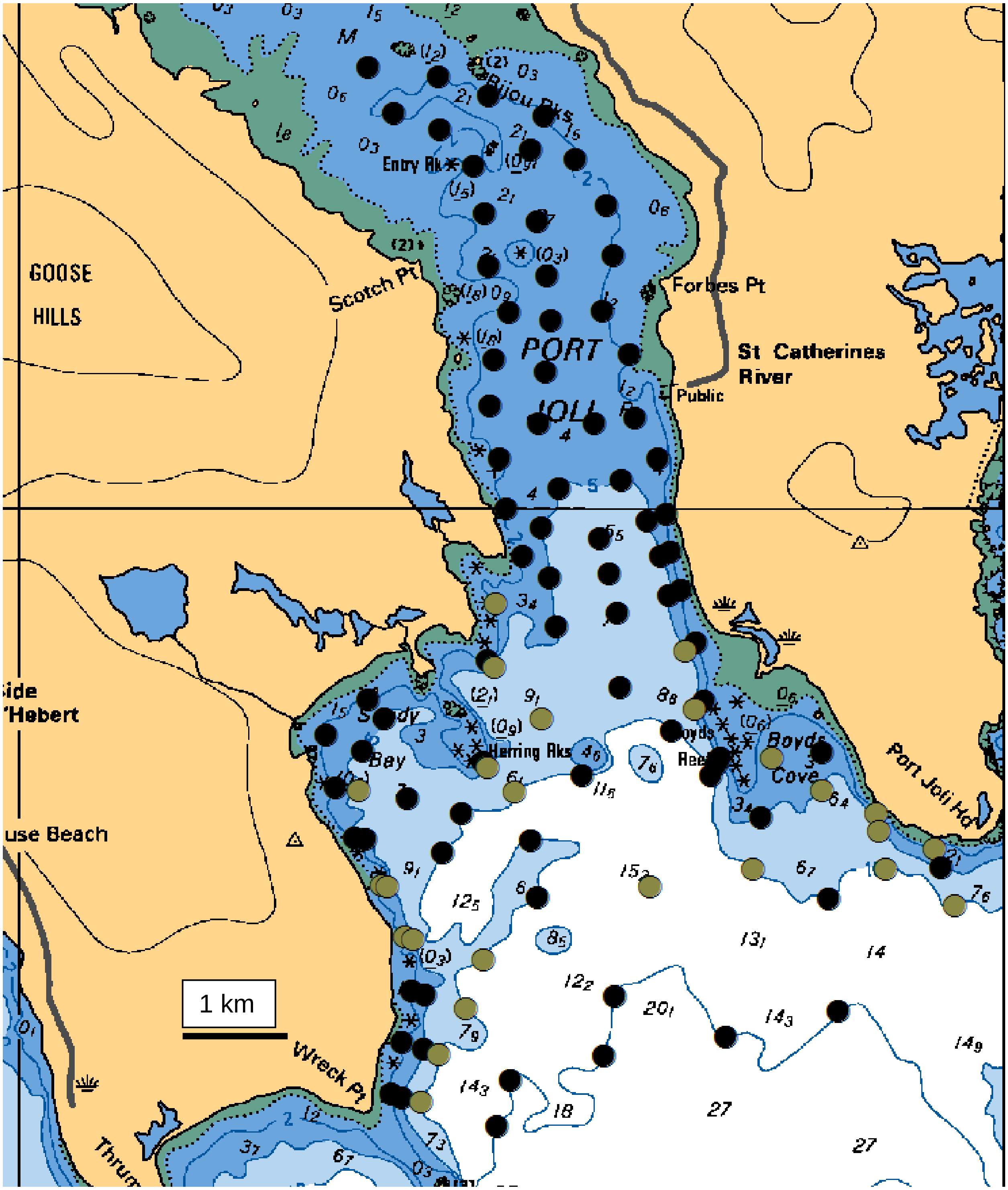

Figure 37: Drop camera locations with *Desmarestia* seen in video (brown dots; black=absent).

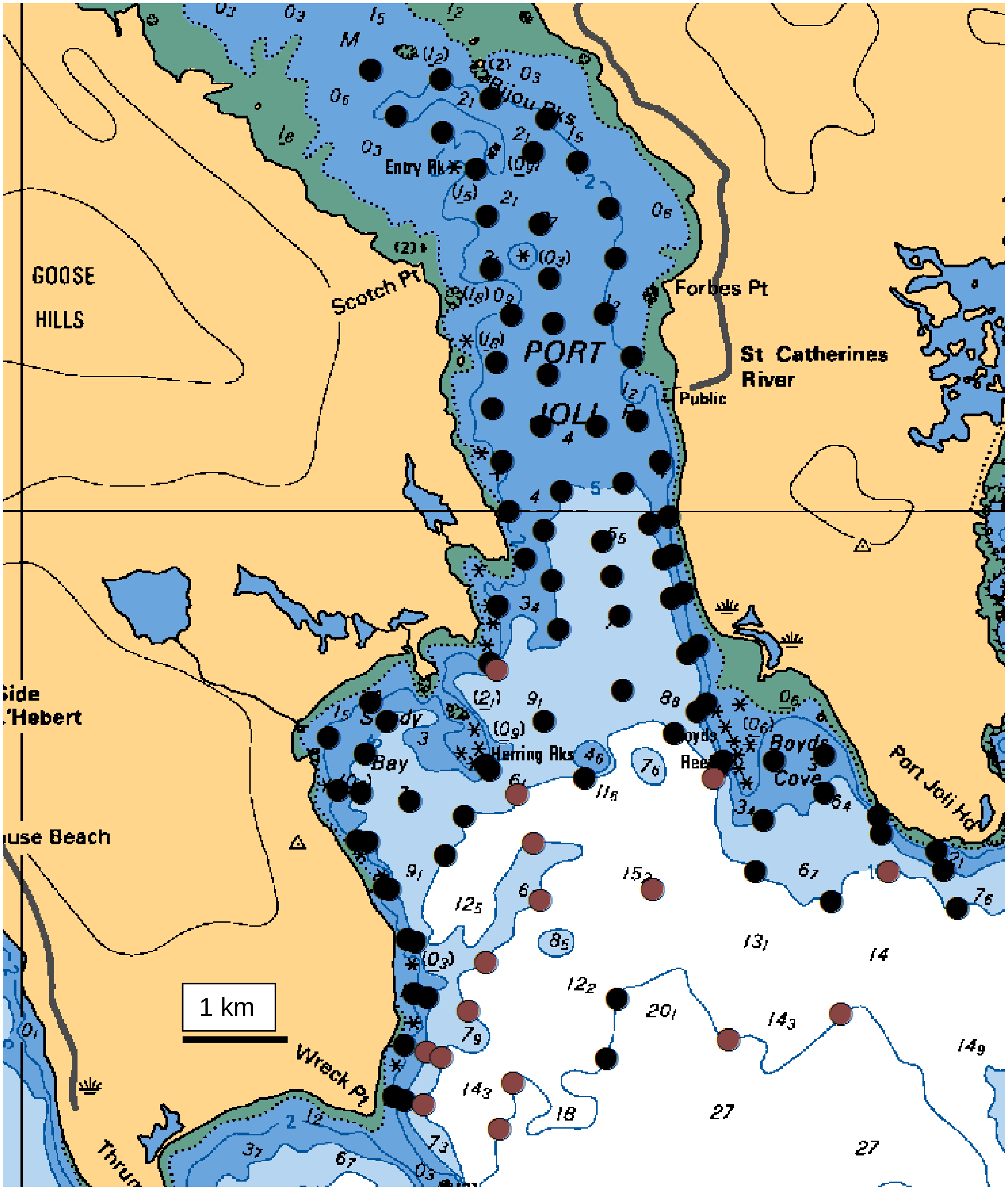

Figure 38: Drop camera locations with *Agarum* seen in video (brown dots; black=absent).

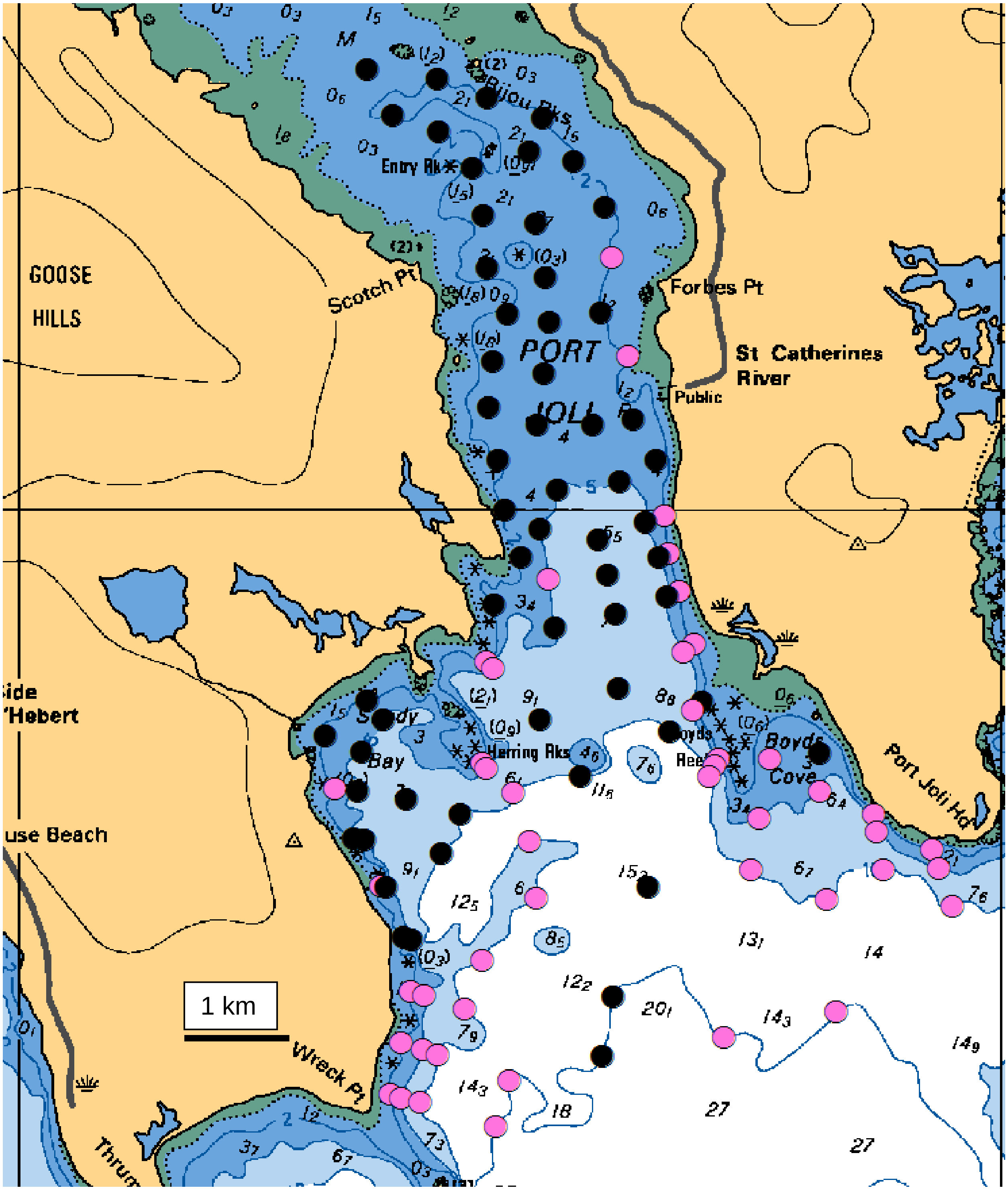

Figure 39: Drop camera locations with coralline algae seen in video (purple dots; black=absent).

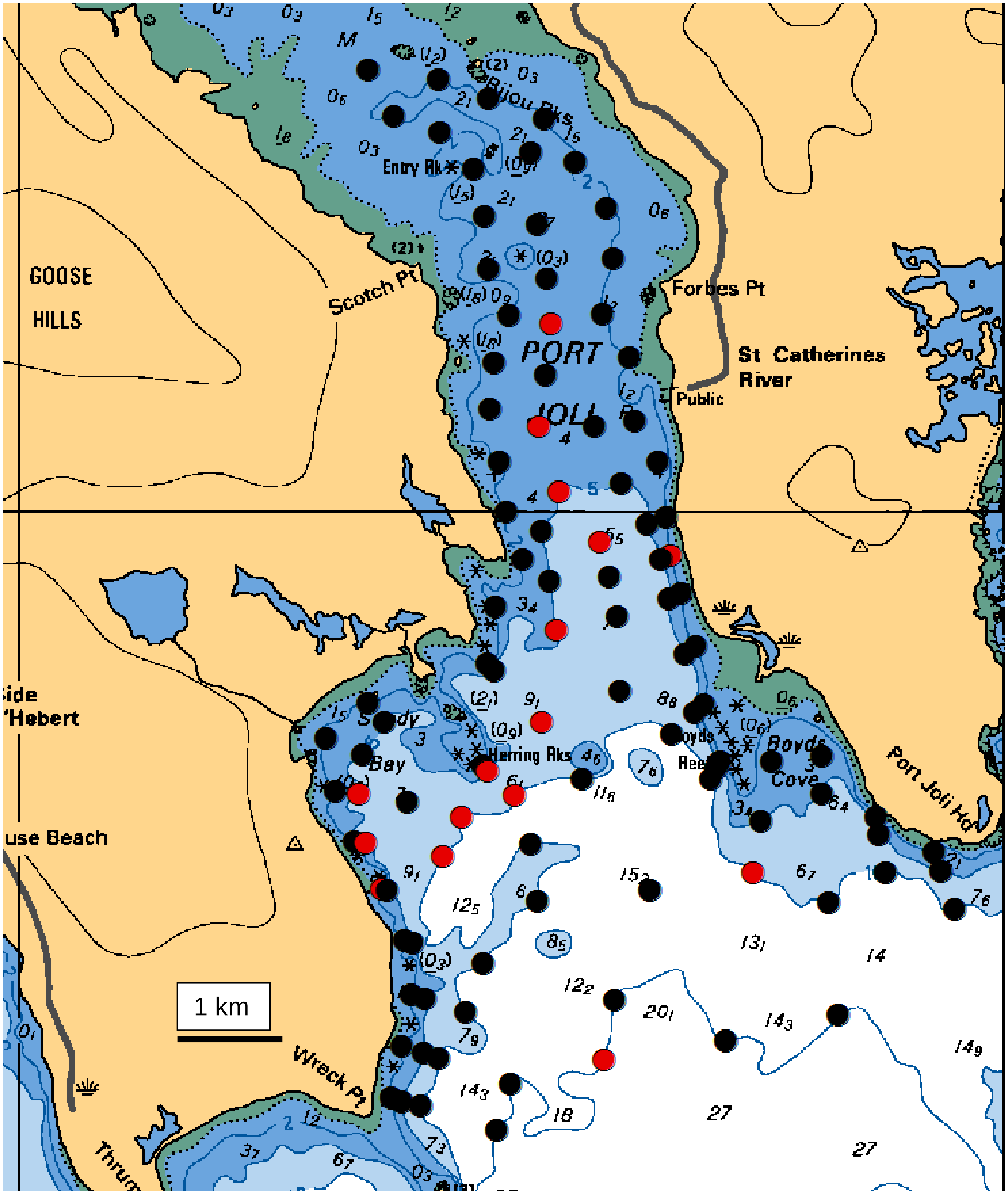

Figure 40: Drop camera locations with lobster seen in video (red dots; black=absent).

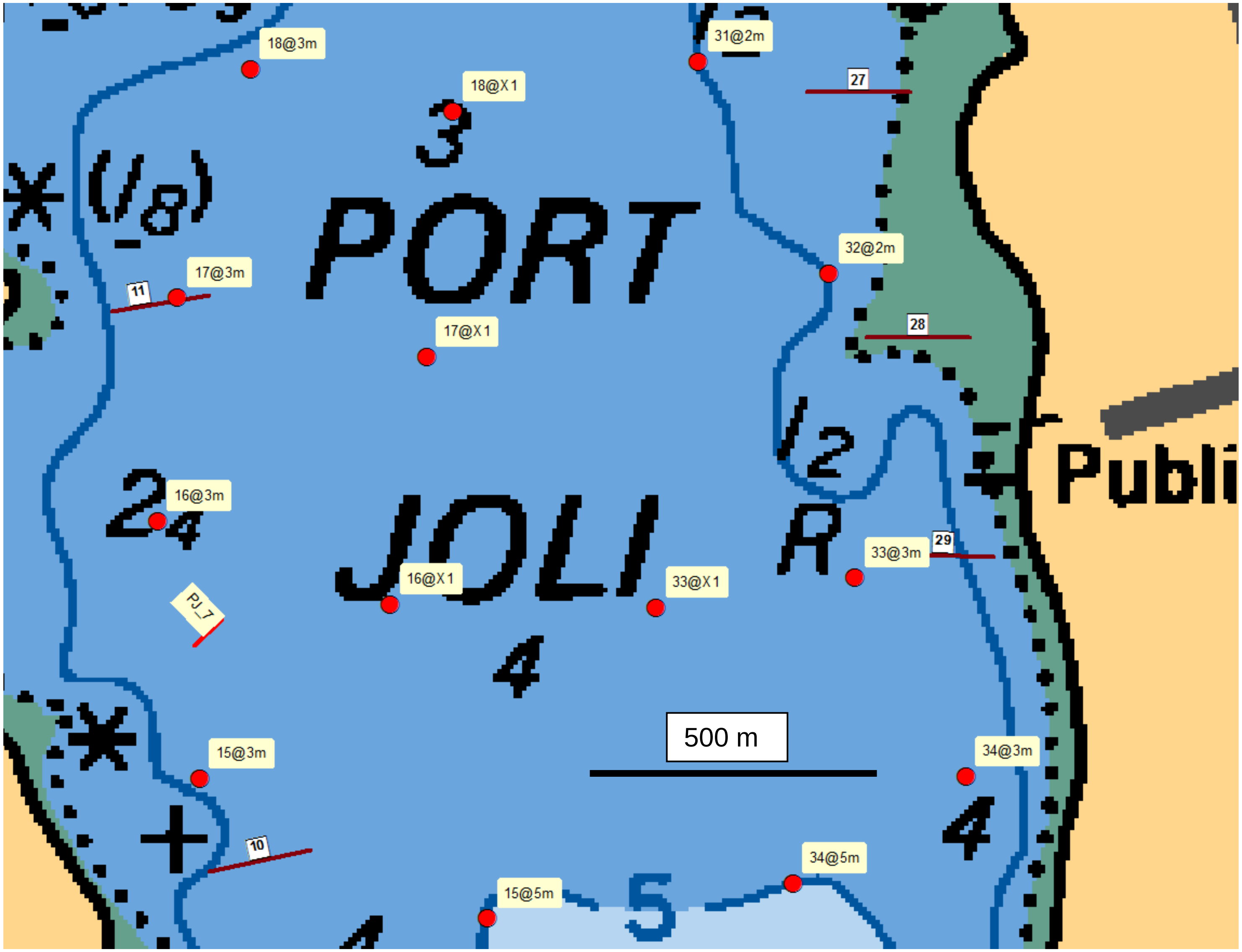

Figure 41: Past transect surveys near present drop camera locations; upper mid-bay.

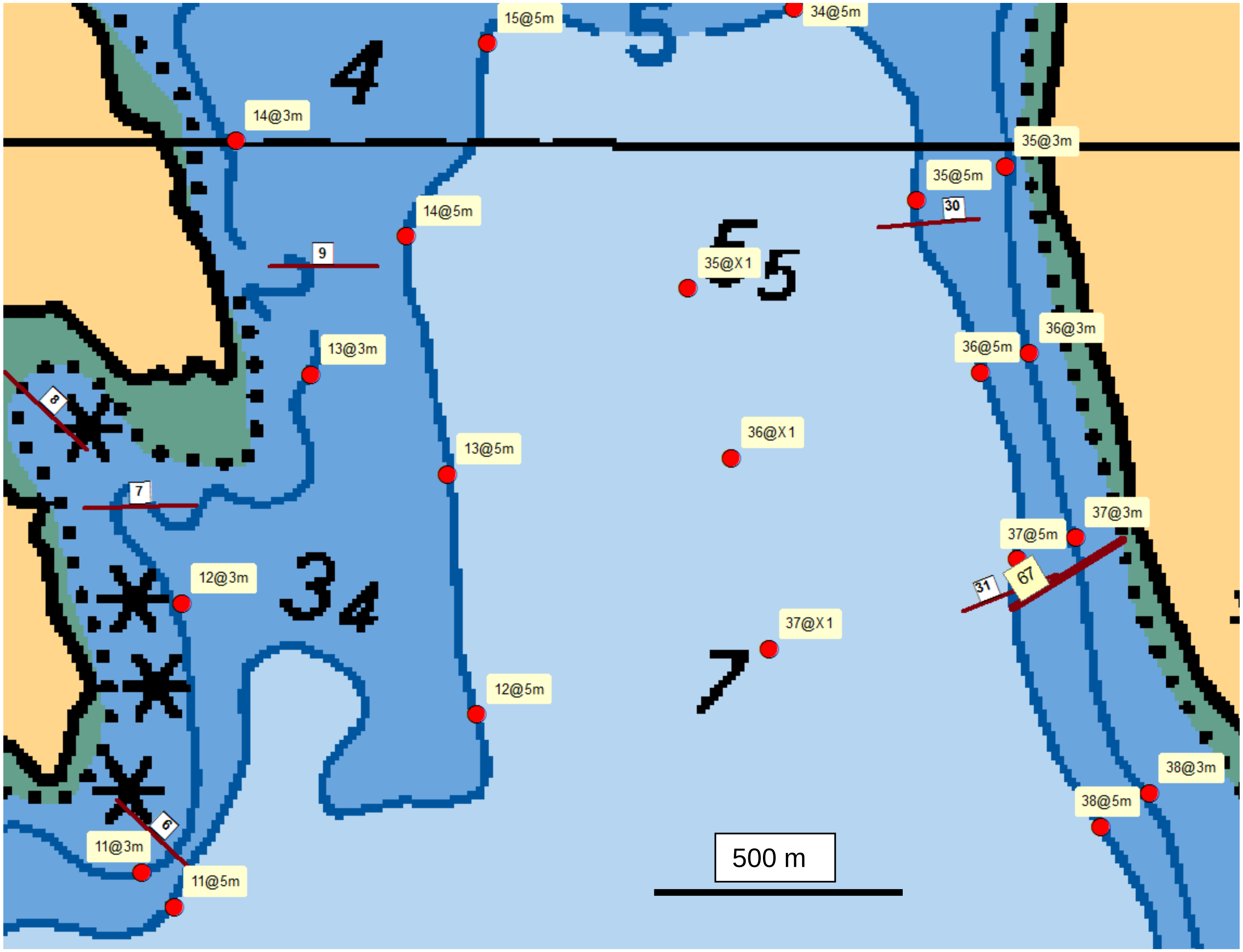

Figure 42: Past transect surveys near present drop camera locations; lower mid-bay

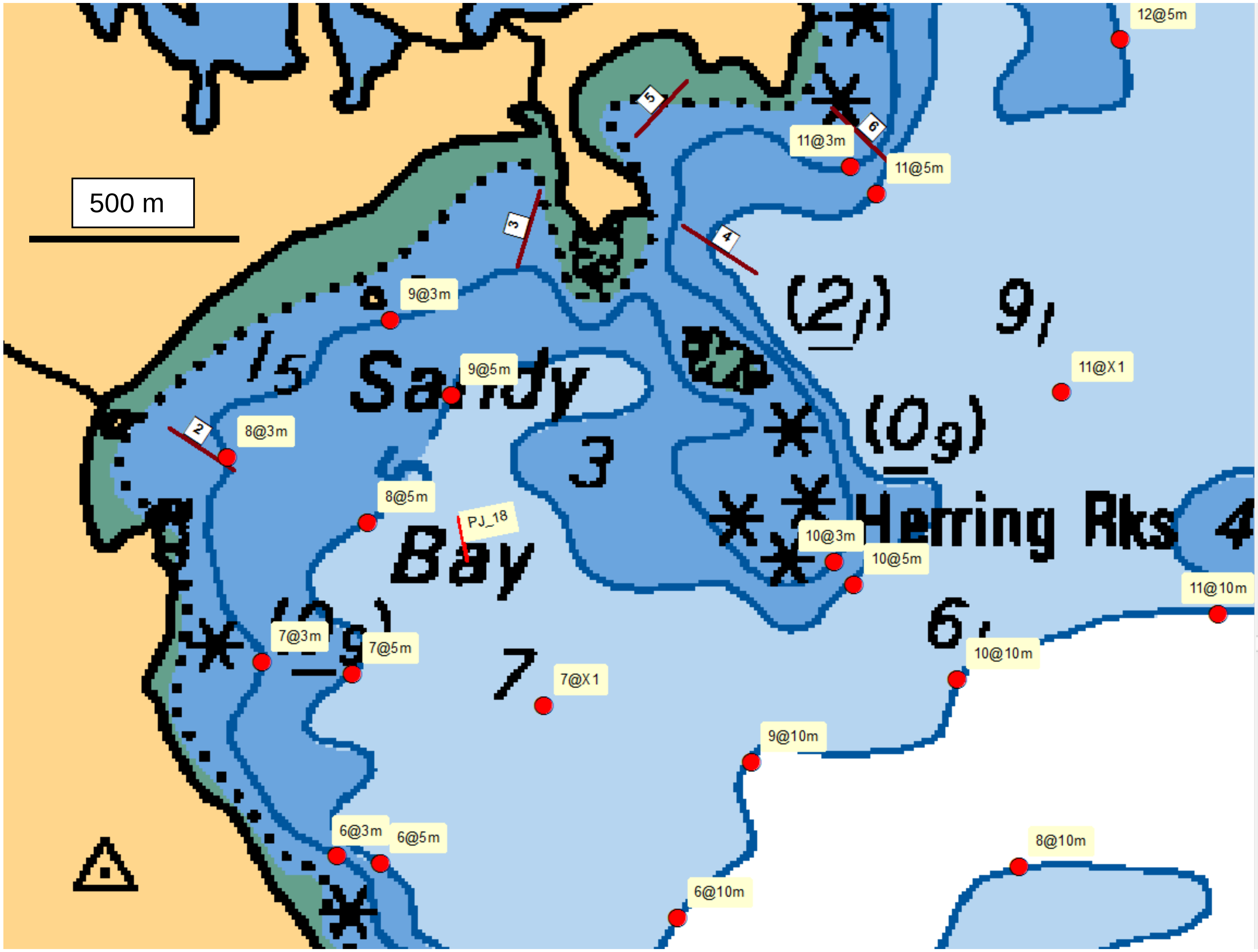

Figure 43: Past transect surveys near present drop camera locations; west mouth of bay

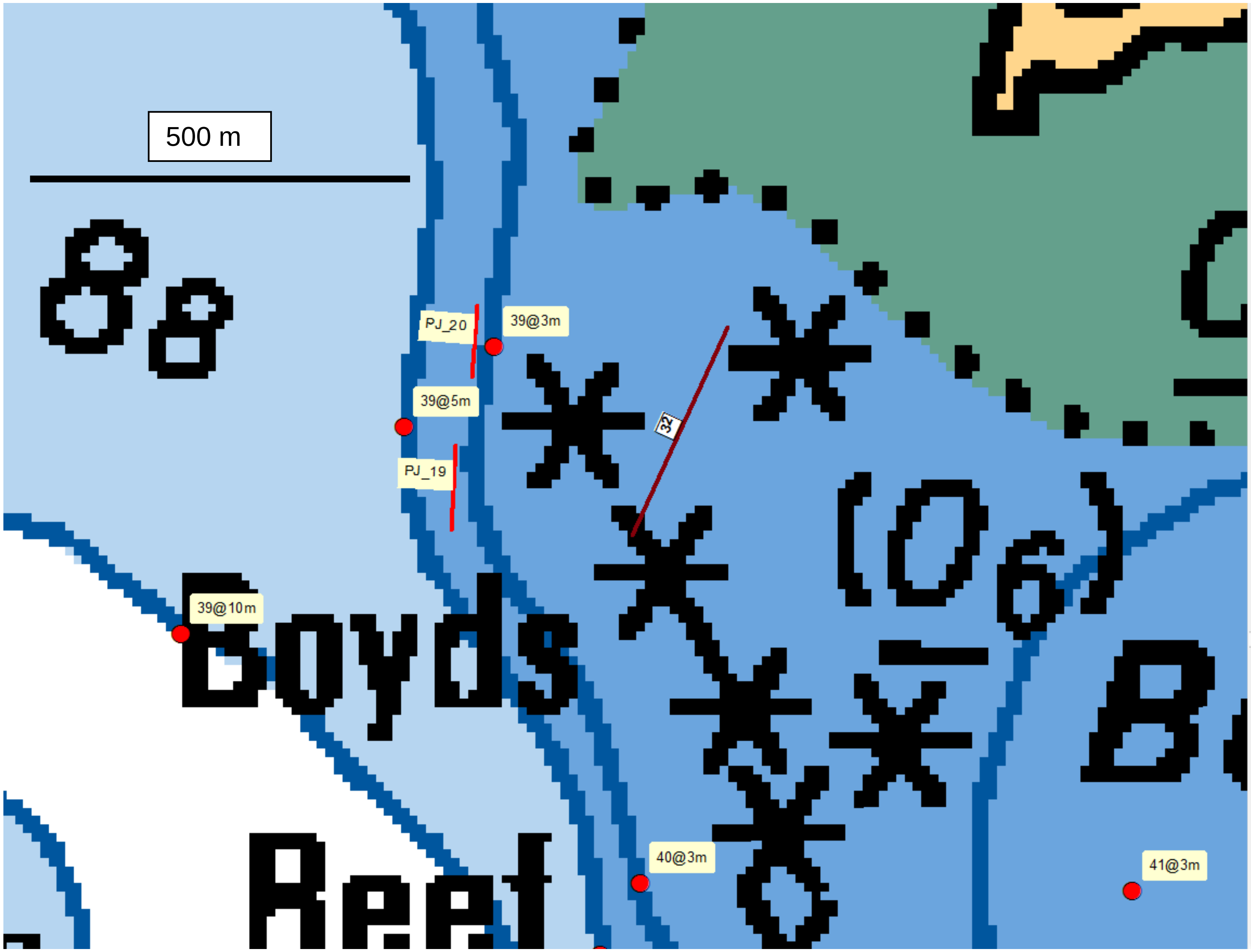

Figure 44: Past transect surveys near present drop camera locations; east mouth of bay