SEAMAP TASMANIA- MAPPING THE GAPS

V. Lucieer, M. Lawler, A. Pender and M. Morffew

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Executive Summary

"SeaMap Tasmania- Mapping the Gaps" has been a NRM North co funded project to facilitate the mapping of significant gaps in the SeaMap Tasmania database of marine habitats in the inshore coastal waters of Tasmania. These gaps included most of the coastline within the NRM North region (from Swan Island to Low Head) and specific priority areas in other NRM jurisdictions including the Tamar Estuary, Macquarie Harbour, and the RAMSAR listed wetlands of Orielton Lagoon, Moulting Lagoon and the Ringarooma lower floodplain. The area captured in this mapping research report adds a further 86,700 ha to the SeaMap Tasmania marine habitat database and completes the mapping of the coastal marine section within the NRM North region from the coastline to a 1.5 km limit.

The outputs of this project have included the production of 1:25,000 marine habitats maps published in both hardcopy form and on the Internet, and a DVD with Image Mapper software for viewing video transects that are linked to habitat maps with representative footage, images and statistics of biological communities. All maps have been provided to NRM North according the standardised data protocol in GIS format so that NRM have the capacity to contribute to resource assessment and investment decisions within their jurisdiction.

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1. Introduction

The current SeaMap Tasmanian database of the near shore habitats of the Tasmanian marine environment (0-40 m) to 2007 had significant gaps. These gaps included most of the coastline within the NRM North region and specific priority areas in other NRM jurisdictions including the Tamar Estuary, Macquarie Harbour, and the RAMSAR listed wetlands of Orielton Lagoon, Moulting Lagoon and the Ringarooma lower floodplain.

The main objectives of this research report were to:

- Generate detailed marine habitat maps at 1:25000 scale of the shallow coastal water to within 1.5 kms of the coastline (or 40m depth, which ever was arrived at first) of the areas 1) Swan Island to the Tamar River (including the Ringarooma lower floodplain), 2) Bicheno to St Helens, 3) Moulting Lagoon, 4) the Tamar River, 5) Macquarie Harbour and 6) Orielton Lagoon.

- Compile a spatial database for all the seagrass and adjacent habitat types and publish the metadata on the Land Information System Tasmania (LIST) and the maps on the SeaMap Tasmania website.

- To provide crucial information to the relevant councils to assist in land use decision making within the relevant catchments.

- To communicate the findings to stakeholders and the community

- To provide a comprehensive assessment of baseline extent of each estuarine and marine habitat type and;

- Establish the presence/absence of key invasive marine species.

The outputs of this project include:

- The production of 1:25,000 marine habitats maps in the identified area available to the public published in both hardcopy form and on the Internet.

- The production of a report detailing the biological and physical structure within the mapped areas of key habitat types (as defined by SeaMap Tasmania)

- The generation of a DVD with Image Mapper software for viewing video transects that are linked to habitat maps with representative footage, images and statistics of biological communities (Appendix 1 and 2).

- Provision of all maps in a GIS format conforming to the NRM North Data Protocol

- Production of comprehensive datasets to build digital layers that will contribute to resource assessment and assist the NRM regions with investment decisions.

These data are required by managers, industry and the community to contribute to sustainable natural resource management in the nearshore shallow marine waters of the NRM regional areas that these ‘gaps’ were present.

Previous studies in the region have either focussed on assessing specific areas for marine farm development (eg. Mitchell, 2003), potential Marine Protected Area (MPA) locations (Barrett and Wilcox, 2001; Barrett and Edgar, 1993), the distribution of selected seagrass beds (Rees, 1993), or have been completed at a very coarse scale (Edyvane *et al.*, 2000). This mapping project builds upon the data collected under the SeaMap Tasmania project and significantly increases the breadth of knowledge regarding subtidal habitats in Tasmanian coastal waters.

Habitat has previously been defined as “plant and animal communities as the characterising elements of the biotic environment, together with abiotic factors operating at a particular scale” (SGMHM Report, 2000). As this definition indicates, combinations of biological and physical parameters of the habitat are normally required to explain where a particular species or community is found. However, physical characteristics can often be reliably used to separate representative areas at the higher levels of the hierarchy of classification (Day and Roff, 2000), assuming that the important physical characters are known (e.g., wave energy, currents, nutrient load, substrate type, turbidity, water temperature).

The area captured in this mapping research report contributes another 86, 700ha to the SeaMap Tasmania marine habitat database since 2007 which completes the near shore marine area from Whale Head in the states south east to Robbins Passage in the northeast to 98% completed.

2. Methods

Information on the distribution of benthic habitats in this report was colleted through a combination of aerial photography (from aerial photography archives), acoustic surveys, underwater video and visual observations. The first step in the mapping process was the examination of aerial photographs from DPIW’s aerial photography library. These often gave good resolution of boundaries between seagrass, reef and unvegetated habitats out to approximately 10 m depth, but did not include information on depth and habitat structure. Extensive ground-truthing from the FRV *Nubeena II* provided substantial additional habitat information, and physical data on depth, relief and substrate type that was not available from the photographs. The 1.5 km limit was considered as the offshore boundary for this mapping project. SeaMap Tasmania protocol usually dictates that the mapping is completed to the 40 m contour but for the majority of this region the 40 m contour was too far from shore to survey in a small vessel. Field ground-truthing and survey work involved a series of transects perpendicular to the coast at distances no greater than 200 m apart in areas of coastal reef. Over broad areas of soft sediments, transects were conducted at greater intervals but with sufficient coverage to provide a reliable estimate of the areas bathymetry. The final maps were produced using the combined aerial photographs and field data to determine the most likely position of habitat boundaries. To determine the correlation of physical data to the biotic component of habitat type, regular video transects were conducted perpendicular to the coast, and biotic elements and physical variables recorded.

2.1. Aerial Photography

2.1.1 Selection of Aerial Photographs

The aerial photography archives of ILS (Information Land Services) DPIW, were searched to identify photographs that covered the selected area between West Head and Swan Island, George Town and Launceston, and St Helens and Bicheno. Fifty seven colour aerial photographs at 1:24,000 and 1:42, 000 were selected based on a calm water surface, suitable sun glint, water clarity, and camera angle for determining sub-surface features through the water column. Images taken between 2000 and 2006 were selected to provide the most recent coverage, with good resolution and water penetration. Appendix 3 lists the aerial photographs selected for this research and their coverage.

2.1.2 Scanning of Aerial Photographs

The selected archival aerial photographs were captured with an A4 flat bed colour scanner at 600 DPI (dots per inch). The scanned images were stored as 24 bit colour TIFF images and viewed in the field as MrSID wavelet compressed images.

2.1.3 Registering and Rectification of Aerial Photographs:

Each image was georectified using ArcGIS 9.2 (Environmental Systems Research Institute (ESRI)) to the LIST (Land Information Services Tasmania) 1: 25 K coastline coverage in GDA94 Zone 55. To rectify, a minimum of 4-ground control points were selected for each image. The RMS (root mean square) error is an indicator of the position of each pixel relative to its location in the real world. The average RMS error calculated for the images was ~ 0.00015 degrees.

2.1.4 Capturing data from Aerial Photographs

The aerial photographs were displayed in *ArcGIS 9.2*. True colour images generally store data using twenty-four bits per pixel. Each pixel is composed of three eight-bit bands representing the red, green and blue colour components. Images are stored as raster data, where each cell in the image has a row and column number. The images were displayed with the coastline information overlayed over the top of the image.

In order to clearly identify certain features such as reef, sand and seagrass, the colour intensity and contrast of the image was altered via “stretching” each band. For multi-band images, a compositing process allows the creation of a true colour image by identifying the three bands used to represent the red, green and blue colour components. These three colour components can be altered using a linear or logarithmic scale to reduce or increase the intensity of that band.

The quality of the imagery accessed for this project was consistently high and consequently the aerial photographs were used as a primary source of information to aid in determining the boundaries of the habitat type. Please note, however, that due to the ambiguities inherent in interpretation of through-water imagery in the shallow subtidal environment, careful checking in the field was required to confirm the habitat types.

2.2 Field Data Collection

Habitat boundaries and attributes from the coastline to 1.5 km from the coast were determined using an echo sounder and video surveys. The details of the field surveys are covered in the following sections.

2.2.1 Acoustic Data Collection

The benthic substrate was acoustically sampled using a Simrad ES60 acoustic echo sounder. A series of transects were conducted perpendicular to the coastline. Transects were spaced approximately 200 m apart, and ran from shore to a baseline established 1.5 km from shore. The echo sounder was set to ping every 0.5 seconds, with a pulse length of 0.256 ms and a power setting of 100 W. The output from the echo sounder along with positional information from an OmniLite132 differential GPS unit was logged using the Simrad ES60 software (v.1.5.2.76 Kongsberg, Simrad).

The logged sounder output was imported into EchoView 3.30 (SonarData) for classification. Different benthic substrates were determined based on changes in the thickness and intensity of the echo sounder output. Harder substrates, which reflect more acoustic energy, appear with a stronger second echo, while rougher substrates, which scatter more of the acoustic energy, appear with a longer tail on the first echo. Seagrass could also be distinguished based on the presence of acoustic reflectance above the sounder detected bottom. These acoustically different echo returns were related back to substrate type based on ground truth information collected by underwater video. The echo sounder output was visually classified as reef, cobble, sand, or seagrass.

Field data was sampled at fixed time intervals adhering to a “zigzag” pattern of transects perpendicular to the coast. These transects were run at 200 m intervals along the coast, or more frequently where habitats changed rapidly or had patchy distributions. *ArcPad* 6.0 was employed in the field to display previous transects and help maintain a regular field-sampling regime. Habitat was broadly categorised into three main groupings. These consisted of consolidated substrates, unconsolidated substrates and seagrass. Each of these broad categories was broken down into numerous sub-categories based on structure for consolidated habitats, dominant sediment type for unconsolidated substrates and blade density for seagrasses (see Table 1 for detailed descriptions).

The only elements of the biotic community that could be readily distinguished on the sounder were dense beds of the macroalgae *Macrocystis angustifolia* and seagrass, mostly *Heterozostera tasmanica*. The remaining biotic components required video drops for identification.

In the shallow lagoons (Orielton Lagoon and Moulting Lagoon), the vessel based mapping was supplemented using a kayak. The kayak was fitted with a GPS device, a sediment corer and a bathyscope. The kayak was paddled across the shallow tidal flats that were inaccessible to the powered vessel. At regular intervals the substrate was recorded along with a GPS mark. Distinct boundaries between habitats were also noted where present.

Figure 1 to Figure 6 demonstrate the acoustic sampling transect surveys for each of the regions.

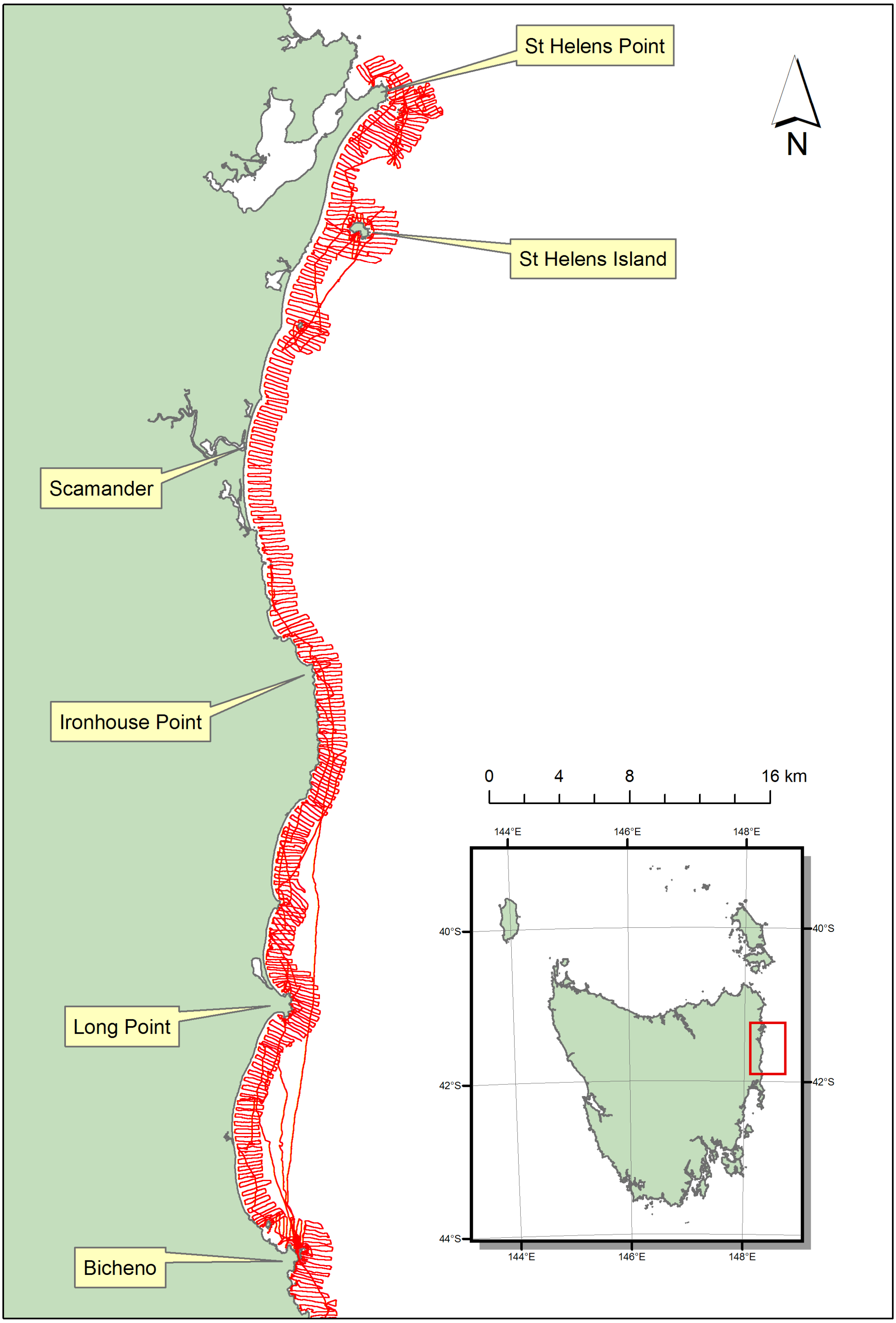

Figure 1. Acoustic transects sampled from Bicheno to St Helens.

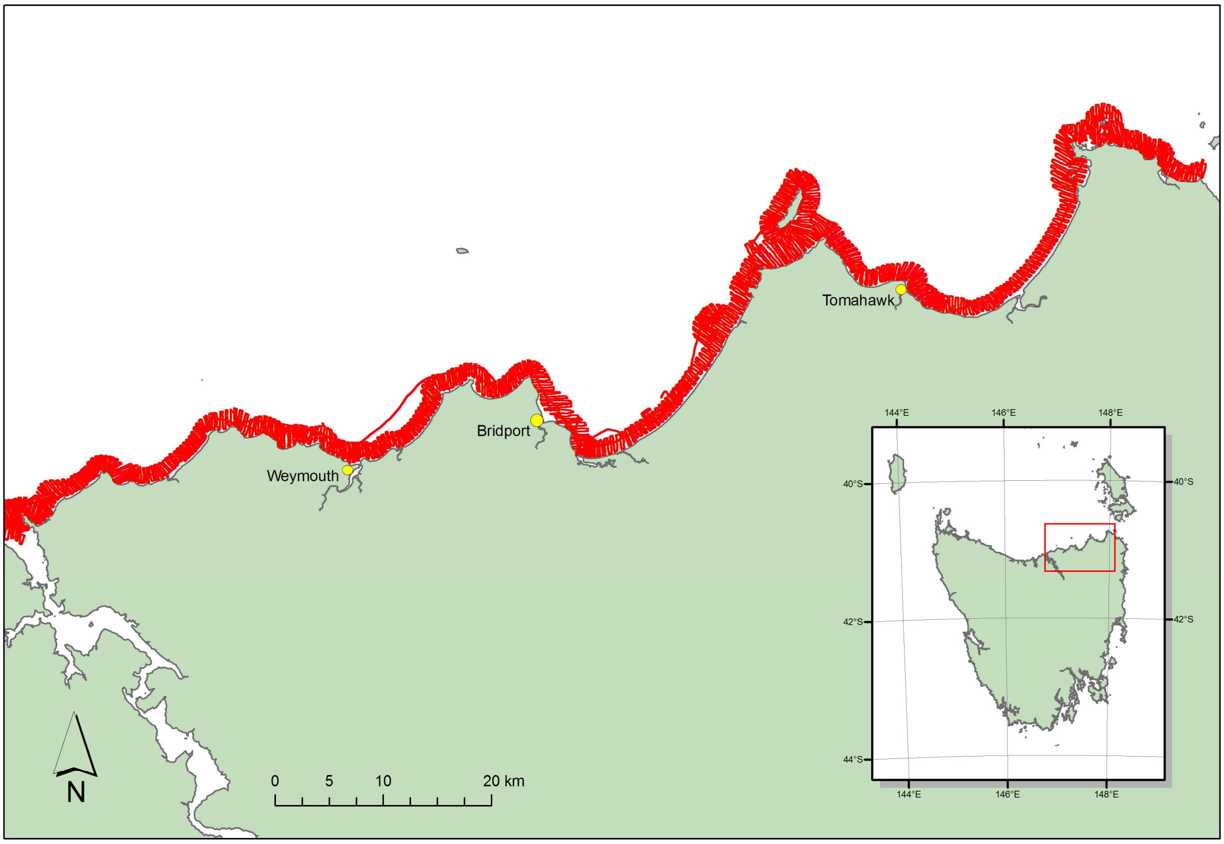

Figure 2. Acoustic transects sampled from the Tamar River to Swan Island.

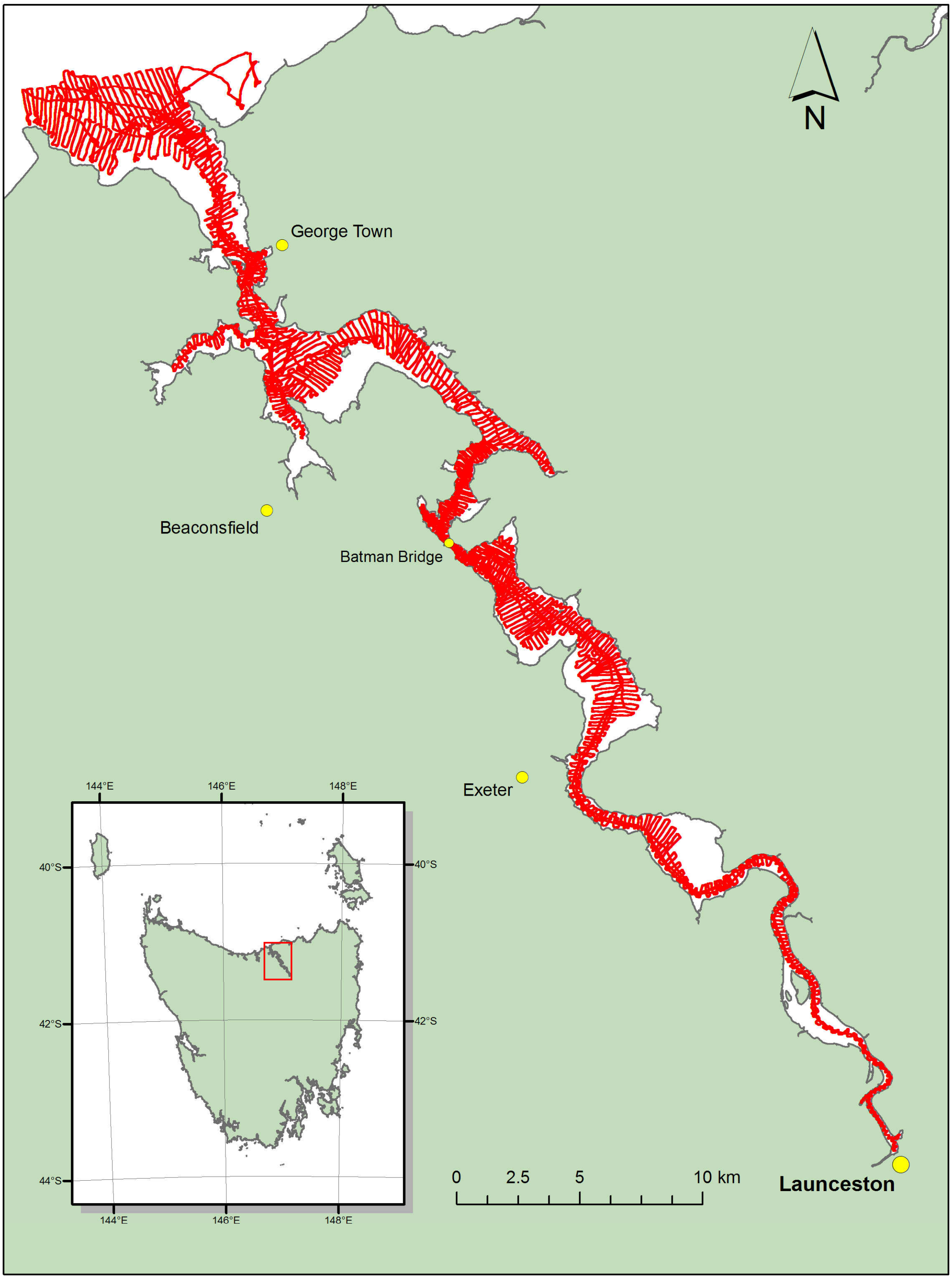

Figure 3. Acoustic transects sampled for the Tamar River.

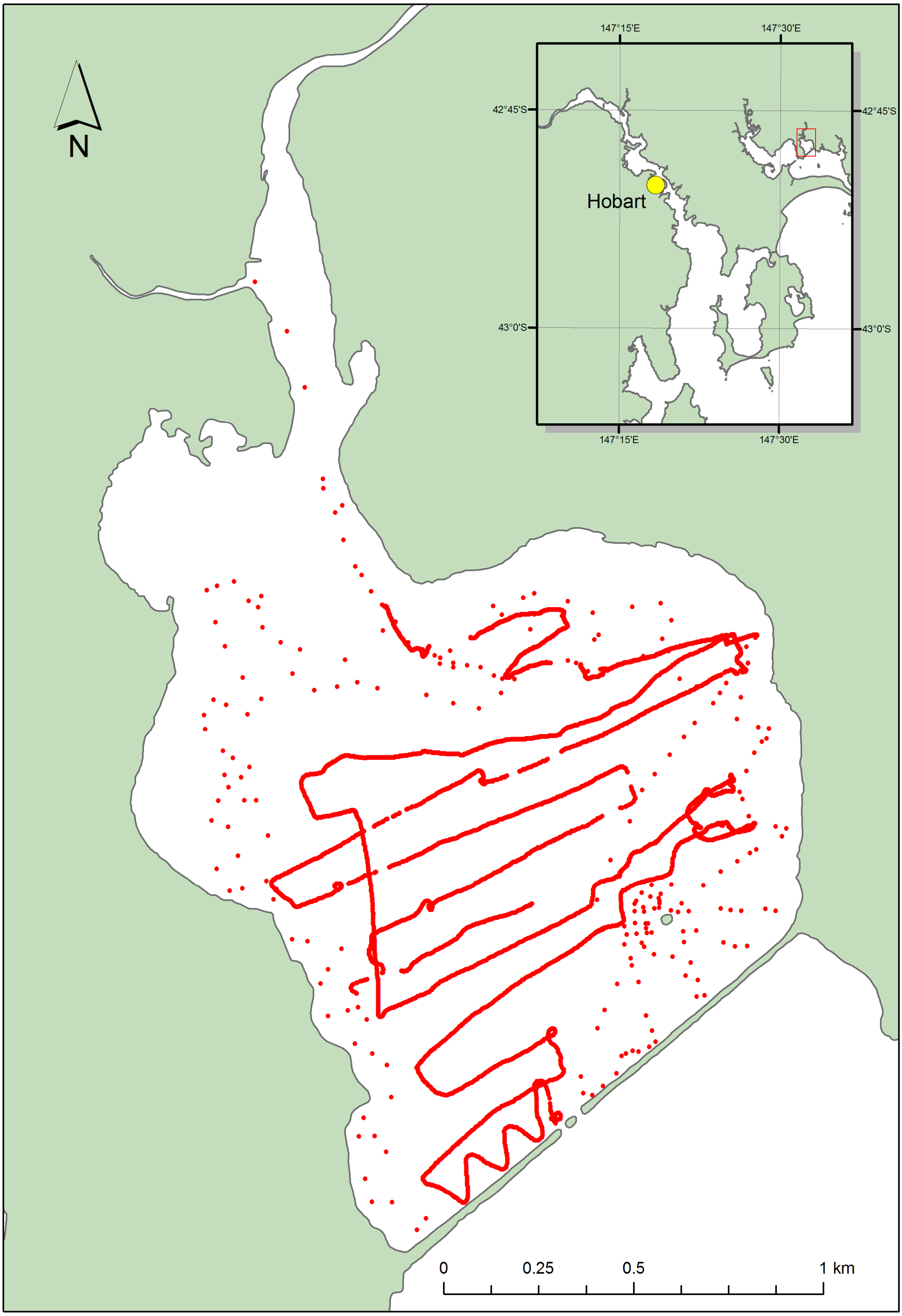

Figure 4. Acoustic transects sampled for Orielton Lagoon.

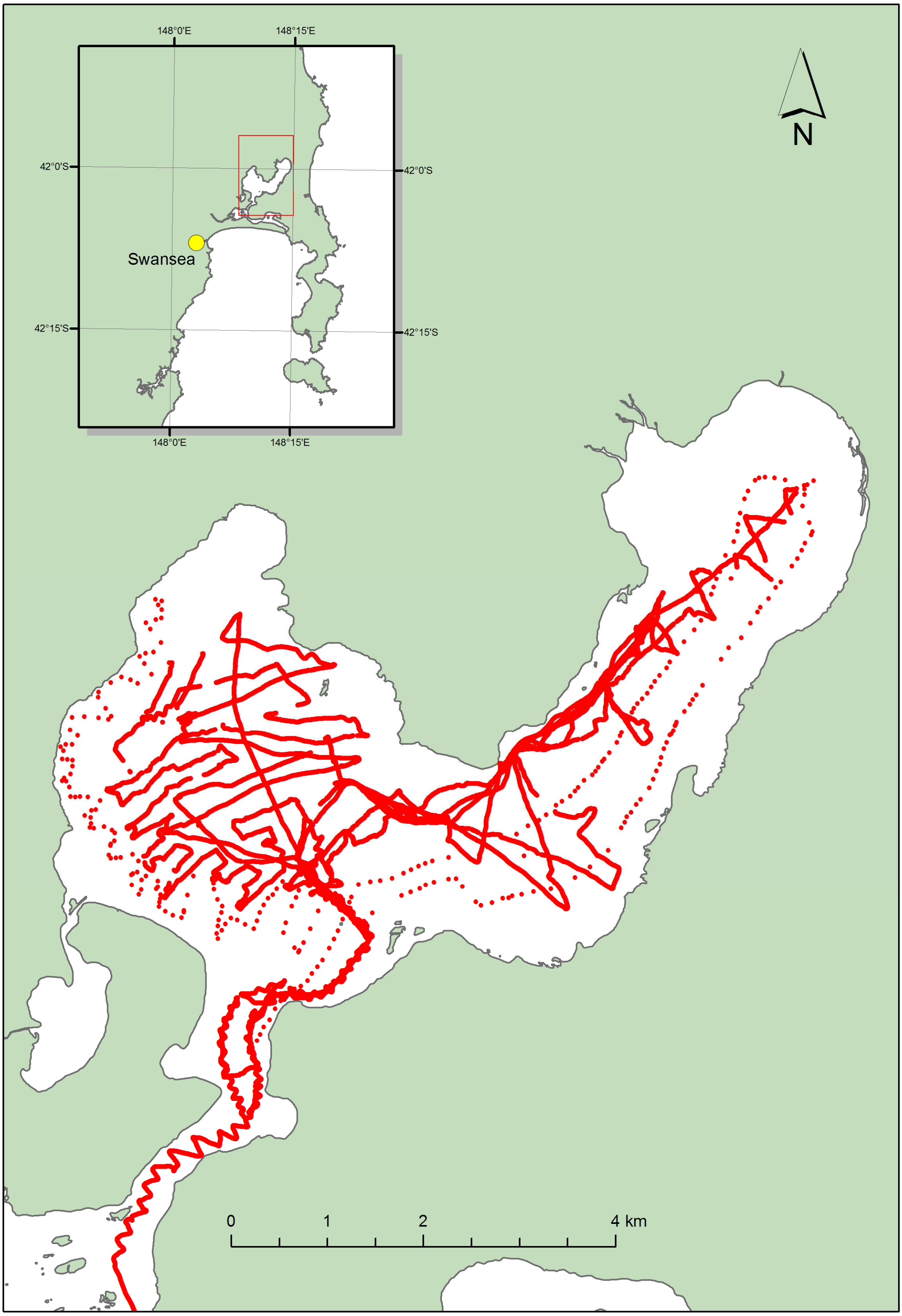

Figure 5. Acoustic transects sampled for Moulting Lagoon.

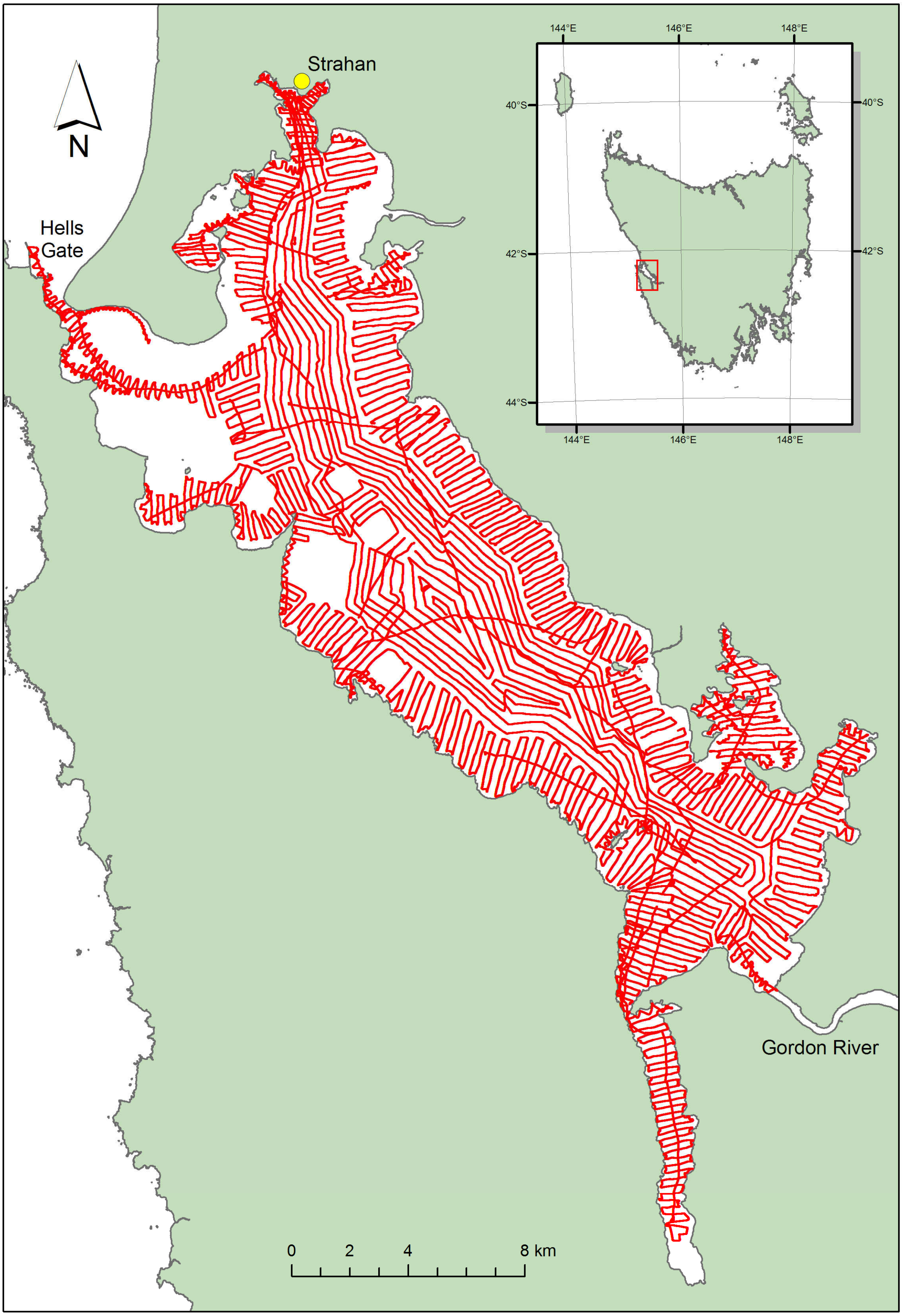

Figure 6. Acoustic transects sampled for Macquarie Harbour.

2.2.2 Bathymetric Layers

Bathymetric data was recorded by the ES60 echo sounder. Logged data files were imported into EchoView 3.30 where the sounder detected bottom was checked for anomalies, corrected for the transducer depth and exported as a comma delimited text file containing depth and position.

2.2.3 Video Data Collection

A submersible digital video camera, (SciElex, TAS, Australia) was deployed at selected locations throughout the study region (Figure 7 to Figure 12). These samples were used to verify the aerial photography and echo sounder substrate classification and obtain more detailed information on algal distribution. Positional information was recorded for each video drop as a series of DGPS co-ordinates and also as a direct overlay of the DGPS output (position, date and time) onto the video. The video was analysed for dominant flora and fauna for each habitat type.

The total percentage covers of all algal and seagrass species was recorded over five second blocks of video. Dominant species were identified to the lowest taxonomic level possible. Percentage cover was recorded in accordance with a 0-4 number scoring system where 0 = no algae, 1 = 0 – 25 % cover, 2 = 25 – 50 % cover, 3 = 50 –75 % cover, 4 = 75 – 100 % cover. The dominant algal communities for each habitat type were examined for each of the reporting sections in 5 m depth bins based on this video data. A minimum of 30 replicates from each combination of habitat type, depth bin and reporting section were completed for the analysis, where this criteria was not met the algal data were not analysed for that class.

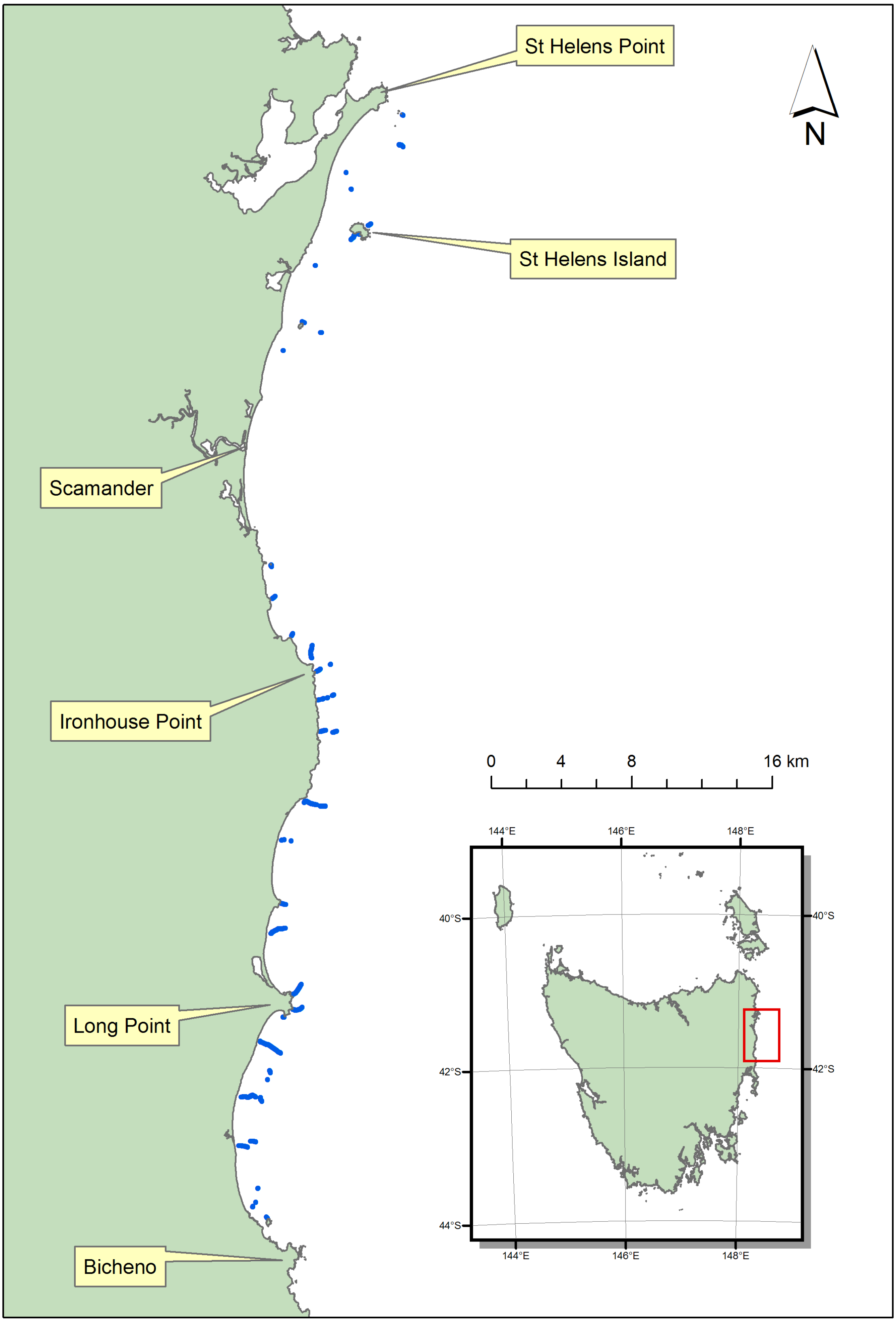

Figure 7. Video transects sampled for Bicheno to St Helens.

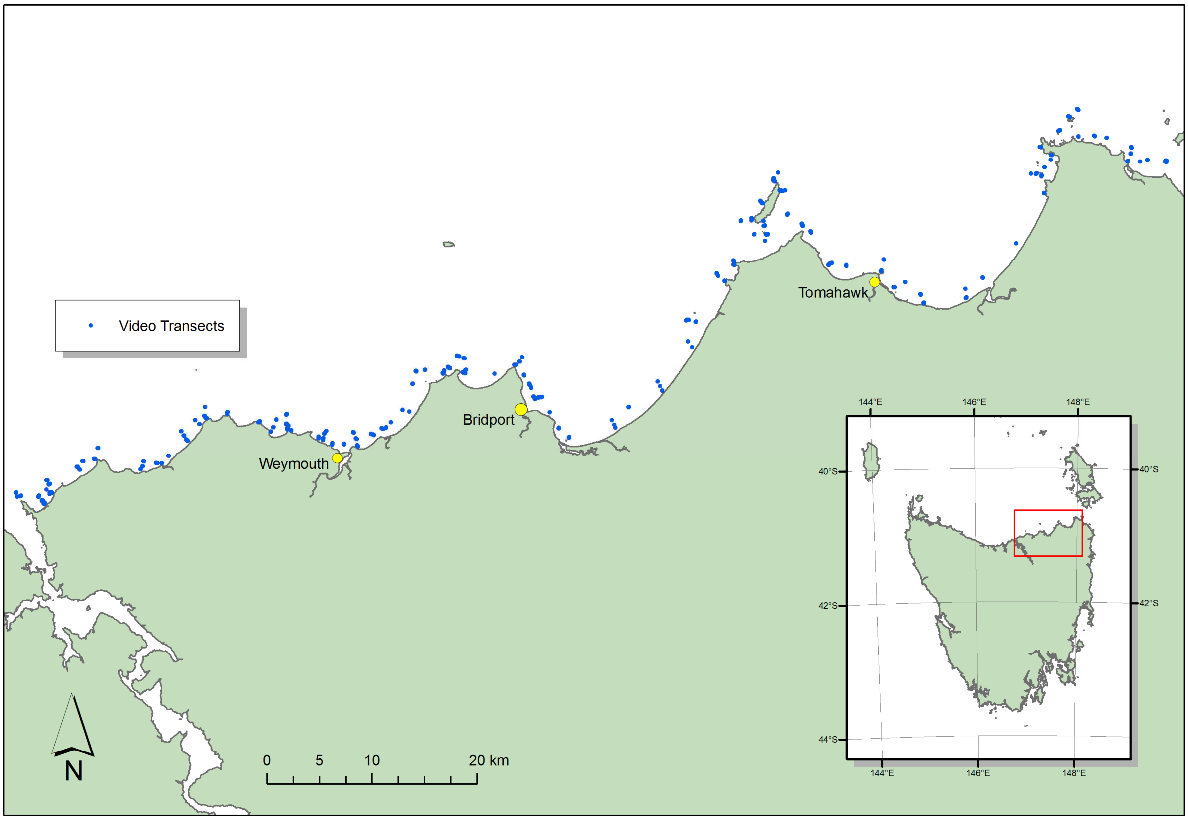

Figure 8. Video transects sampled from the Tamar River to Swan Island.

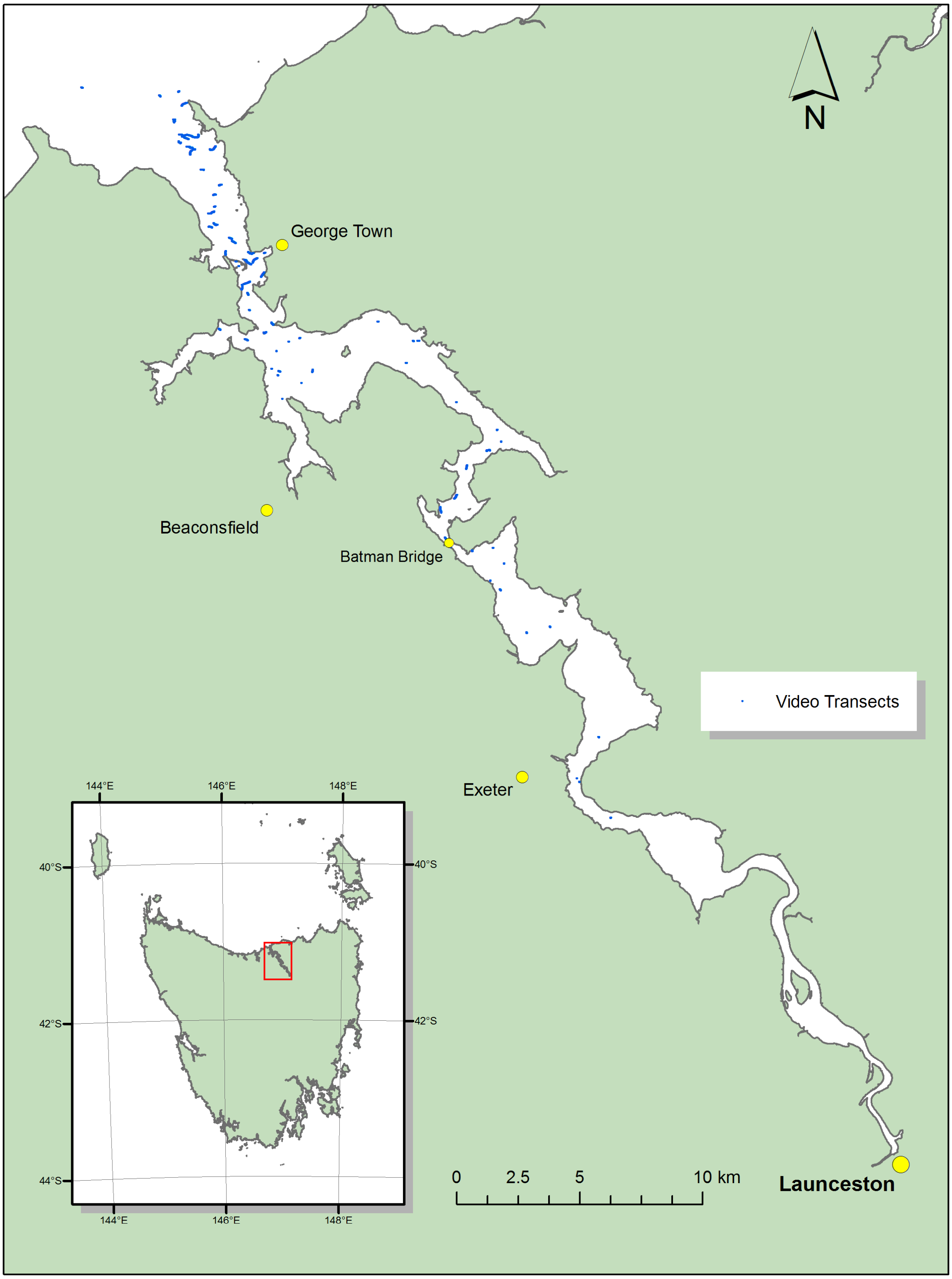

Figure 9. Video transects sampled for the Tamar River.

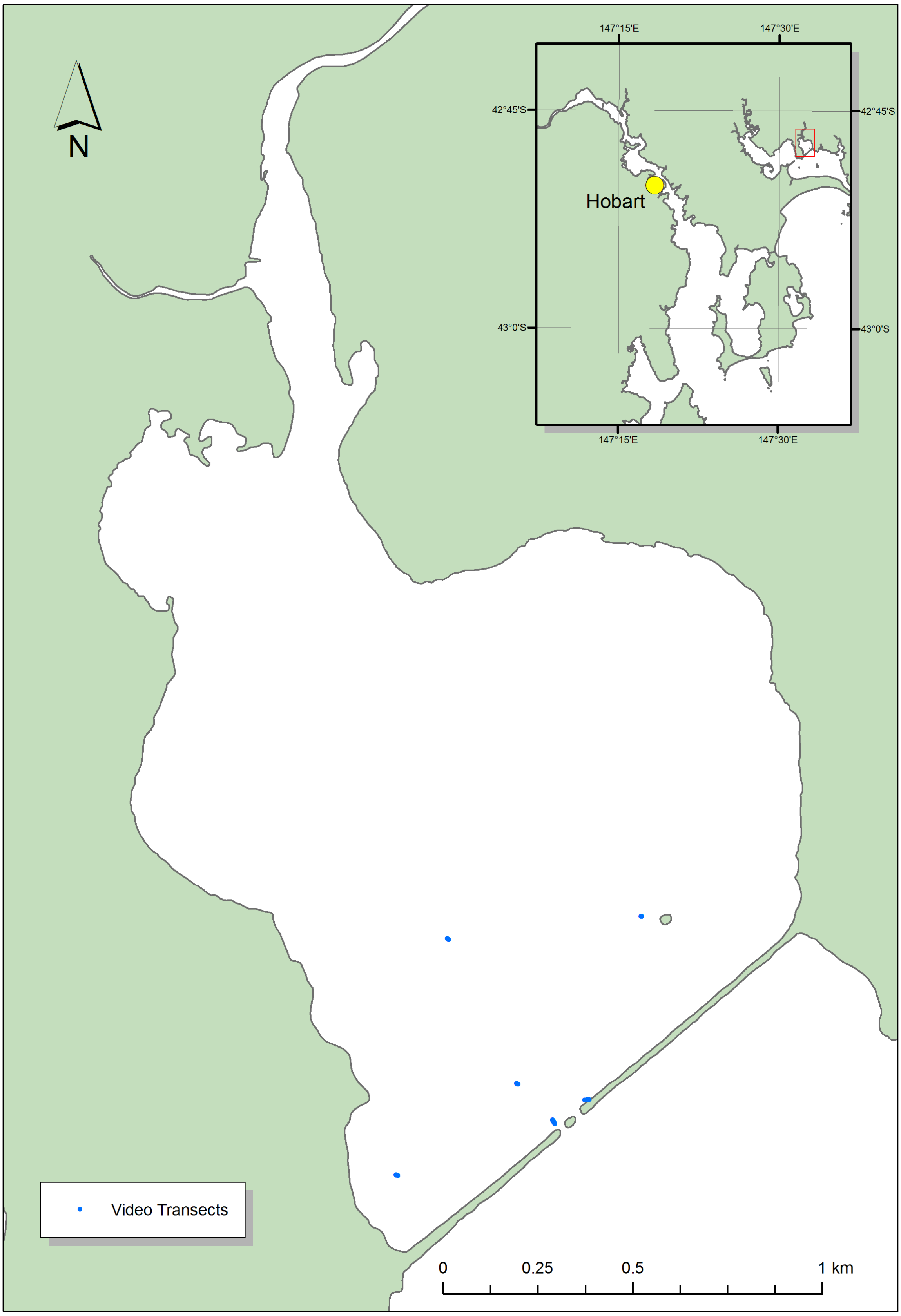

Figure 10. Video transects sampled for Orielton Lagoon.

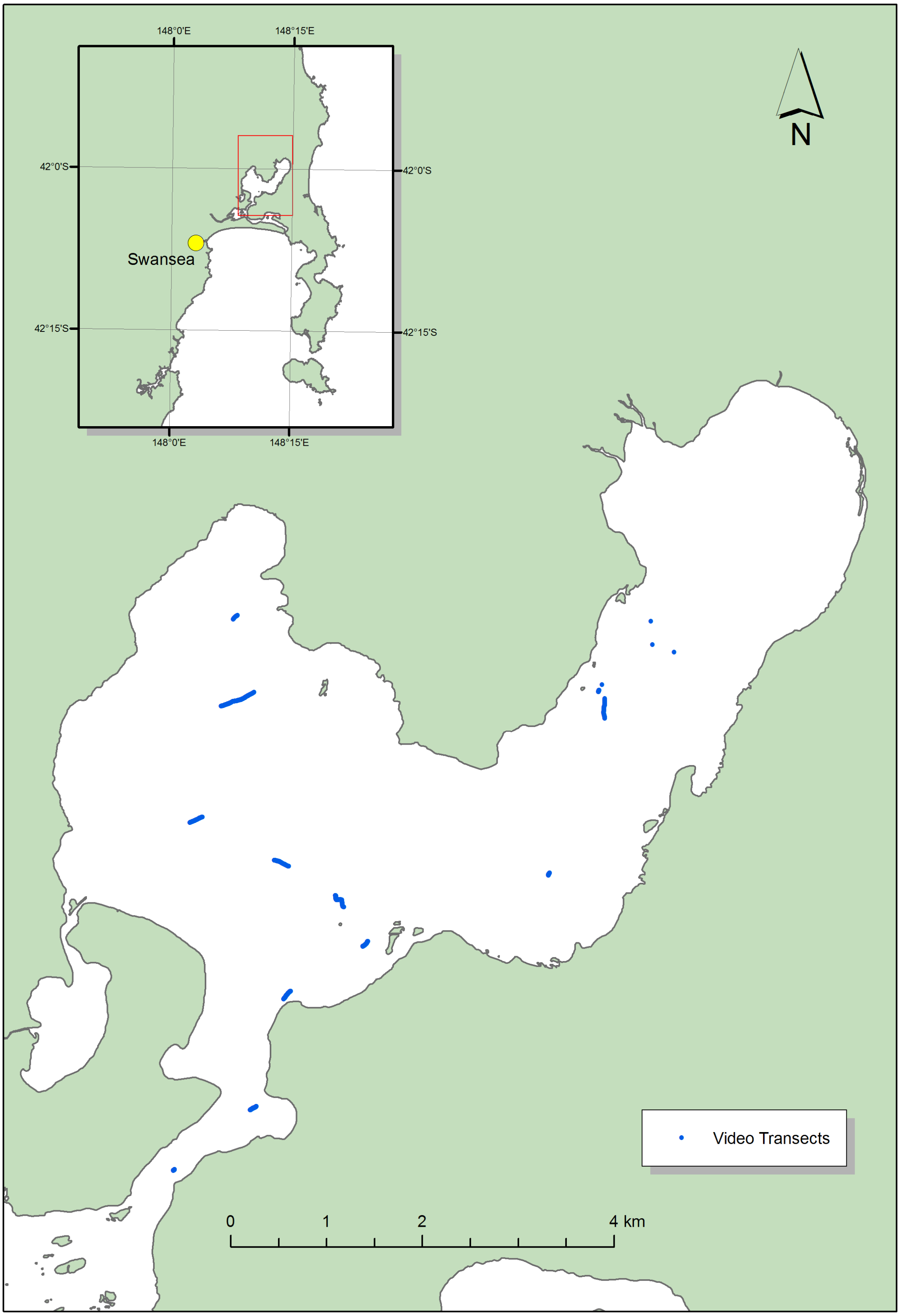

Figure 11. Video transects sampled for Moulting Lagoon.

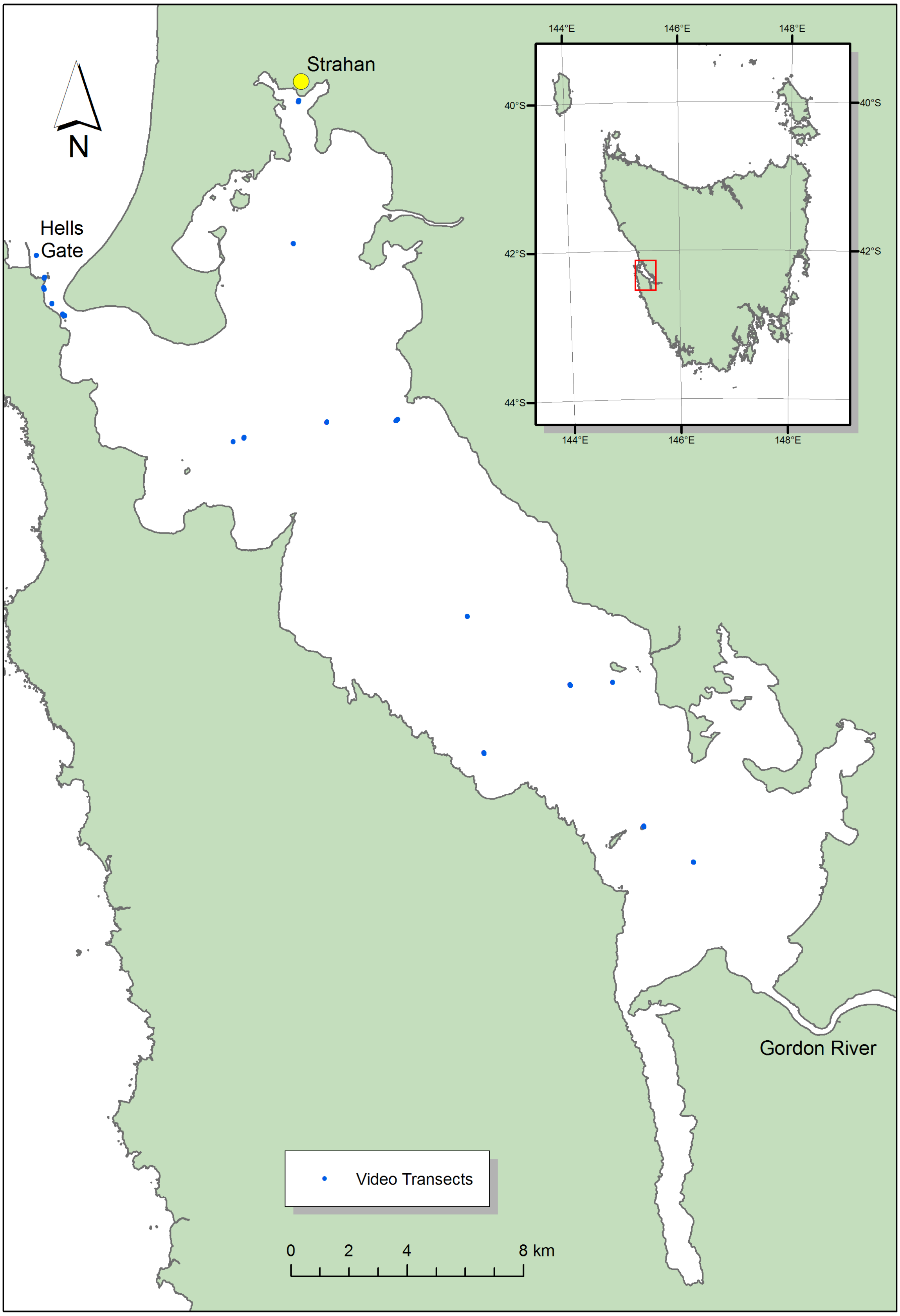

Figure 12. Video transects sampled for Macquarie Harbour.

The trends in algal cover were also examined from east to west across the entire region. These trends were most apparent in the 0 – 5 and 5 – 10 m depth bins. For this analysis the algae were divided into broad groupings. The classification of 'thallus brown algae', referred to in the bar graphs of this analysis, is used to describe large brown algae with fleshy thalli, as opposed to filamentous brown algae, which have filamentous thalli. Along the north east coast of Tasmania this group comprises a broad grouping of species including the following main species *Phyllospora comosa*, *Ecklonia radiata*, *Acrocarpia paniculata*, *Carpoglussum confluens*, *Cystophora* spp., *Sargassum* spp., *Caulocystis* sp., and *Seirococcus axillaris*. *Ecklonia radiata* has been presented separately from this group to show the specific trends in this species.

There are limitations to using video to survey algal communities including water clarity and weather conditions. The ability to identify many algae to species level is not possible given the resolution of the video. Often algae can only be identified to genus level (i.e. *Cystophora* sp.) or functional groupings (i.e. turfing algae). Video can only be deployed in water depth where the vessel could survey, thus depths less than ~1 m were not surveyed in sheltered areas, and often as deep as 3 – 4 m in more exposed areas. This coupled with the large tidal range (> 2 m) along this coast resulted in many of the intertidal and immediate subtidal algae not being consistently sampled across the study region.

2.2.4 Algal ID validation

Many of the turfing algal species could not be identified from the video transects due to the speed and resolution of the video sampling. An algal dredge was used to take samples at locations corresponding to the video drops where large amounts of turf were observed. The algal dredge, made from a plate of aluminium with tapering slots to capture the algae, was towed along the reef for several minutes to collect algae. The algal sample was labelled and stored for identification in the laboratory using a microscope. The major species were identified to the lowest taxonomic level based on Fuhrere *et. al.* (1981), Edgar (1997), and Huisman (2000).

2.2.5 Sediment Sampling

Sediment samples were taken at regular intervals to confirm the sounder classification of the unconsolidated substrate using a Van Veen grab. A representative sample of the surface sediment was taken for particle size analysis. This sample was processed using a wet sieving method and the resulting particle size data classified using the Wentworth scale. The locations of the sediment sampling sites are shown in Figure 13 to Figure 17. No sediment samples were obtained in the Bicheno to St Helens mapping region due to unsuitable weather conditions during the sampling period. The sediment sample numbers on the maps correspond to the particle size graphs within each reporting section.

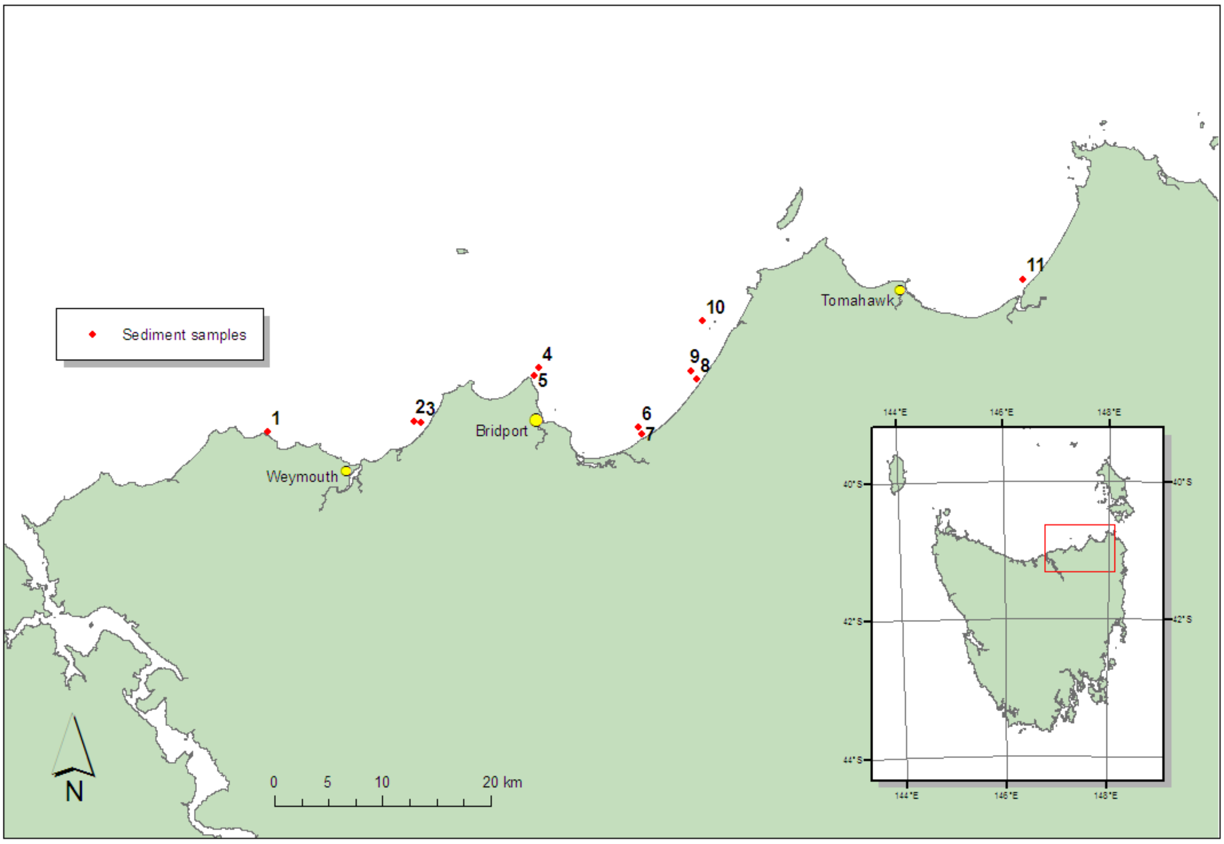

Figure 13. Sediment sample sites for Swan Island to the Tamar River mapping region.

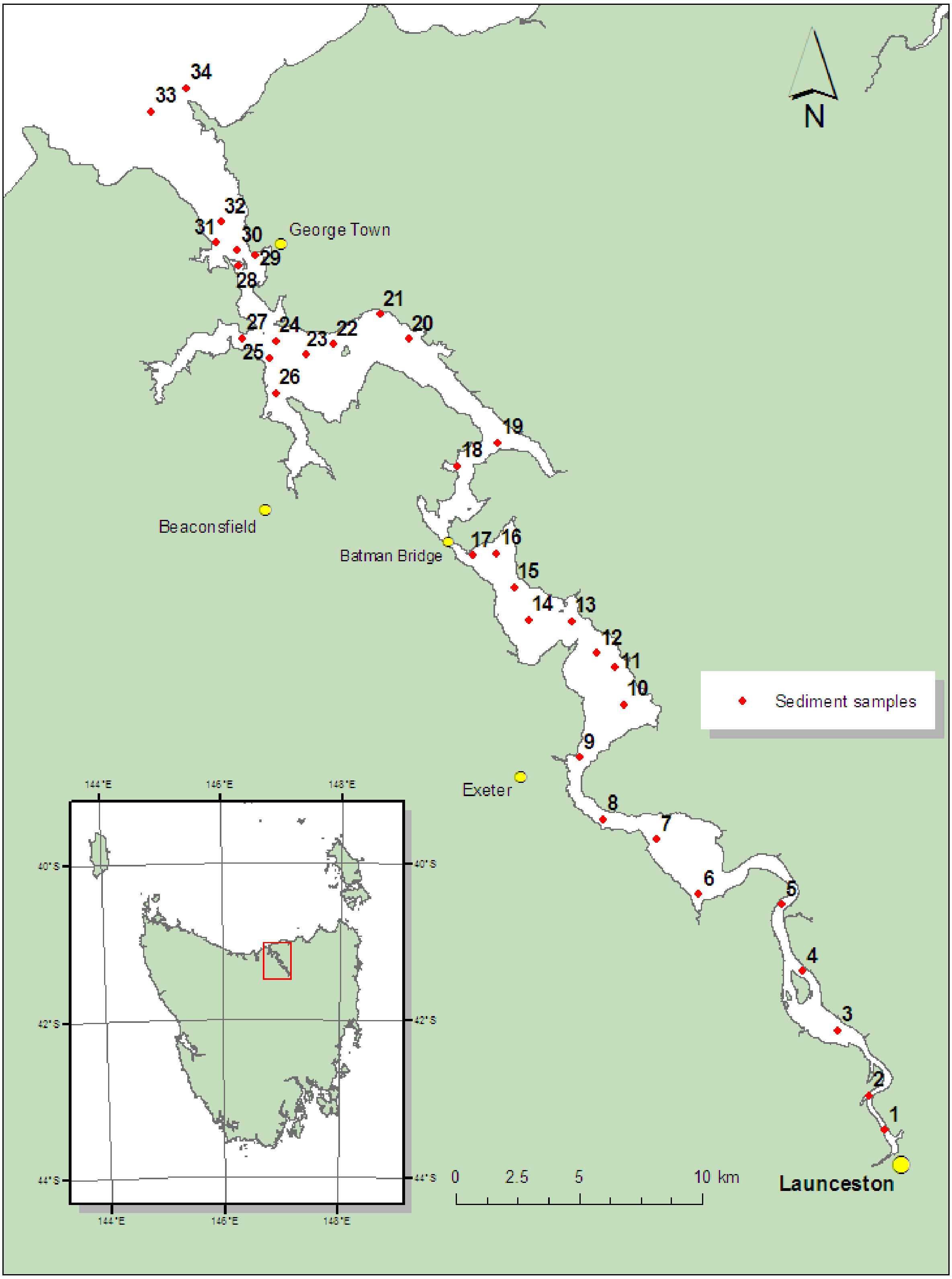

Figure 14. Sediment sample sites for the Tamar River mapping region.

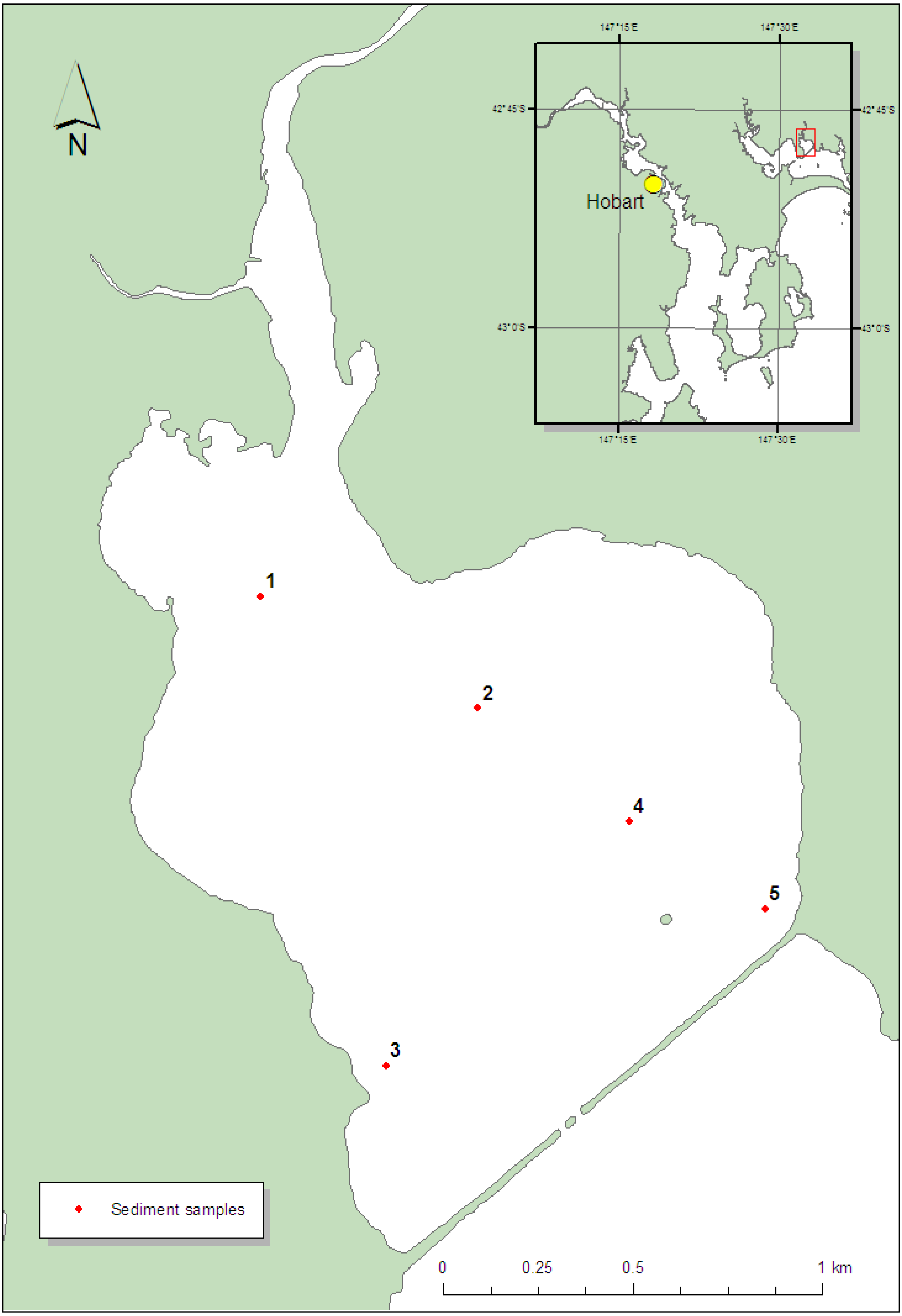

Figure 15. Sediment sample sites for Orielton Lagoon mapping region.

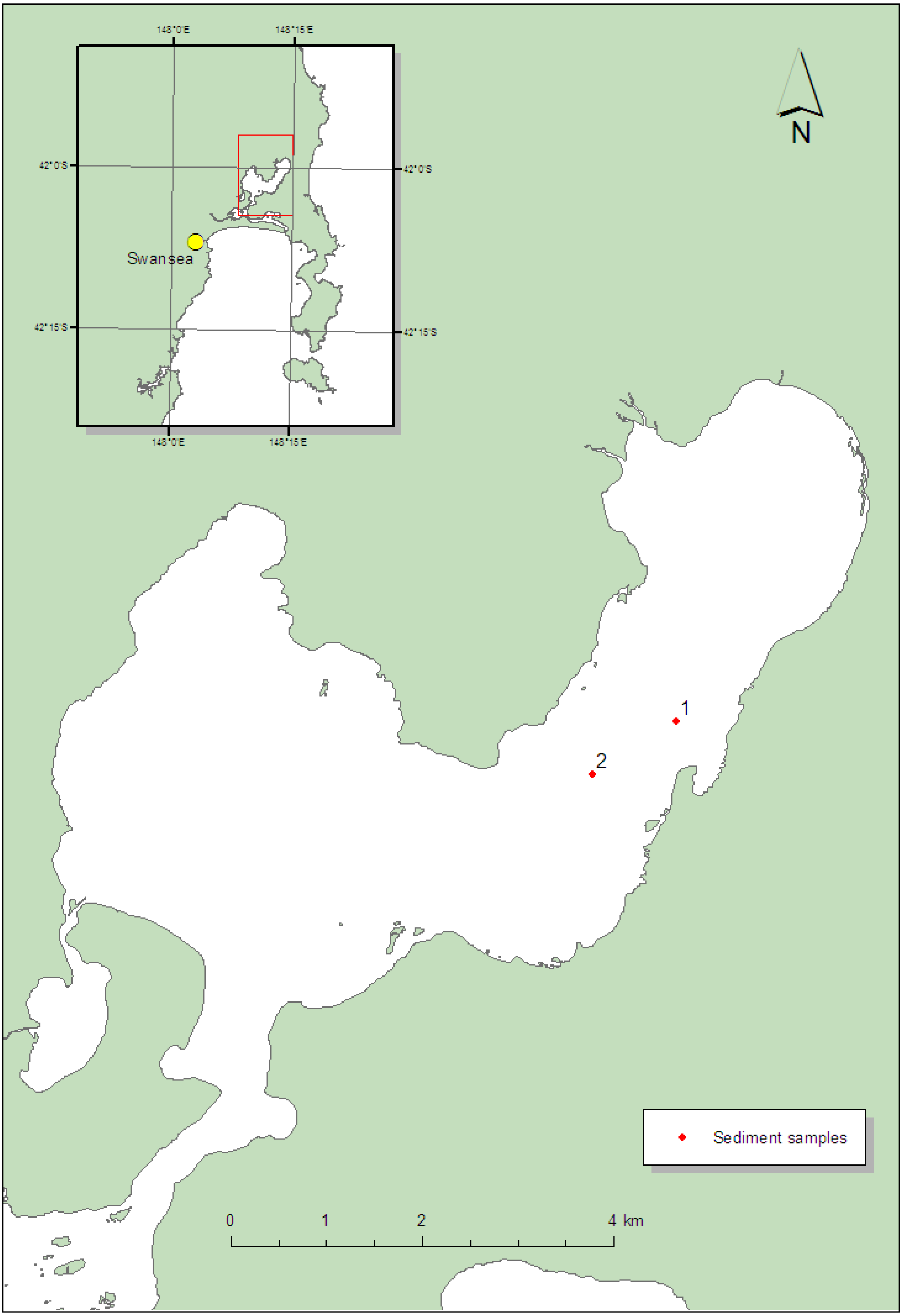

Figure 16. Sediment sample sites for Moulting Lagoon mapping region.

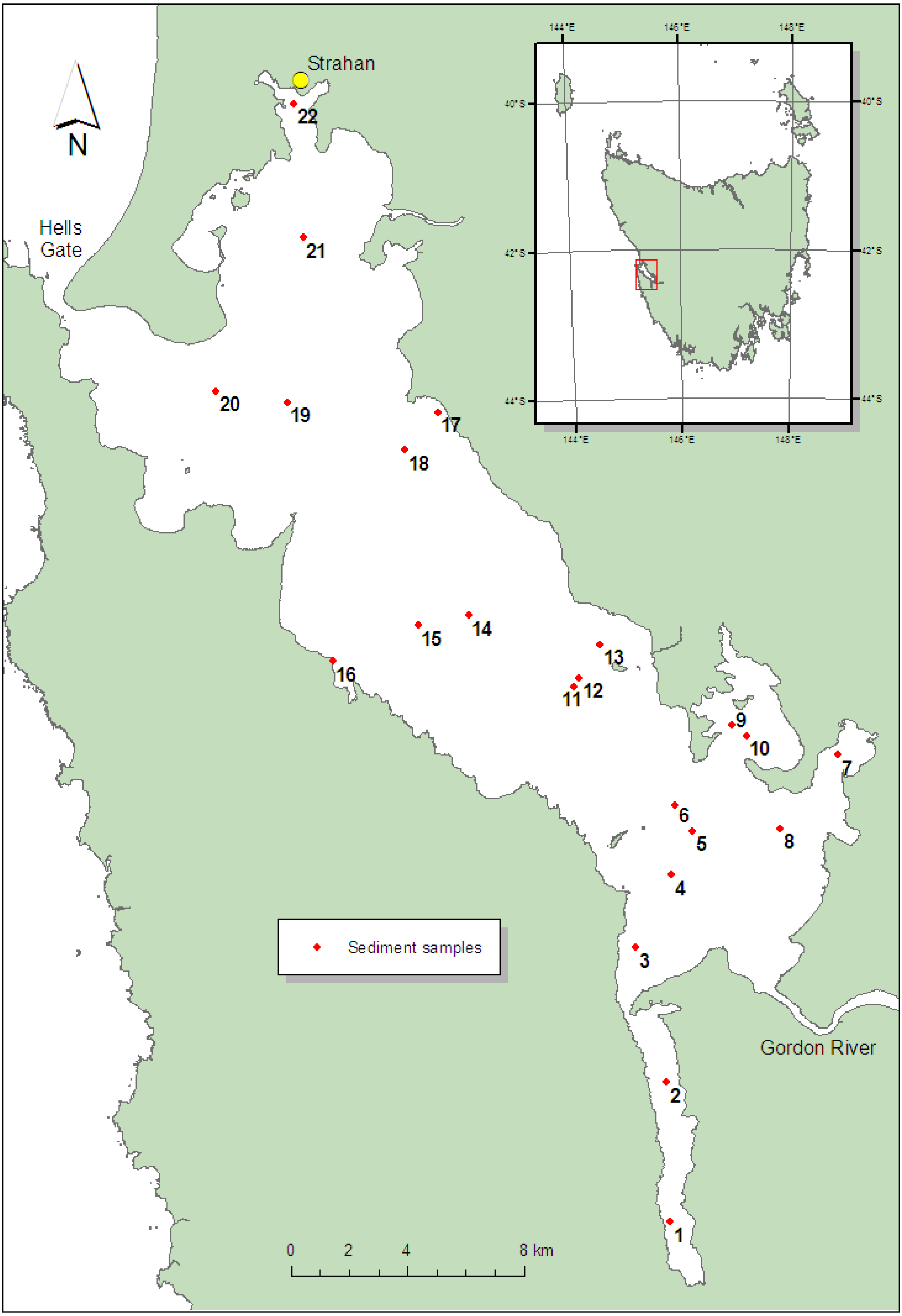

Figure 17. Sediment sample sites for Macquarie Harbour mapping region.

2.3 Analysis

2.3.1 Cartography

The classified data files from Echo View 3.30 were imported into ArcGIS 9.2 as point data and were used to generate shapefiles of the different habitat types by on-screen digitising. At the 1:2,000 scale, the points were carefully connected to form polygons of similar habitat type. The outer (deeper) boundary of the polygon was generally identified in the field and with these points overlaid on aerial photographs, a habitat boundary was identified and a polygon drafted. The aerial photographs were primarily used to help in determining the boundaries between sand and reef that were initially attributed from the field data. The underwater video documentation was used to help verify the habitat type and the interface between different substrates. In some instances, reef covered by sand and not seen in the aerial photo were picked up by the echo sounder. Likewise, low plant biomass areas observed from photographs that reflected as predominantly sand on the echo sounder have been recorded as sand, unless the plant biomass was found from video drops to be seagrass beds.

The classification table followed for the mapping of habitats on this section of coast is shown in Table 1.

Table 1. Map Legend and definitions of substrate types and habitat categories used in this study.

Consolidated Substrates
Reef The term reef is applied to any consolidated substrate. It typically consists of rocky outcroppings and may be of any profile or rugosity.
Cobble This definition referred to a hard bottom type consisting of small rocks generally less than 30 cm in diameter.
Unconsolidated Substrates
Sand Sand was the most commonly encountered unconsolidated substrate. It represents the coarser end of a scale of sediments.
Silt Silt substrate is common in deeper sheltered bays or the within the estuarine regions. This habitat category represented the finest unconsolidated substrate. Silt was characterised in the echogram by a lack of a second echo and often little scatter in the trace tail.
Vegetated unconsolidated substrate
Aquatic Macrophytes The aquatic macrophyte category covered subtidal vegetated in areas that included multiple species, and were unable to be separated based on acoustic data. These species included but were not limited to the seagrasses *Heterozostera* tasmanica, *Ruppia* sp, and the hornwort.

Seagrass

The seagrass category referred to the areas of dense seagrass, where the substrate, usually sand, was completely covered by seagrass and the patch size was greater than 20 m wide. Three species of seagrass commonly occurred sub-tidally within this regions surveyed. These being *Heterozostera tasmanica*, *Amphibolis antarctica* and *Posidonia australis*.

Ruppia

Ruppia sp. is a seagrass that form extensive beds in brackish water. This species is confined to estuaries and coastal lagoons, and has been separated from the other seagrass species based on it forming large single species beds that are rarely mixed with the other species, which generally occur in more marine water.

Ricegrass

Ricegrass, *Spartina anglica*, is an introduced species found in several estuaries around Tasmania, most notable the Tamar estuary. This species is common on intertidal mud flats.

The field data were assessed for errors before cartography commenced. The resulting habitat polygons are the basis of the habitat maps forming the main body of this report, which were summarised to establish the extent of each habitat class for each reporting section.

2.3.2 Tidal correction of bathymetric data

Depth measurements from the Simrad ES60 were tidally corrected. These depths were corrected for tidal variation based on the predicted tide heights from the National Tidal Facility (http://www.bom.gov.au/oceanography/tides/). The tidal cycle can be described by a harmonic equation:

$$D_i = D[h_1+(h_2-h_1)*(\cos(\pi*((t-t_1)/(t_2-t_1)+1))+1)/2]$$

Where D_i is corrected depth and D is measured depth, $h_{1,2}$ correspond to the heights of the high and low tides, $t_{1,2}$ are the times of the high and low tides with t being the current time. This formula calculates the height of the tidal cycle for a given time and a given location and then applies this as a correction to the measured field data. All depth measures were corrected to Mean Sea Level based on the available standard port measurements.

2.3.3 Contouring

A depth surface was generated from the field-collected data through the interpolation of depth (*z*) values. Interpolation is the procedure of predicting the values of attributes at unsampled sites from measurements made at point locations within the same area or region. This transformation is based on the Triangular Irregular Network (TIN) data model. Contours in ArcGIS 9.2 were created by interpolating the point data into a TIN. To minimise erroneous data points and to create smoother, more natural contours the TIN data was converted into a 10m raster grid, then a 5 cell circular focal filter was applied to the raster. The contours were created from this raster. The contour coverage provides another source of information from which the habitat polygons can be verified against, especially for seagrass, which has a maximum growth limitation. The contour intervals were generated every 5 m.

2.3.4 Reef Profile

Reef profile was calculated from the raw acoustic data collected from eh ES60 Echo sounder. Reef profile was calculated as the rise/fall of reef height over a moving 10 linear metre window (see figure below). Reef profile was only calculated for acoustic transects that were perpendicular to the shoreline (i.e. onshore/offshore transects). Low profile reef was defined as a rise/fall of less than 1 m, medium profile reef was defined as a rise/fall of 1 – 4 m, and high profile reef was defined as a rise/fall of greater than 4 m across the 10 m window.

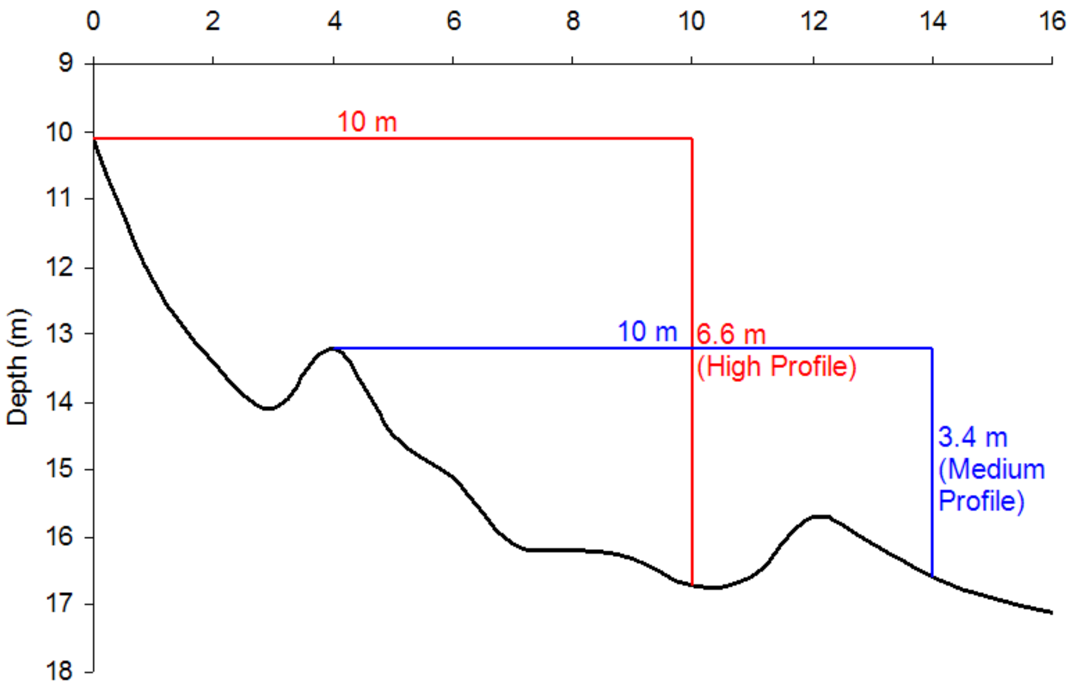

Figure showing two moving 10 metre windows (red and blue) used for calculating the reef profile across the sounder detected bottom (black line)

2.3.5 Error analysis

An error analysis has been completed for each of the reporting regions within this report. The error analysis is a validation of the acoustically defined classes using the video transects. The overall accuracy results are defined as the closeness or nearness of the measurement to the true or actual value being measured (usually represented as a percentile). Error matrices were generated in Excel to calculate the overall interpolated map accuracy and the accuracy of each class within each reporting section. The video points were overlaid with the habitat polygon layer to compare the ground acoustically sampled data with the interpolated habitat map. By overlaying the interpolated habitat layers derived from the acoustic transects with the video classified points, the number of video sample points assigned to the mapped classes could be calculated using a vector based point-in-polygon overlay analysis in ArcGIS 9.2 (ESRI). What is termed ‘producers’ accuracy results from dividing the number of correctly classified points in each category on the major diagonal of the error matrix, by the number of training set points used in that category. ‘Users’ accuracy results are calculated by dividing the total number of correctly classified points in each category by the total number of points that were classified in that category. Once the data are summarised into an error matrix, their interpretation relies on statistical analysis. The Kappa statistic result quantifies the degree of agreement regarding a particular variable (or habitat) corrected for agreement by chance alone (Lillesand and Kiefer, 1994). The Kappa statistic takes the form:

$$K = \frac{\theta_1 - \theta_2}{1 - \theta_2}$$

where,

$$\theta_1 = \frac{\sum_{i-1}^{r} x_{di}}{N}$$

and,

$$\theta_2 = \frac{\sum_{i-1}^{r} x_{ri} x_{ci}}{N}$$

where

θ_1 = proportion of samples which agree
θ_2 = proportion of cells for expected chance agreement

r = number of rows and columns in the error matrix
N = total number of observations in error matrix
x_{di} = major diagonal element for class i
x_{ri} = total number of observations in row r for class i
x_{ci} = total number of observations in column c for class i

3. Results

For the purposes of analysis each of the regions shall be discussed independently with each area further subdivided into separate zones as indicated by a figure at the beginning of each section. The extent of each habitat type is presented for each of these areas along with the statistics of the algal and seagrass analysis.

3.1. Bicheno to St Helens

The Bicheno to St Helens survey zone extends from St Helens Point south to Bicheno. This region is within the NRM North jurisdiction and the habitat mapping of this area completes the SeaMap Tasmania database for the entire east coast. Figure 18 indicates the four (A-D) analysis regions that have been subset for the coastline from St Helens Point to Bicheno. The maps generated in this region cover a total of 13,935.91 ha (or 139.36 km^2) of seabed from the coastline 1 m to 65 m depth in the region around St Helens Island (Figure 19). The survey area is has been clipped to 1.5kms from the coastline. Figure 20-34 show the habitat maps at 1:25,000 of the region depicting the distribution of reef and sand habitats across this survey zone.

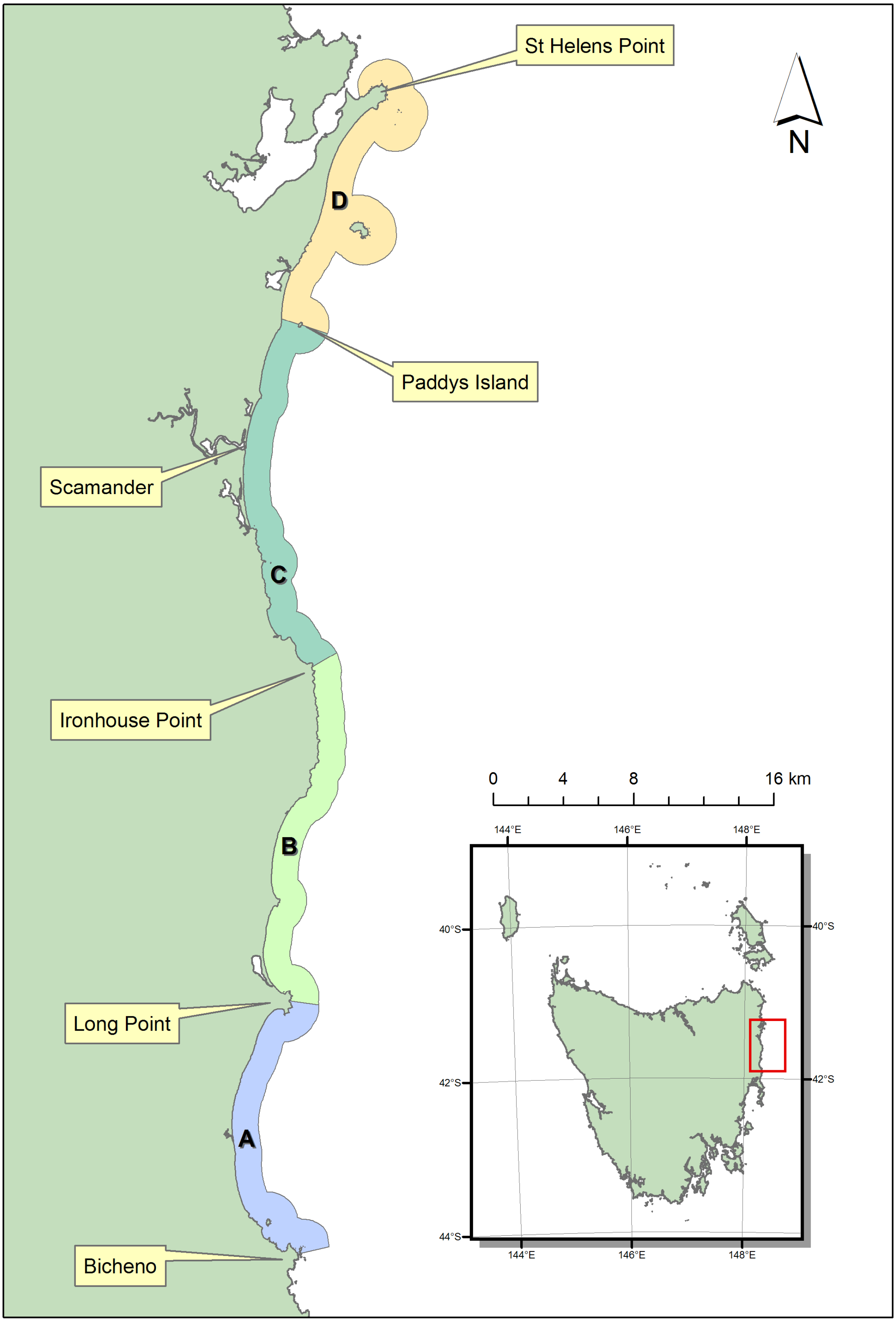

Figure 18. Location map showing analysis and reporting sections for Bicheno to St Helens.

3.1.1. Bathymetry and habitat maps from Bicheno to St Helens

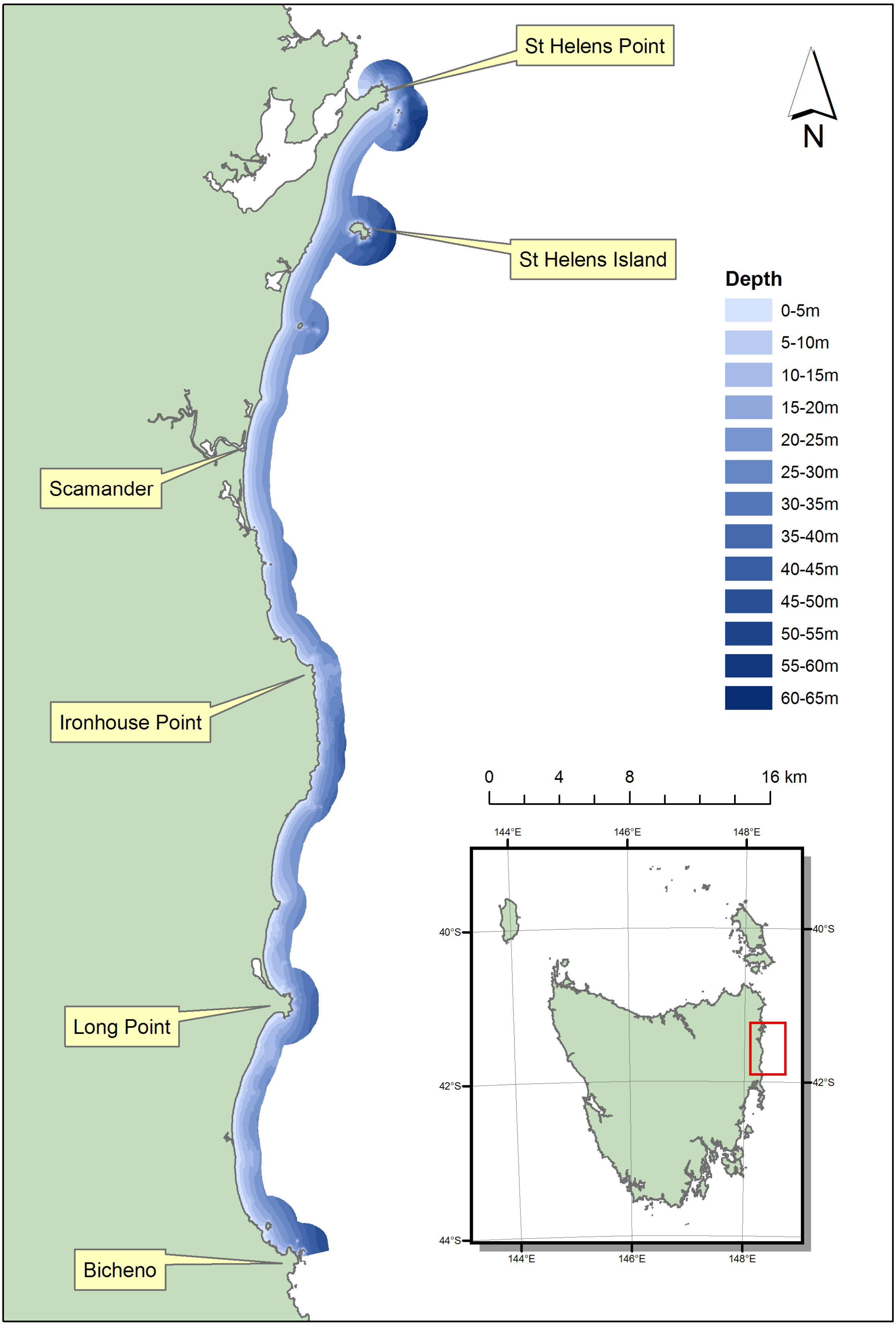

Figure 19. Map of bathymetry for Bicheno to St Helens based on interpolated acoustic data.

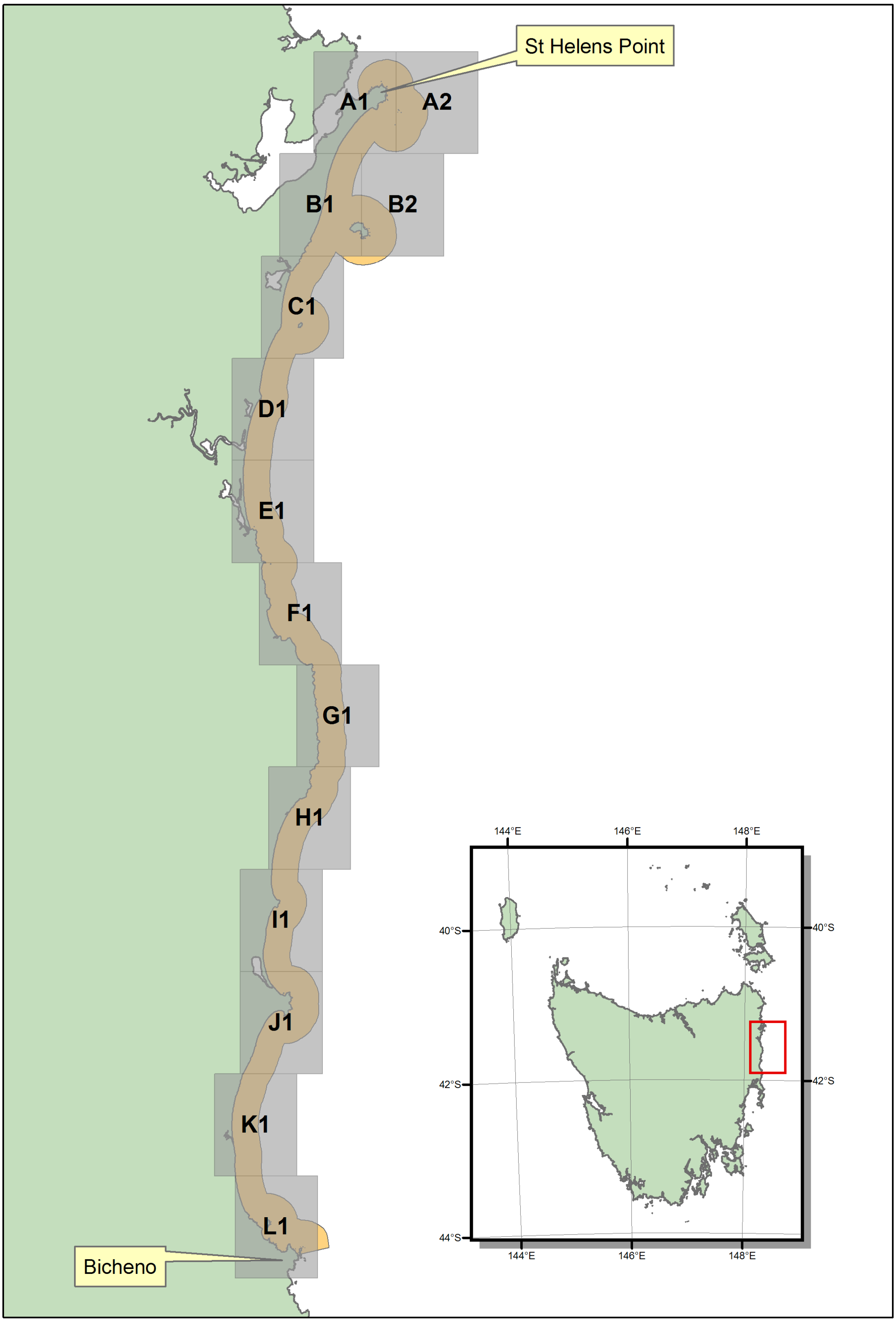

Figure 20. Index map of 1:25 000 habitat maps for Bicheno to St Helens map series.

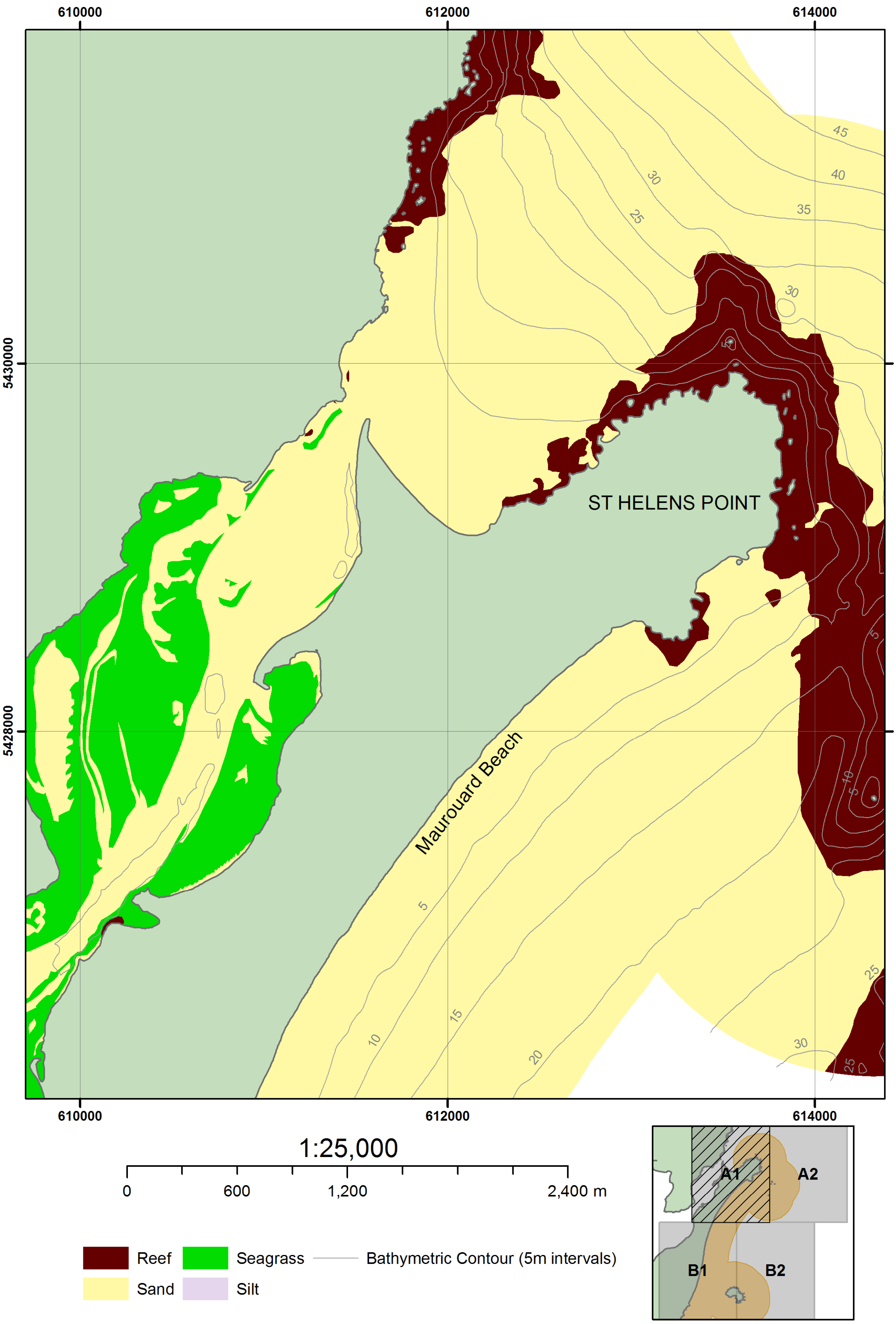

Figure 21. Bicheno to St Helens map series map A1 showing bathymetry and habitats around St Helens Point and Maurouard Beach.

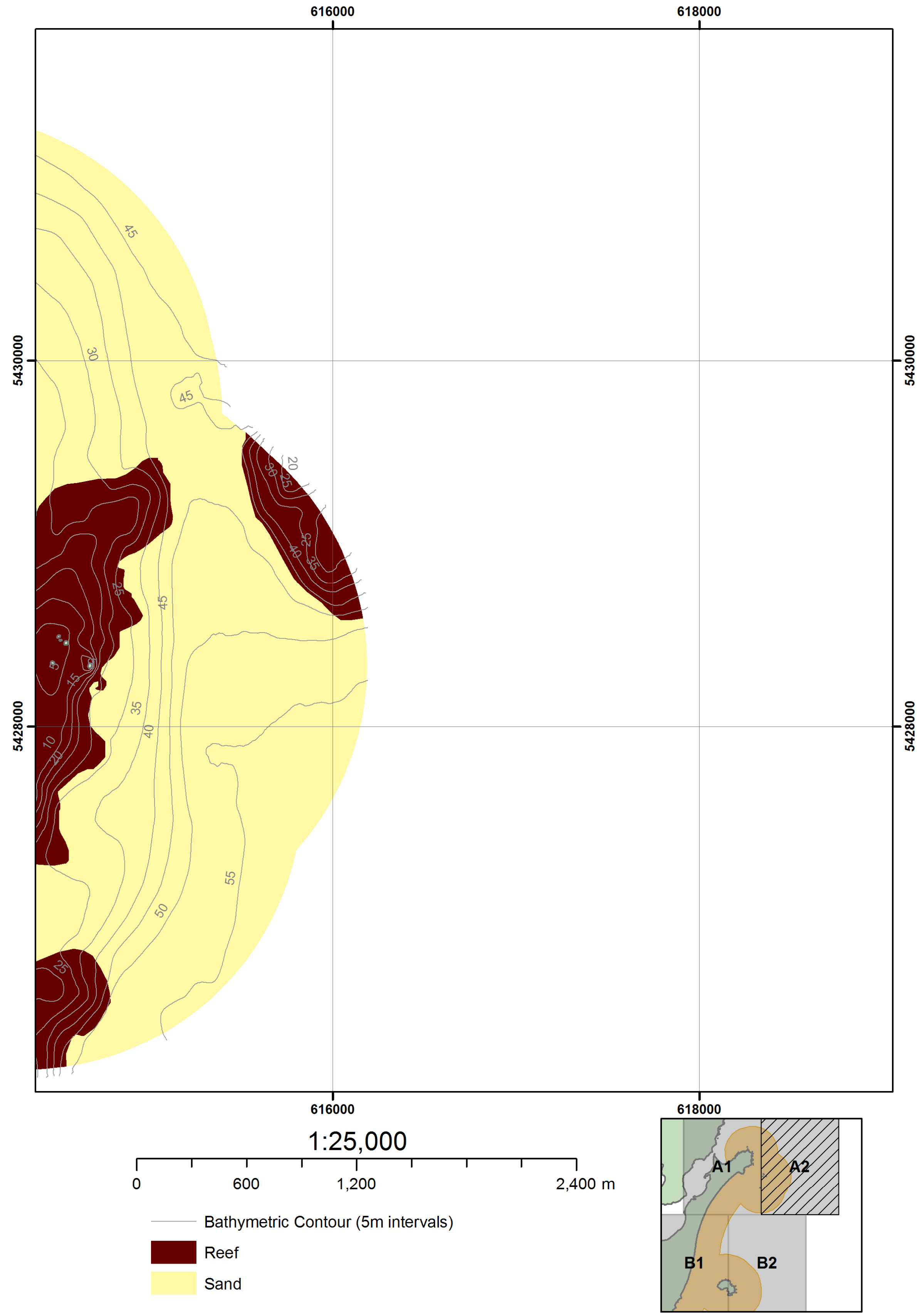

Figure 22. Bicheno to St Helens map series map A2 showing bathymetry and habitats off shore from St Helens Point.

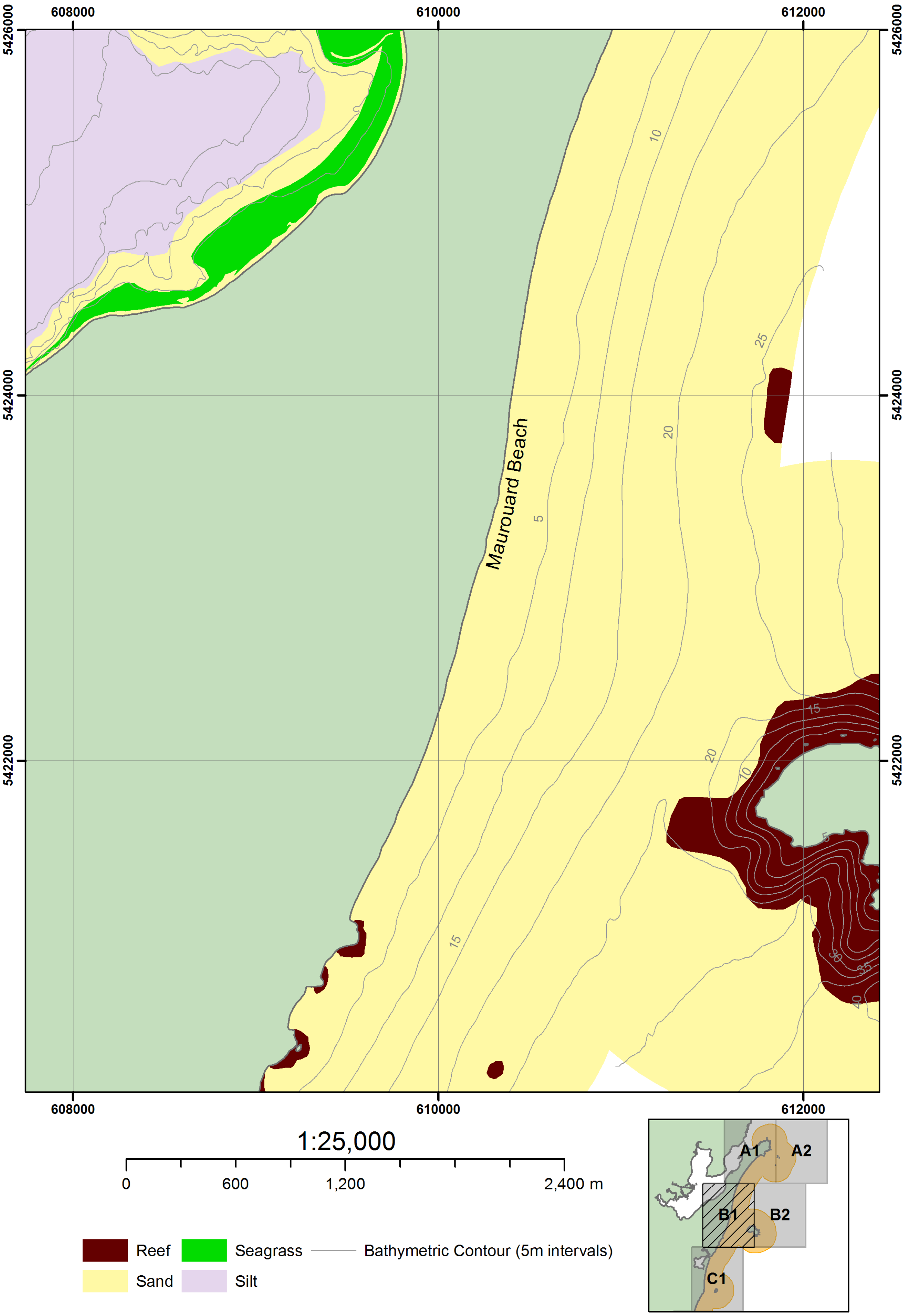

Figure 23. Bicheno to St Helens map series map B1 showing bathymetry and habitats off Maurouard Beach and inshore from St Helens Island.

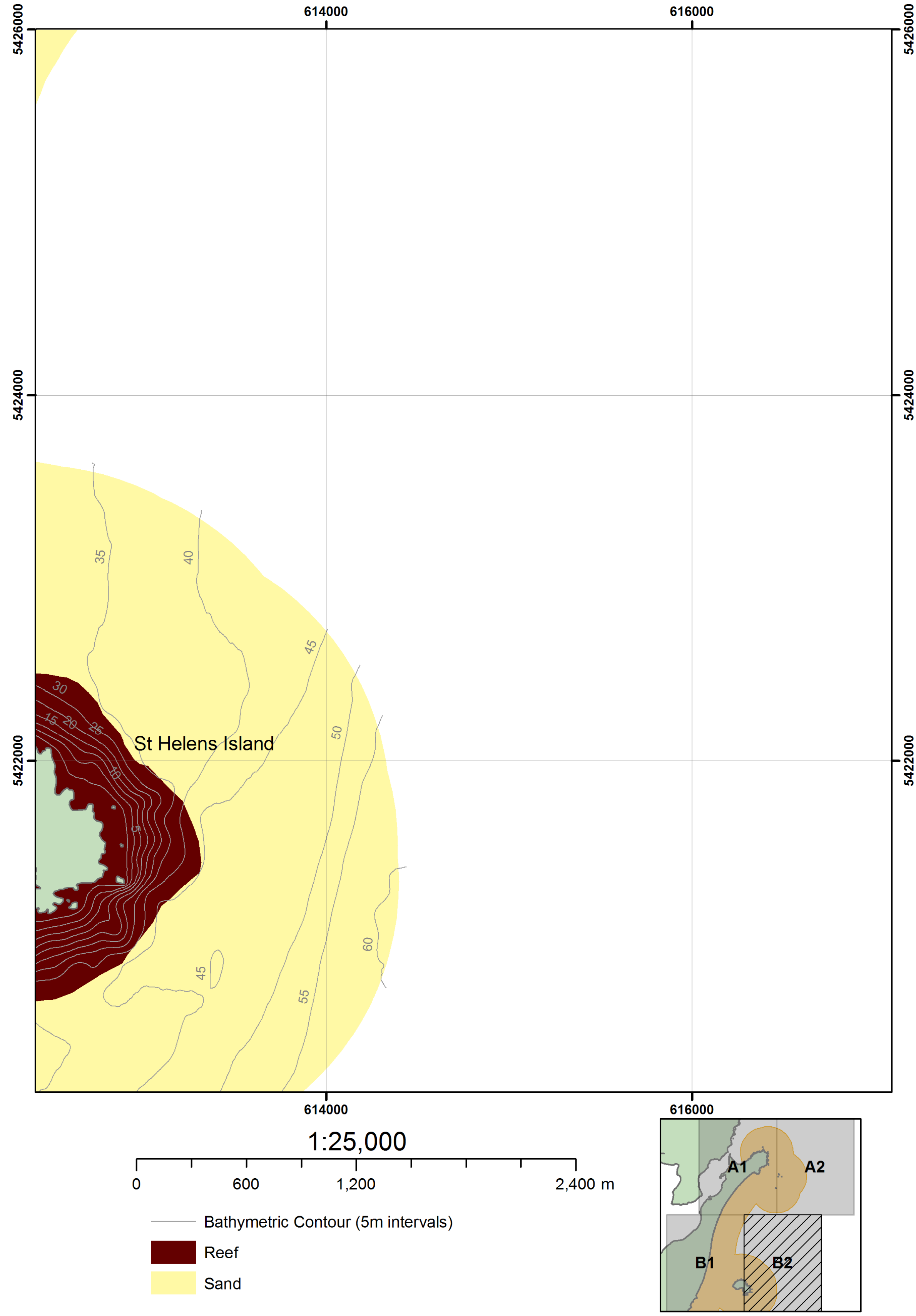

Figure 24. Bicheno to St Helens map series map B2 showing bathymetry and habitats off shore from St Helens Island.

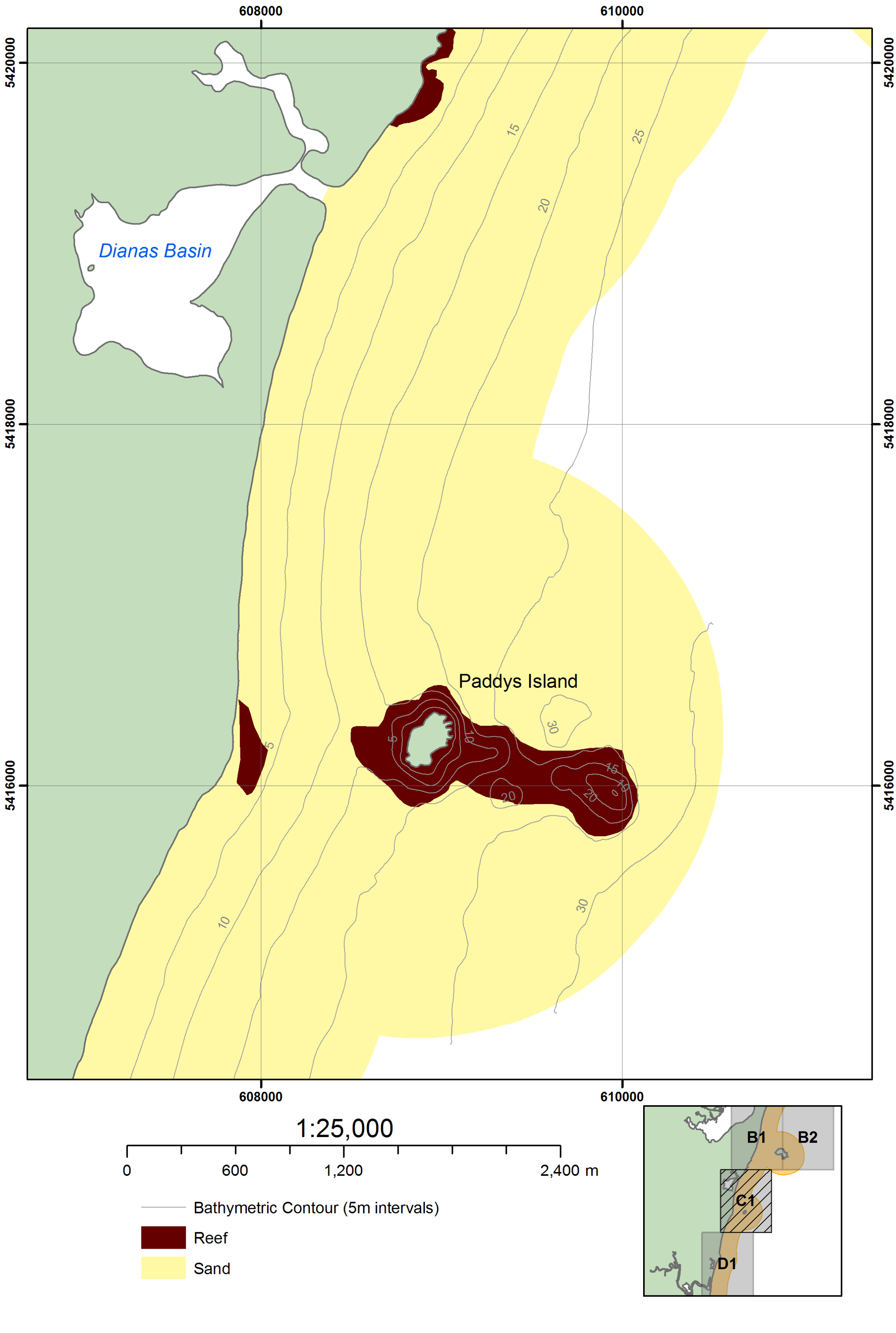

Figure 25. Bicheno to St Helens map series map C1 showing bathymetry and habitats around Paddys Island.

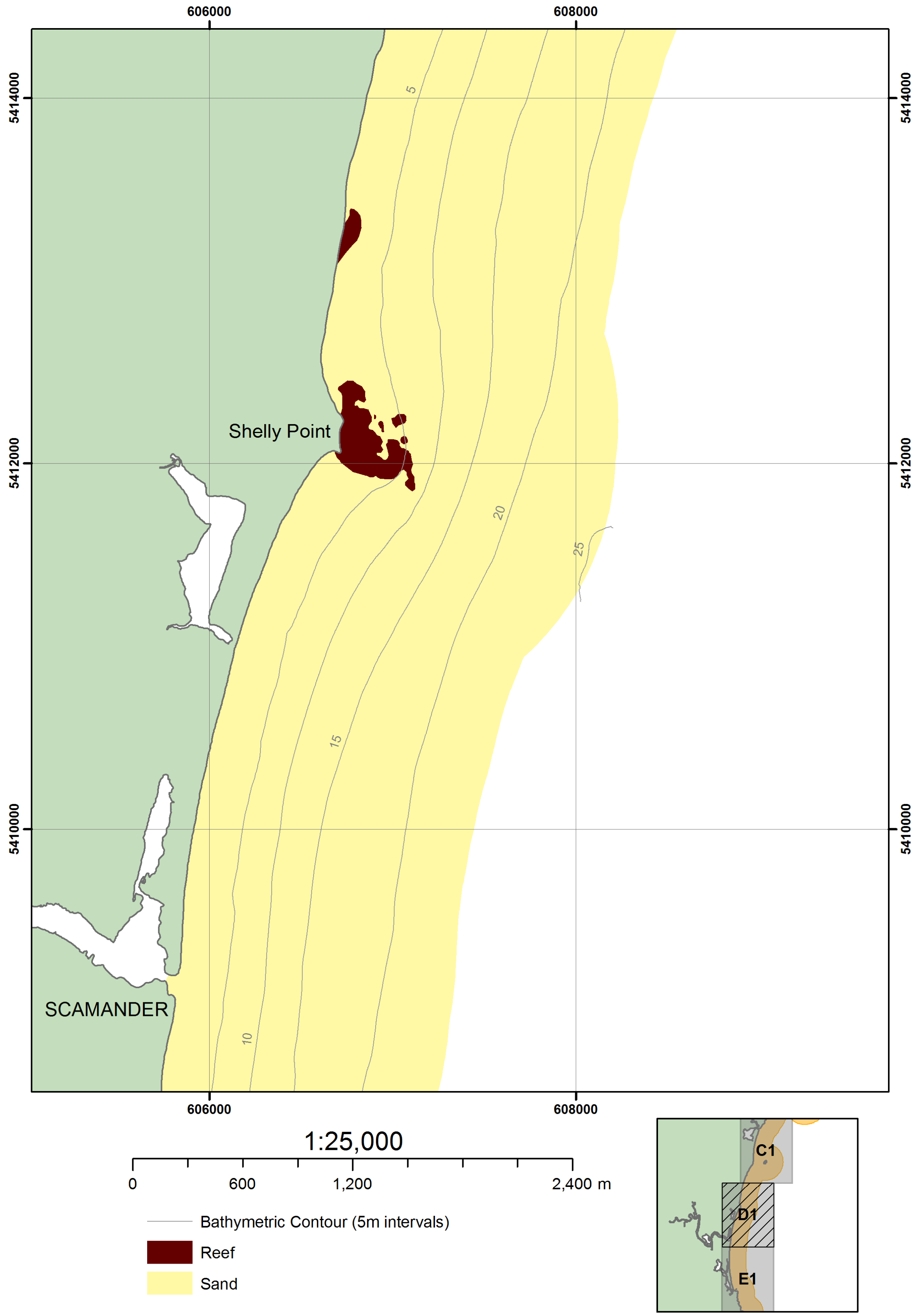

Figure 26. Bicheno to St Helens map series map D1 showing bathymetry and habitats off Shelly Point.

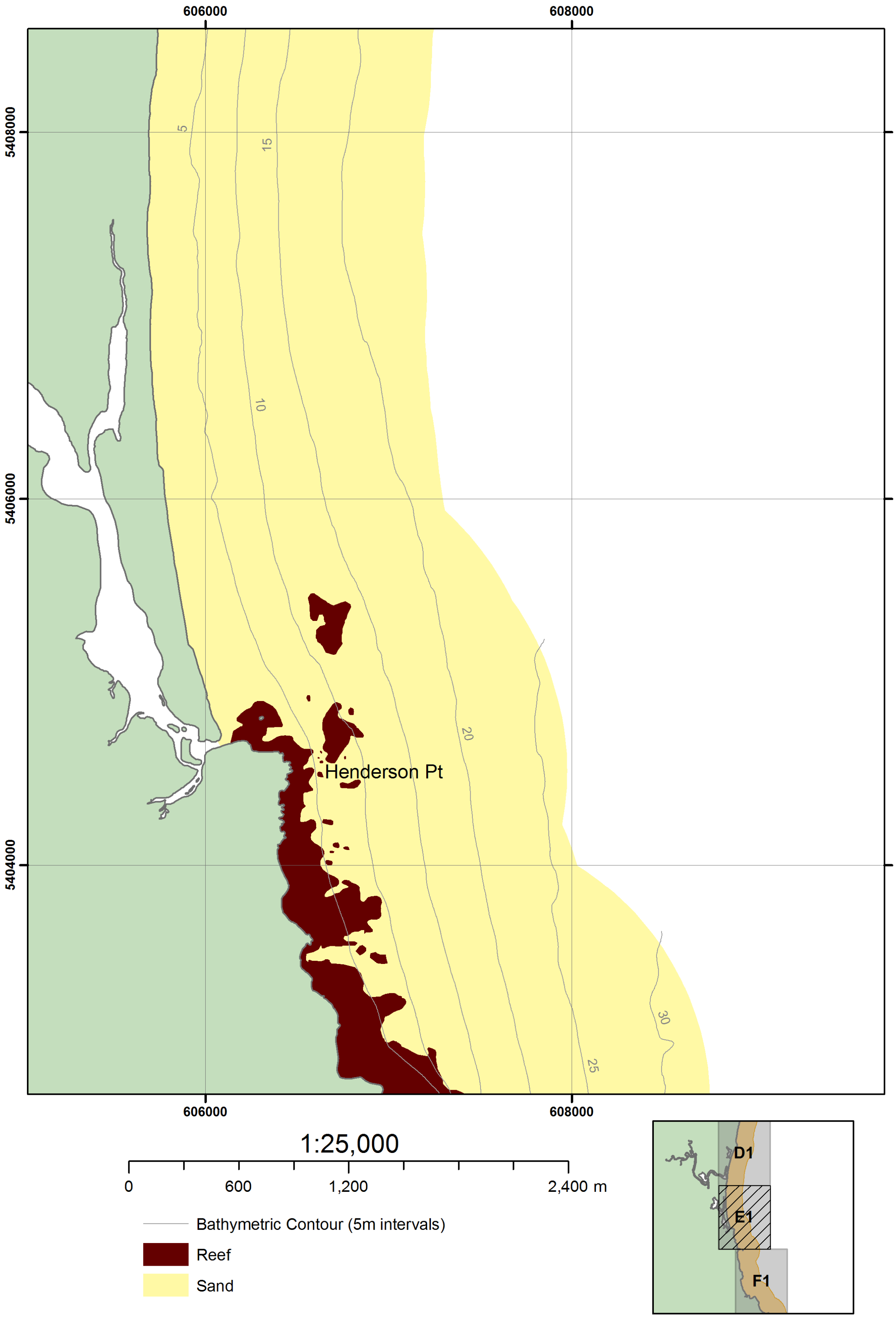

Figure 27. Bicheno to St Helens map series map E1 showing bathymetry and habitats off Henderson Point.

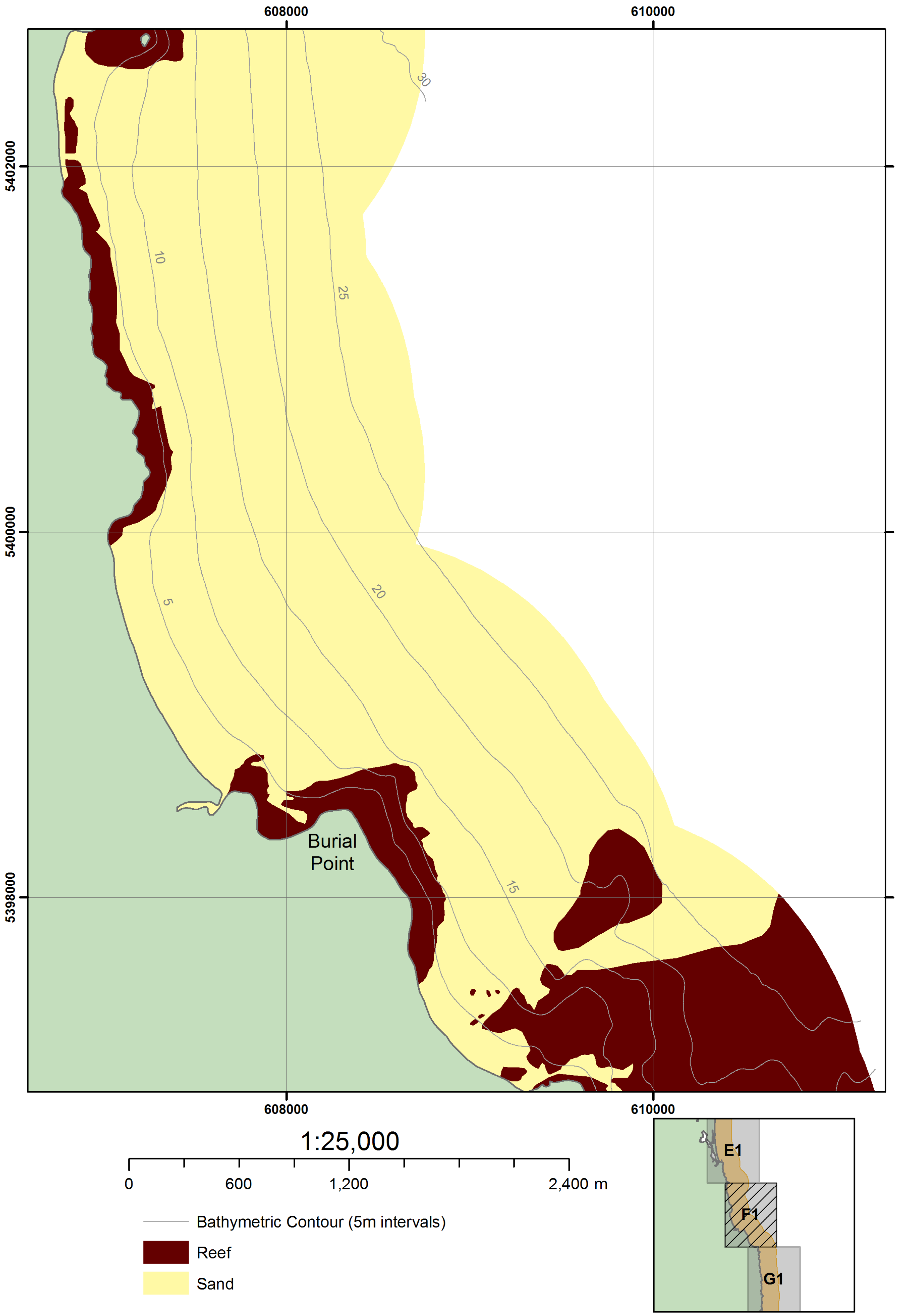

Figure 28. Bicheno to St Helens map series map F1 showing bathymetry and habitats off Burial Point.

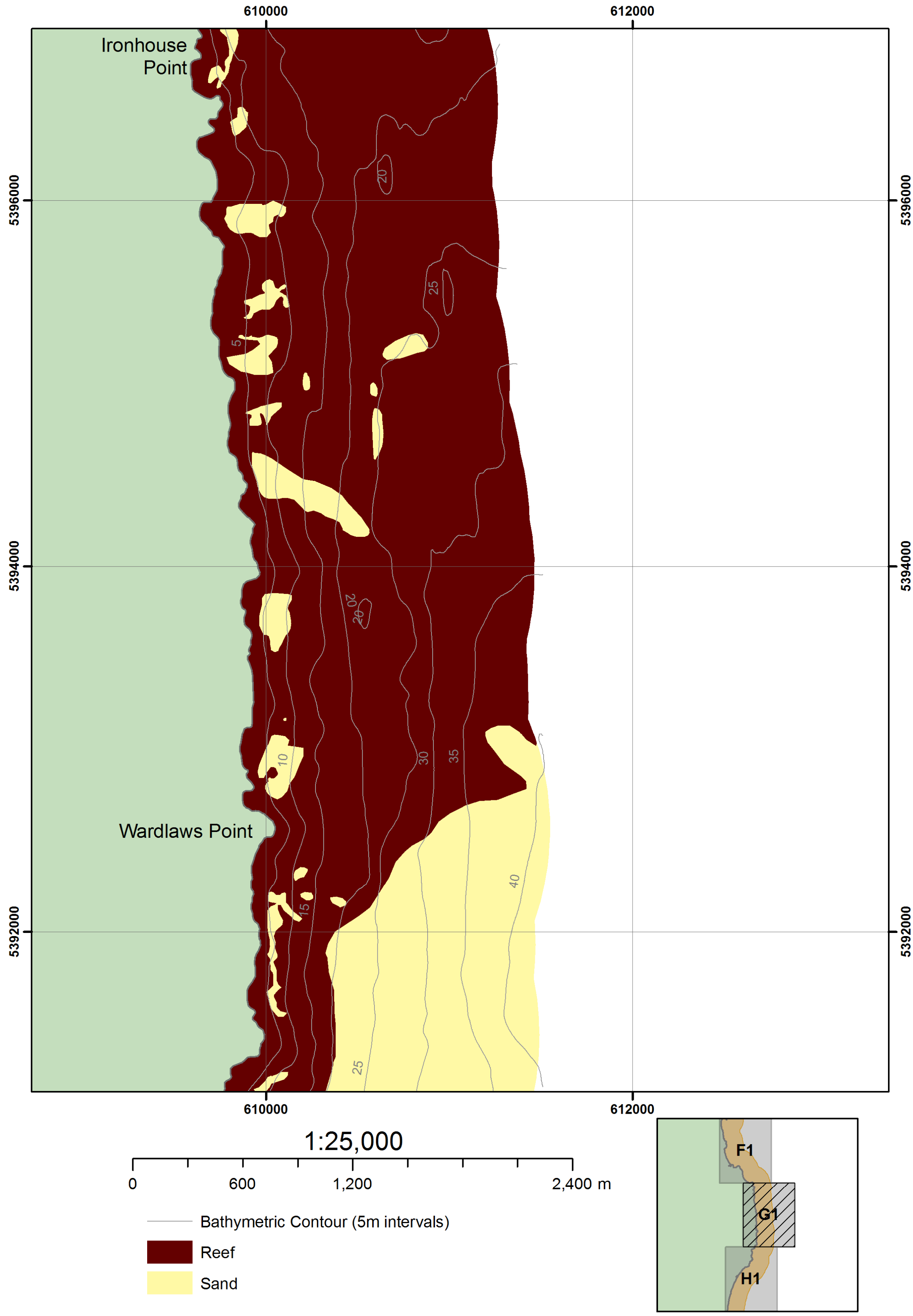

Figure 29. Bicheno to St Helens map series map G1 showing bathymetry and habitats between Ironhouse Point and Wardlaws Point.

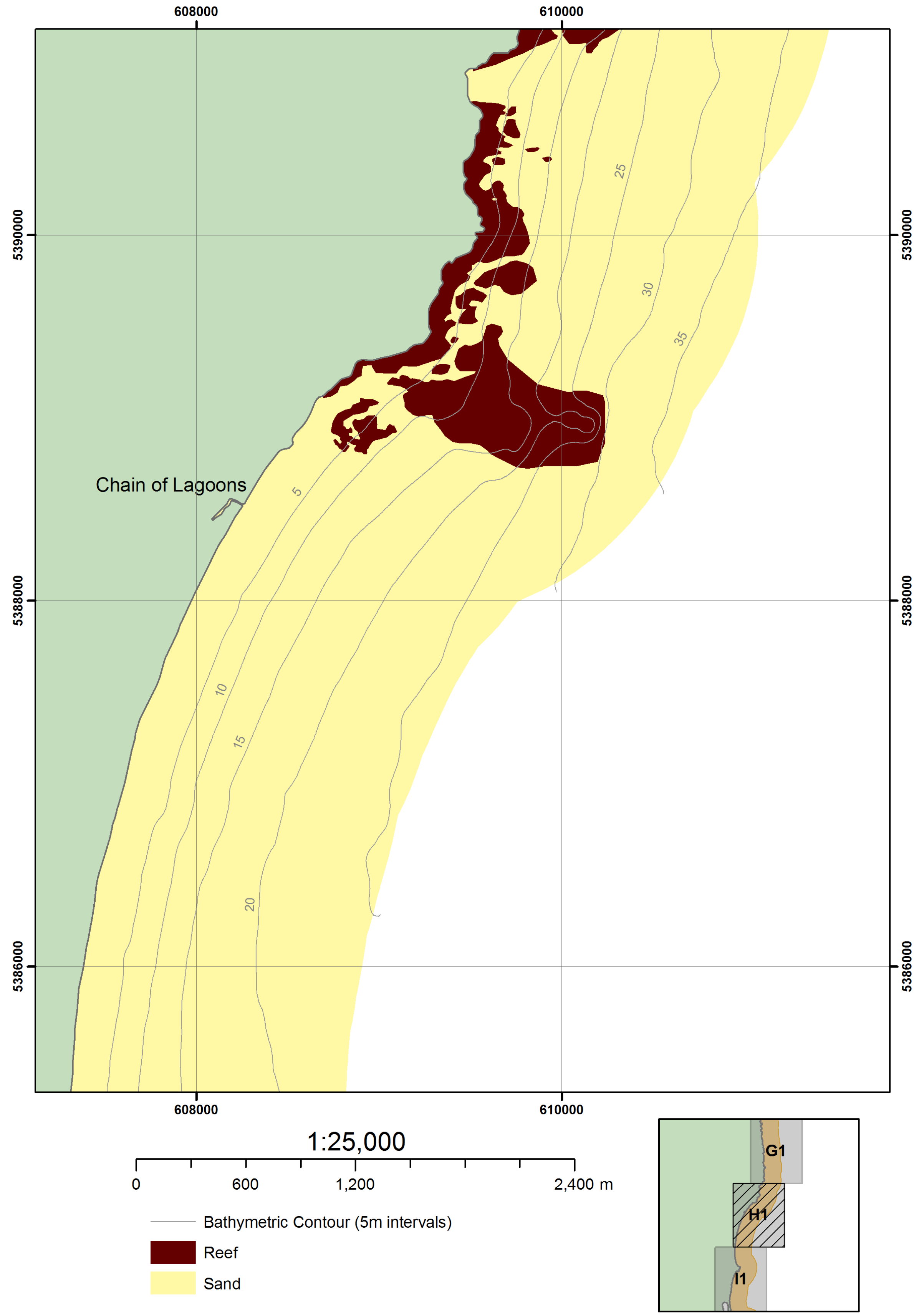

Figure 30. Bicheno to St Helens map series map H1 showing bathymetry and habitats off Chain of Lagoons.

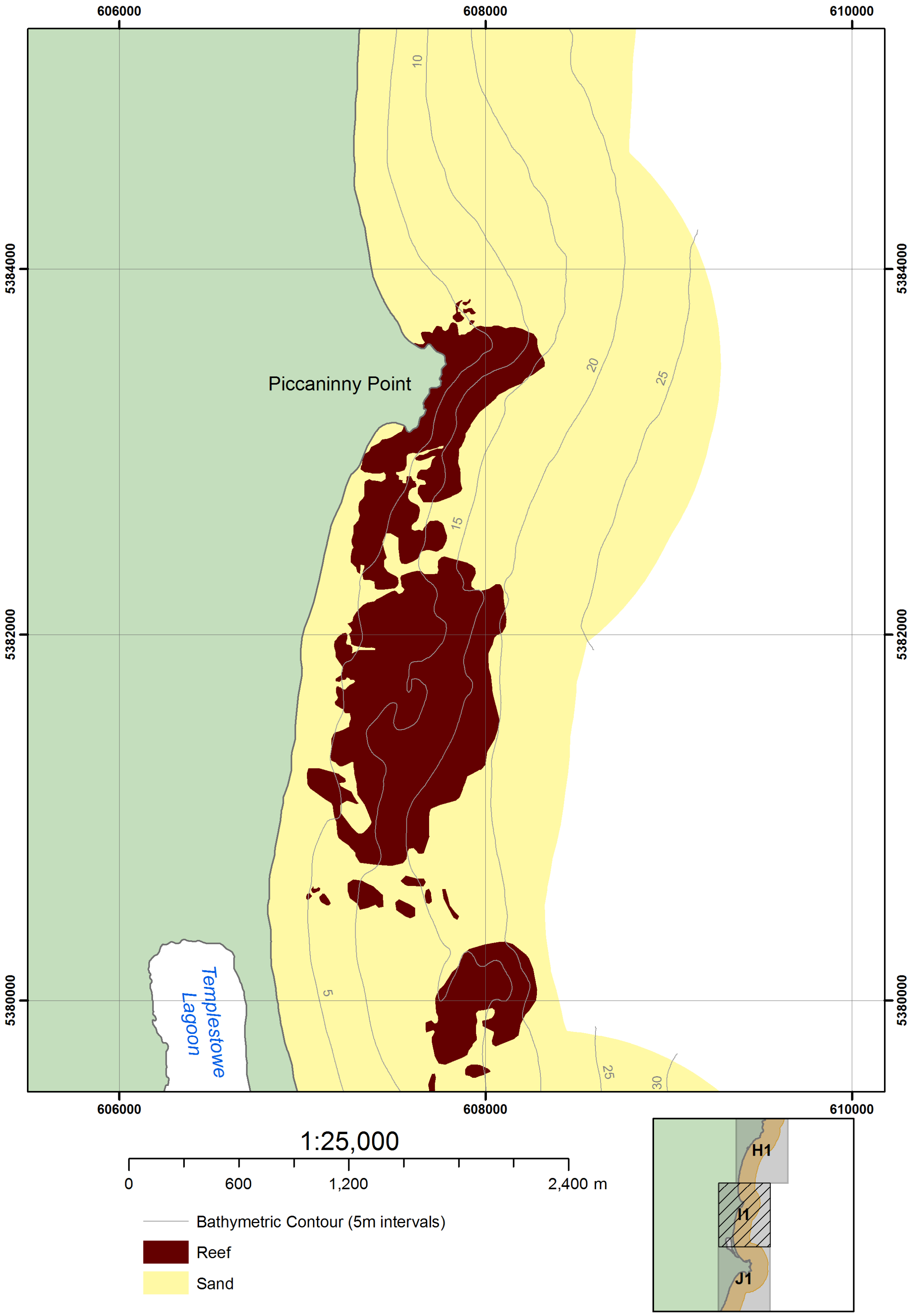

Figure 31. Bicheno to St Helens map series map I1 showing bathymetry and habitats off Piccaninny Point.

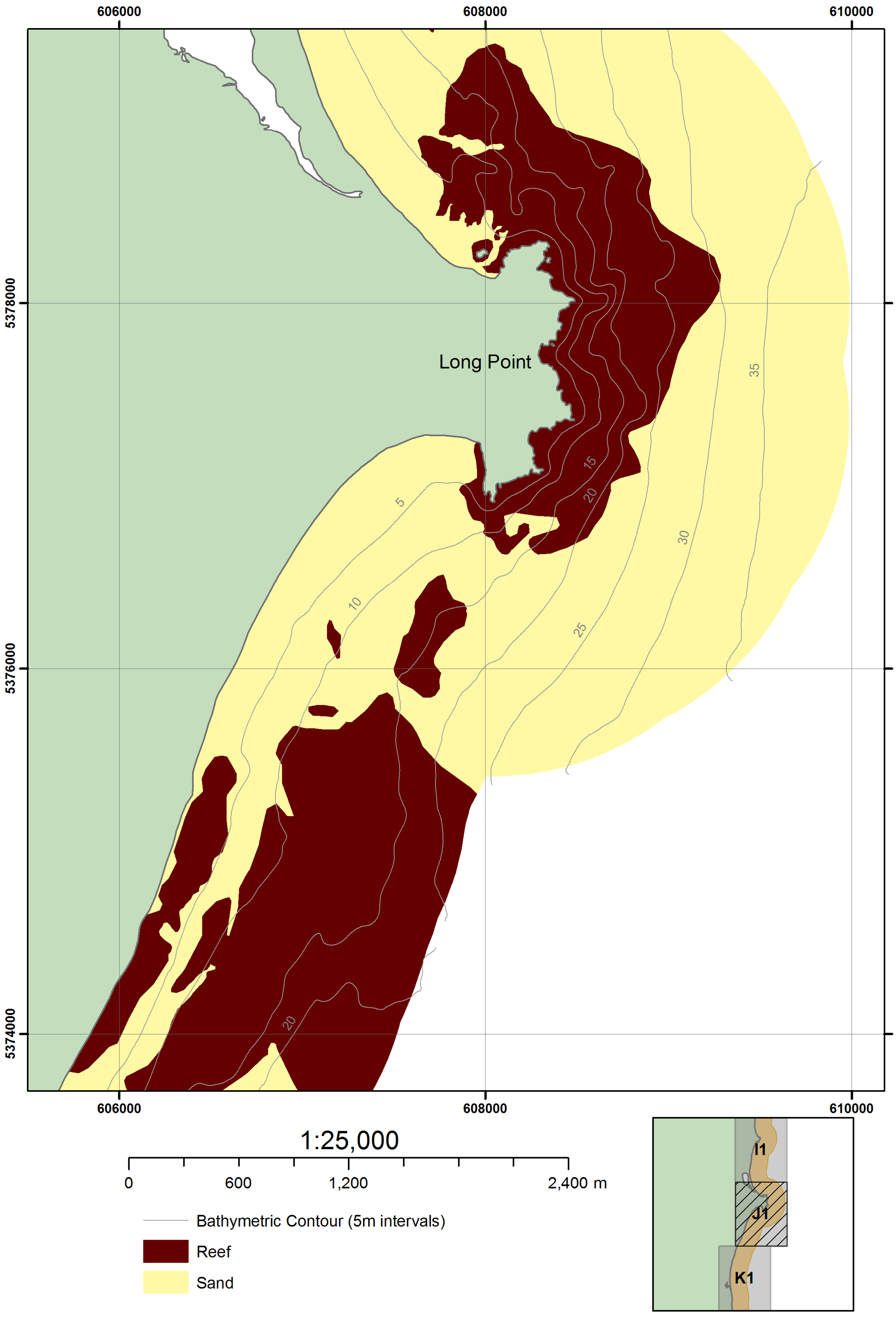

Figure 32. Bicheno to St Helens map series map J1 showing bathymetry and habitats off Long Point.

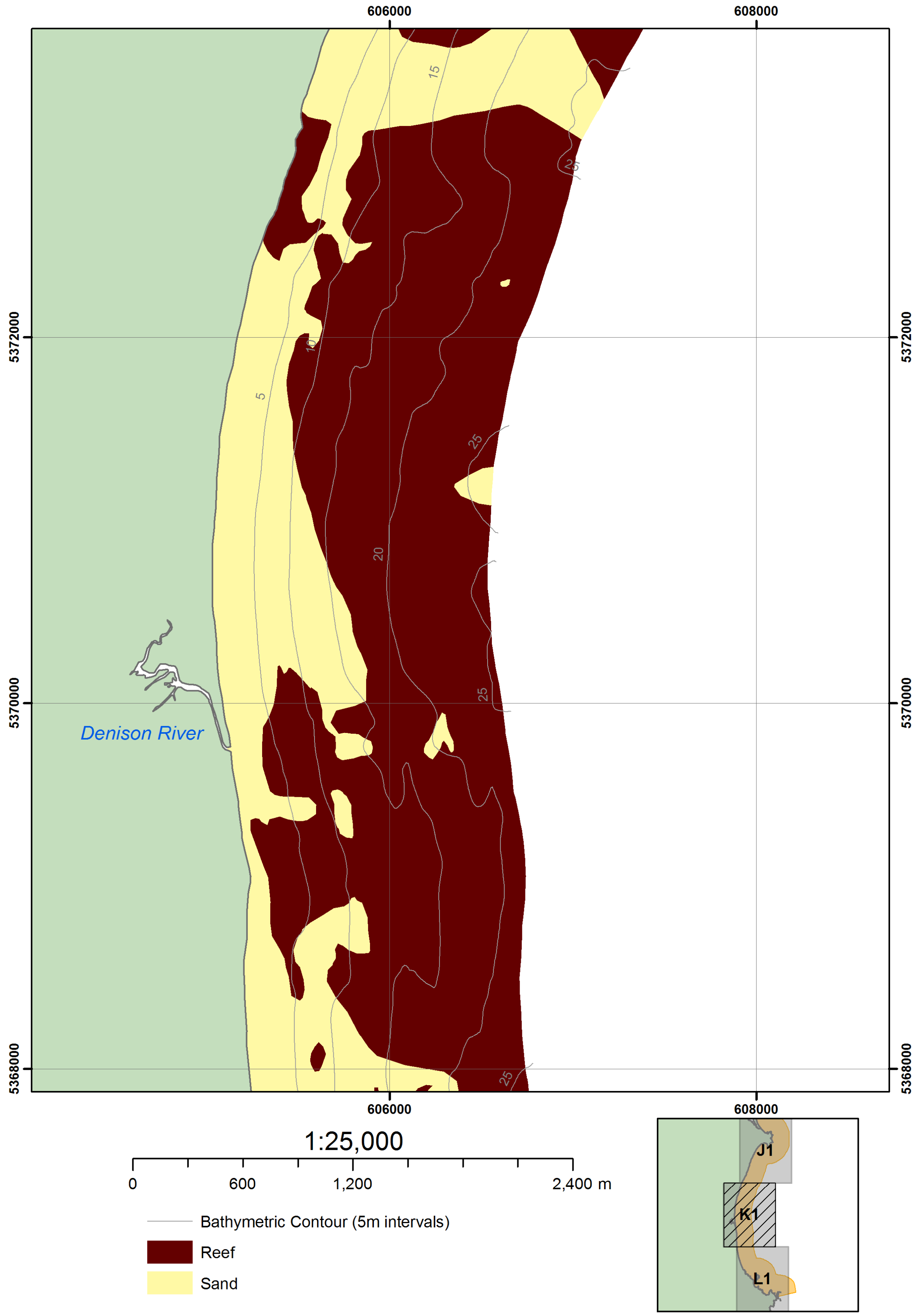

Figure 33. Bicheno to St Helens map series map K1 showing bathymetry and habitats off the Denison River.

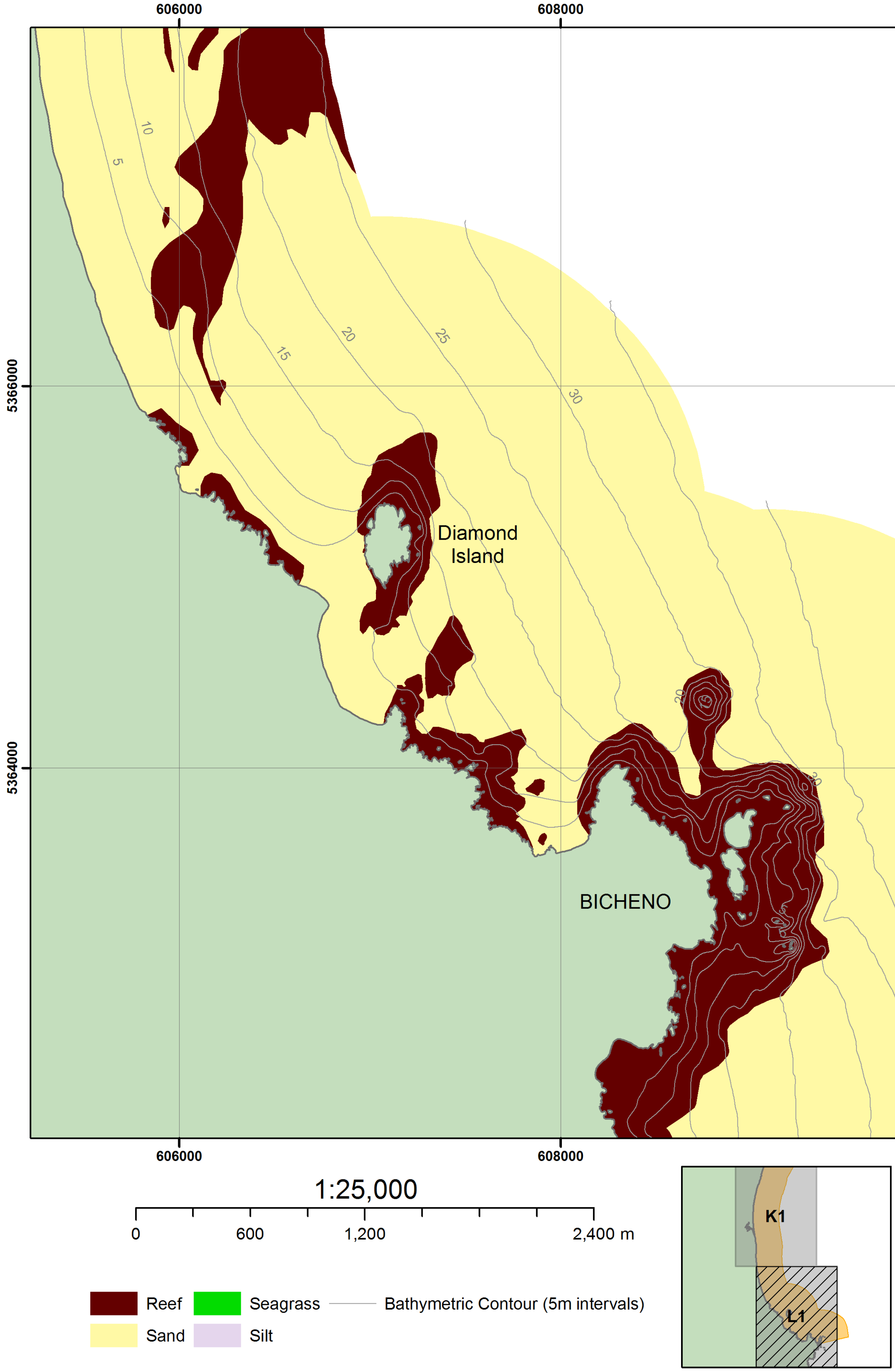

Figure 34. Bicheno to St Helens map series map L1 showing bathymetry and habitats off Diamond Island and Bicheno.

3.1.2. Section A

Section A defines the subsection between Bicheno and Long Point (Seymour). The surveyed zone covers an area of 2838.53 ha (28.38 km^2) across a depth range of 0 -45 m +.

3.1.2.1 Habitat Distribution Section A

The distribution of habitats by depth in section A is detailed in Table 2. The total area of sand habitat in this subsection was 1721.84 ha with the majority of this habitat occurring between 0 m and decreasing from 20 m where the habitat changed to consolidated reef. The total area of reef within this section was 1116.69 ha. Table 3 summaries the mapping accuracy for this subsection. The overall accuracy of this zone was 85.28% indicating that some confusion existed between the sand and reef categories. The uncertainty may have been introduced in either the attribution of the acoustics or in the interpolation process in producing continuous polygons from the acoustic points.

Table 2. Habitat distribution by depth for Section A Bicheno to Long Point (Seymour).

DEPTH	SUBSTRATE		TOTAL
	Reef (ha)	Sand (ha)	
0-5	113.96	288.77	**402.73**
5-10	109.41	213.64	**323.04**
10-15	308.00	181.76	**489.76**
15-20	301.52	165.07	**466.59**
20-25	259.20	212.18	**471.39**
25-30	21.45	210.21	**231.65**
30-35	2.39	173.61	**176.00**
35-40	0.77	120.38	**121.16**
40-45	0.00	84.42	**84.42**
45+	0.00	71.80	**71.80**
TOTAL	**1116.69**	**1721.84**	**2838.53**
Percentage	*39.34%*	*60.66%*	

Table 3. Accuracy assessment for Section A Bicheno to Long Point (Seymour).

Video Class	Map Class					User Total	User Accuracy
	Cobble	Reef	Sand	Seagrass	Silt		
Cobble	0	0	0	0	0	**0**	0.00%
Reef	0	5639	678	0	0	**6317**	89.27%
Sand	0	311	728	0	0	**1039**	70.07%
Seagrass	0	0	110	0	0	**110**	0.00%
Silt	0	0	0	0	0	**0**	0.00%
Producer Total	**0**	**5950**	**1516**	**0**	**0**	**7466**	
Producer Accuracy	0.00%	94.77%	48.02%	0.00%	0.00%		
Accuracy:	85.28%						
Kappa:	0.505115						

3.1.2.2. Seagrass Distribution Section A

No seagrass beds were mapped within section A, from Bicheno to Seymour, however small amounts of sparse seagrass, *Heterozostera tasmanica*, were present on the unconsolidated sand substrate in the vicinity of Diamond Island. The *H. tasmanica* occurred between 10 and 25 m depth, with the cover less than 10 % at its maximum between 15 and 20 m depth, and less than 5 % for the remainder (Figure 35).

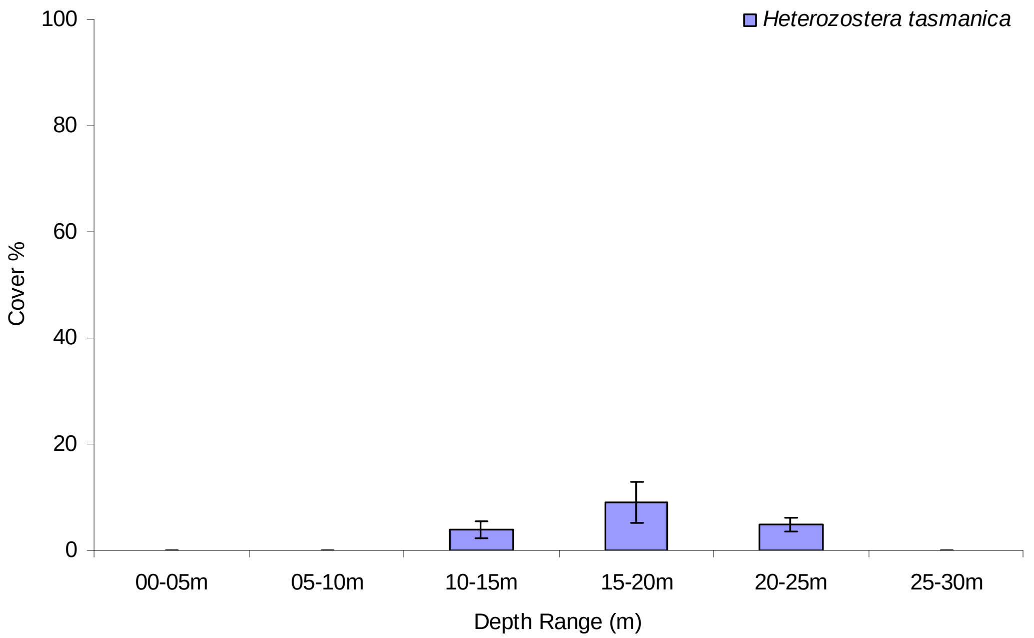

Figure 35. Mean seagrass cover (± s.e.) on unconsolidated sand substrate by depth strata (5 m bin) for analysis section A, Bicheno to Seymour.

3.1.2.3. Algal Distribution Section A

The total algal cover in section A was greater than 80 % for all depths, with peak cover of 95% in the 10 – 15 m depth range (

Figure 36). The slightly lower algal cover in the 0 – 10 m depth range corresponds to the presence of several small incipient urchin barrens within this depth range. The algae in the 0 – 5 m depth range was dominated by a mixture of *Durvillaea potatorum* and *Pyllospora comosa*, each comprising approximately 30% cover. *Phyllospora comosa* was then the dominant algae in the 5 – 20 m depth range (>50% cover), with *Ecklonia radiata* the dominant algae in the 20 – 25 m depth range (~50% cover). Both red algae and coralline algae had low cover across all depth ranges, generally less than 15% cover, with small amounts of *Cystophora* sp. in the 0 – 10 m depth range.

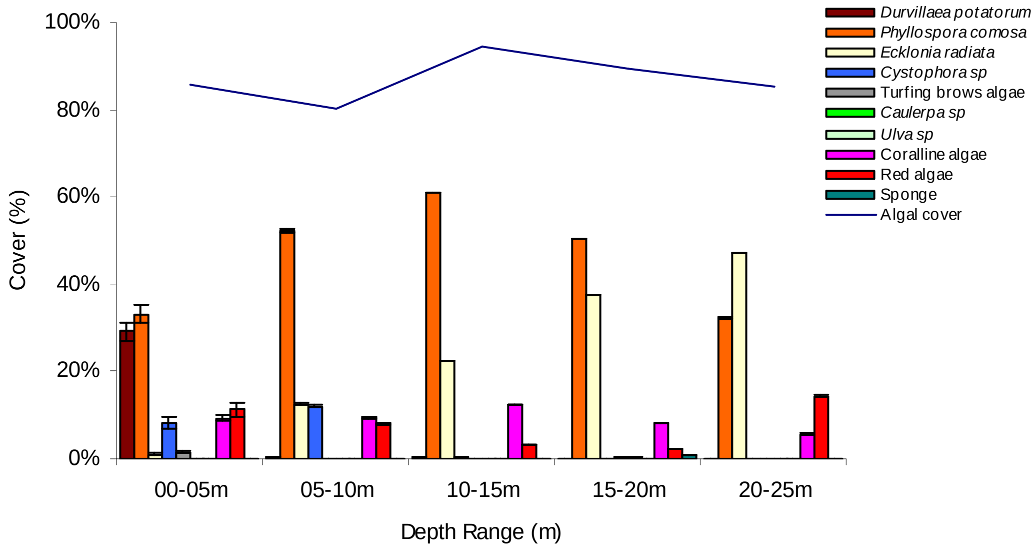

Figure 36. Mean Algal Cover (± s.e.) by depth strata (5 m bin) for analysis section A, Bicheno to Seymour.

3.1.3. Section B

Section B defines the subsection between Long Point and Ironhouse Point. The surveyed zone covers an area of 3323.08 ha (33.23 km^2) across a depth range of 0 - 40 m +.

3.1.3.1. Habitat Distribution Section B

The distributions of habitats in section B were again comprised of reef and sand habitats (Table 3). The reef habitat began to decrease from 35 m depth however the sand habitat was present across all depth zones from 0- 40+ meters. The accuracy of the habitat maps in section B had an overall accuracy of 93.9% (Table 4).

Table 3. Habitat distribution by depth for Section B Long Point (Seymour) to Ironhouse Point.

DEPTH	SUBSTRATE		TOTAL
	Reef (ha)	Sand (ha)	
0-5	136.47	268.40	**404.87**
5-10	161.32	218.40	**379.71**
10-15	213.42	237.26	**450.68**
15-20	225.05	346.27	**571.33**
20-25	212.89	453.68	**666.58**
25-30	135.71	255.96	**391.67**
30-35	58.04	219.20	**277.24**
35-40	30.81	132.10	**162.91**
40+	0.00	18.09	**18.09**
TOTAL	**1173.71**	**2149.36**	**3323.08**
Percentage	*35.32%*	*64.68%*	

Table 4. Accuracy assessment for Section B Long Point (Seymour) to Ironhouse Point.

Video Class	Map Class					User Total	User Accuracy
	Cobble	Reef	Sand	Seagrass	Silt		
Cobble	0	0	0	0	0	**0**	0.00%
Reef	0	10698	43	0	0	**10741**	99.60%
Sand	0	787	2089	0	0	**2876**	72.64%
Seagrass	0	0	0	0	0	**0**	0.00%
Silt	0	0	0	0	0	**0**	0.00%
Producer Total	**0**	**11485**	**2132**	**0**	**0**	**13617**	
Producer Accuracy	0.00%	93.15%	97.98%	0.00%	0.00%		
Accuracy:	93.90%						
Kappa:	0.797926						

3.1.3.2. Seagrass Distribution Section B

Seagrass was not identified in section B.

3.1.3.3. Algal Distribution Section B

The total algal cover for section B decreased with depth from around 90% in the 0 – 15 m depth range to around 65% by the 25 – 30 m depth range (Figure 37). *Durvillaea potatorum* was the dominant algae in the 0 – 5 m depth range, with approximately 45% cover. This decreased to less than 15% cover in the 5 – 10 m depth range. *Phyllospora comosa* comprised approximately 34% cover in the 0 – 5 m depth range, and was the most dominant algae in the 5 - 20 m depth range, with between 46 and 61% cover. Very little *Phyllospora* cover was below 20 m depth. *Ecklonia radiata* was present in all depth ranges, and increased in cover to be dominant algae below 20 m depth, with greater than 50% cover. Small amounts of red algae and coralline algae were present across all depths, generally less than 10%, with the exception of red algae in the 25 – 30 m depth range which comprised 16% of the algal cover. Small amounts of *Cystophora* sp. and turfing brown algae were present in the 0 – 10 m depth range and small amounts of *Caulerpa* sp. occurred in the 15 – 25 m depth range. Sponges were present below 10 m depth, with sponge cover increasing with depth to comprise nearly 25% cover in the 25 – 30 m depth range.

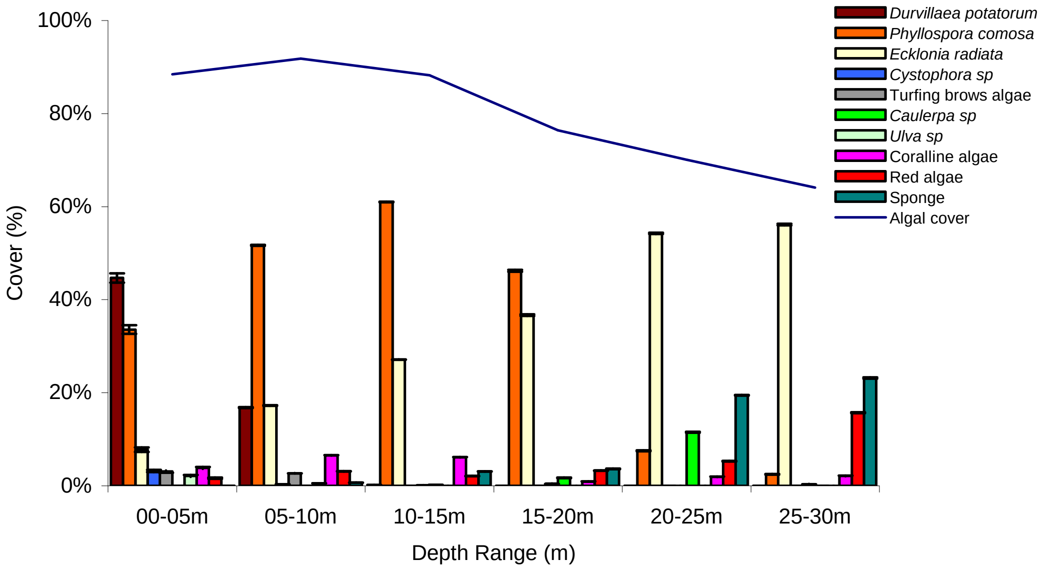

Figure 37. Mean Algal Cover (± s.e.) by depth strata (5 m bin) for analysis section B, Seymour to Ironhouse Point.

3.1.4. Section C

Section C defines the subsection between Ironhouse Point and Paddys Island. The surveyed zone covers an area of 3454.37 ha (34.54 km^2) across a depth range of 0 - 30 m +.

3.1.4.1. Habitat Distribution Section C

The distribution of habitat in section C was dominated by sand habitat (90%) (Table 5). Reef habitat was not identified from 30 m depth however was present across all depth zones from 0- 30+ meters. Only 9.02% of the habitat surveyed in this section consisted of reef. The accuracy of the habitat maps in section B had an overall accuracy of 92.8% (Table 6).

Table 5. Habitat distribution by depth for Section C Ironhouse Point to Paddys Island

DEPTH	SUBSTRATE		TOTAL
	Reef (ha)	Sand (ha)	
0-5	131.67	407.06	**538.73**
5-10	51.57	420.80	**472.37**
10-15	38.62	533.09	**571.70**
15-20	31.88	702.07	**733.95**
20-25	41.67	720.63	**762.30**
25-30	16.15	313.74	**329.89**
30+	0.00	45.42	**45.42**
TOTAL	**311.56**	**3142.82**	**3454.37**
Percentage	*9.02%*	*90.98%*	

Table 6. Accuracy assessment for Section C Ironhouse Point to Paddys Island

Video Class	Map Class					User Total	User Accuracy
	Cobble	Reef	Sand	Seagrass	Silt		
Cobble	0	0	0	0	0	**0**	0.00%
Reef	0	2503	27	0	0	**2530**	98.93%
Sand	0	281	1468	0	0	**1749**	83.93%
Seagrass	0	0	0	0	0	**0**	0.00%
Silt	0	0	0	0	0	**0**	0.00%
Producer Total	**0**	**2784**	**1495**	**0**	**0**	**4279**	
Producer Accuracy	0.00%	89.91%	98.19%	0.00%	0.00%		
Accuracy:	92.80%						
Kappa:	0.847665						

3.1.4.2. Seagrass Distribution Section C

Seagrass was not identified in Section C.

3.1.4.3. Algal Distribution Section C

The section of coast from Ironhouse Point to Paddys Island contained the least reef of all the sections. The total algal cover on this reef was relatively consistent between 90 – 95% cover in the 0 – 20 m depth range surveyed (Figure 38). *Durvillaea potatorum* was common in the 0 – 5 m depth range comprising approximately 50% cover, decreasing to 15% cover in the 5 – 10 m depth range. *Phyllospora comosa* was abundant at all depths, with grater than 50% cover and maximum cover of 76% in the 5 – 10 m depth range. *Ecklonia radiata* was present below 5 m depth, with its abundance increasing with depth to comprise 50% cover in the 15 – 20 m depth range. Very little other algae was observed in this section, with a small amount of coralline algae in the 5 – 10 m depth range.

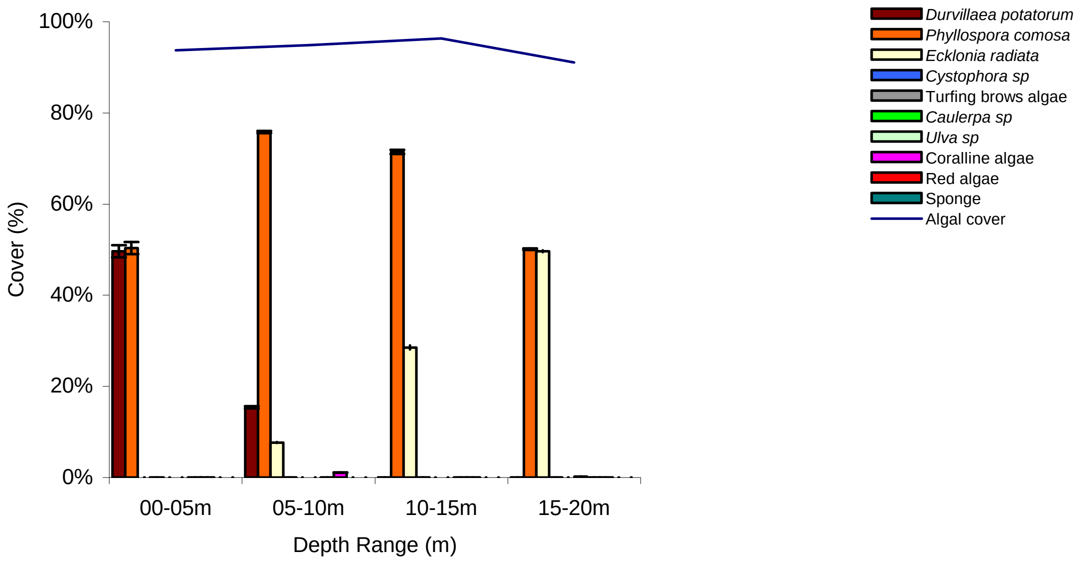

Figure 38. Mean Algal Cover (± s.e.) by depth strata (5 m bin) for analysis section C, Ironhouse Point to Paddys Island.

3.1.5. Section D

Section D defines the subsection between Paddys Island and St Helens Point. The surveyed zone covers an area of 4319.93 ha (43.19km^2) across a depth range of 0 - 50 m +.

3.1.5.1. Habitat Distribution Section D

The majority of reef habitat occurred in the shallow waters from 0-35 m where it began to decline. Reef habitat only comprised 12.3% of the total for this section which was dominated by sand habitat (Table 7). The accuracy of this subsection was 87.36% which indicates that some of the boundaries between the reef and sand habitats may have been characterised by a transition zone from hard to soft habitat. This is identified in the error matrix where on the video some of the habitat was identified as cobble but in the map class (acoustics) it was identified as either reef or sand (Table 8).

Table 7. Habitat distribution by depth for Section D Paddys Island to St Helens Point

DEPTH	SUBSTRATE		TOTAL
	Reef (ha)	Sand (ha)	
0-5	87.85	388.77	**476.62**
5-10	67.81	314.10	**381.91**
10-15	76.23	388.32	**464.55**
15-20	73.76	497.37	**571.13**
20-25	78.73	537.56	**616.30**
25-30	66.49	448.67	**515.16**
30-35	36.73	243.96	**280.70**
35-40	22.60	224.72	**247.32**
40-45	18.98	229.02	**248.00**
45-50	2.28	251.92	**254.21**
50+	0.03	264.01	**264.05**
TOTAL	**531.51**	**3788.43**	**4319.93**
Percentage	*12.30%*	*87.70%*	

Table 8. Accuracy assessment for Section D Paddys Island to St Helens Point

Video Class	Map Class					User Total	User Accuracy
	Cobble	Reef	Sand	Seagrass	Silt		
Cobble	0	104	28	0	0	**132**	0.00%
Reef	0	2452	226	0	0	**2678**	91.56%
Sand	0	48	355	0	0	**403**	88.09%
Seagrass	0	0	0	0	0	**0**	0.00%
Silt	0	0	0	0	0	**0**	0.00%
Producer Total	**0**	**2604**	**609**	**0**	**0**	**3213**	
Producer Accuracy	0.00%	94.16%	58.29%	0.00%	0.00%		
Accuracy:	87.36%						
Kappa:	0.579801						

3.1.5.2. Seagrass Distribution Section D

Seagrass was not identified in Section D.

3.1.5.3. Algal Distribution Section D

The total algal cover in the section from Paddys Island to St Helens Point was high in the shallow water (between 90 and 100% in the 0 – 5 m depth range), and gradually decreasing to around 70% by 25 – 30 m depth, before a rapid decrease to less than 10% by 35 – 40 m depth (Figure 39). *Durvillaea potatorum* was not observed on the video, however is known to occur in this section of coast. *Phyllospora comosa* was dominant in the 0 – 5 m depth range with over 50% cover, and common in the 5 – 15 m depth range with around 25% cover, however very little was observed below this depth range. *Ecklonia Radiata* was common between 0 and 35 m depth, with between 25 and 79% cover. The maximum cover of *Ecklonia* was in the 15 – 20 m depth range. *Caulerpa* sp. was present in all depth ranges, with maximum cover in the 20 – 30 m depth range of 17 – 18% cover. Red algae were present below 5 m depth, with cover never exceeding 10 %. Sponge growth occurred below 10 m with peak sponge cover in the 30 – 35 m depth range of 20 % cover.

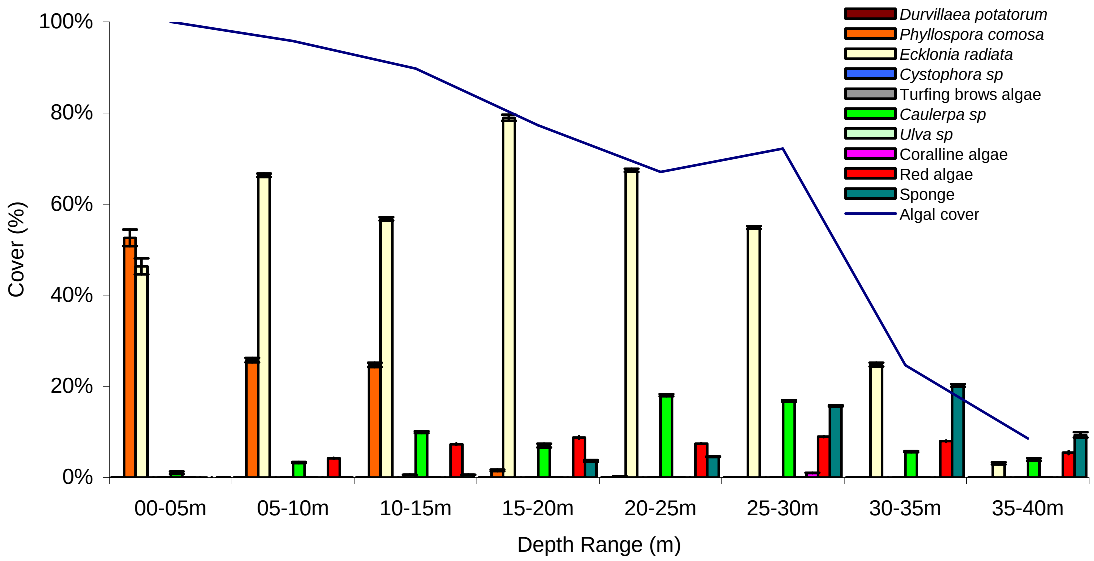

Figure 39. Mean Algal Cover (± s.e.) by depth strata (5 m bin) for analysis section A, Paddys Island to St Helens Point.

3.1.6. Bicheno to St Helens Point Region Summary

The summary statistics for the entire region from Bicheno to St Helens Point is presented in Tables 9 – 11. The majority of the habitat in the 1.5km buffer zone from the coastline was dominated by both sand and reef habitat with virtually no seagrass present (except in a very insignificant amount near Diamond Island). Sand habitat comprised 77.52% of the area of 13,935.91 ha and reef only 22.48%. The majority of the reef habitat was found within subsections A and B in the depth range <30 meters. The majority of the habitats mapped in this section were mainly in the 0- 30m depth range with smaller % areas surveyed outside of 30 meters.

The error analysis (Table 12) of the region from St Helens Point to Bicheno resulted in an overall accuracy result of 90.75% when validating the acoustic interpretation of boundary delineation of habitats with the video classifications.

Reef was interpreted correctly 93.29% of the time with sand interpreted 80.67% of the time. These results could have been due to the patchy nature of the boundary of some of the reef systems where by the reef edge is not crisp (easily determined) and on the video record may be defined as sand at that point rather than reef, where as on the acoustic record it still may have a ‘hard’ residual signature.

Table 9. Distribution of habitats (reef and sand) in the St Helens to Bicheno region by depth and as a total percentage of the habitat occurring within the region.

DEPTH	SUBSTRATE		TOTAL	
	Reef (ha)	Sand (ha)	% Total of all habitat mapping in this region	
0-5	469.94	1353.02	**1822.96**	13.1%
5-10	390.10	1166.93	**1557.03**	11.2%
10-15	636.26	1340.42	**1976.69**	14.2%
15-20	632.22	1710.78	**2343.00**	16.8%
20-25	592.50	1924.06	**2516.56**	18.1%
25-30	239.80	1228.57	**1468.37**	10.5%
30-35	97.17	682.19	**779.36**	5.6%
35-40	54.18	477.20	**531.38**	3.8%
40-45	18.98	331.52	**350.51**	2.5%
45-50	2.28	323.73	**326.01**	2.3%
50+	0.03	264.01	**264.05**	1.9%
TOTAL	**3133.47**	**10802.45**	**13935.91**	
Percentage	*22.48%*	*77.52%*		

Table 10. Distribution of habitats (reef and sand) in the St Helens to Bicheno region by reporting section.

HABITAT	SECTION				TOTAL
	A	B	C	D	
Reef	1,116.69	1,173.71	311.56	531.51	3,133.47
Sand	1,721.84	2,149.36	3,142.82	3,788.43	10,802.45
TOTAL	2,838.53	3,323.08	3,454.37	4,319.93	

Table 11. Percentage of habitat area total by reporting section in the St Helens to Bicheno region.

HABITAT	SECTION				TOTAL
	A	B	C	D	
Reef	8.0%	8.4%	2.2%	3.8%	22.5%
Sand	12.4%	15.4%	22.6%	27.2%	77.5%
TOTAL	20.4%	23.8%	24.8%	31.0%	100.0%

Table 12. Error analysis of habitats within the St Helens to Bicheno region.

Video Class	Map Class						
	Cobble	Reef	Sand	Seagrass	Silt	User Total	User Accuracy
Cobble	0	104	28	0	0	**132**	0.00%
Reef	0	21292	974	0	0	**22266**	95.63%
Sand	0	1427	4640	0	0	**6067**	76.48%
Seagrass	0	0	110	0	0	**110**	0.00%
Silt	0	0	0	0	0	**0**	0.00%
Producer Total	**0**	**22823**	**5752**	**0**	**0**	**28575**	
Producer Accuracy	0.00%	93.29%	80.67%	0.00%	0.00%		
Accuracy:	90.75%						
Kappa:	0.723818						

3.1.7. Reef Profile

Low profile reef was the dominant category in all the analysis sections comprising between 65 and 89 % of all reef substrate (Figure 40). Sections A and B had the highest proportion of low profile reef, with around 89 % of all reef classified as low profile. The amount of low profile reef decreased in sections C and D, with 80 and 65 % respectively. The proportion of medium profile increased from south to north, with 11 % of all reef classified as medium profile in sections A and B, which increased to 20 % in section C and 33% in section D. The higher proportion of medium profile reef in sections C and D is a reflection of the more complex reef found off Paddy’s Island, St Helens Island and St Helens Point. High profile reef was present in low quantities (< 1 %) in sections A – C, and increased to 2 % in section D.

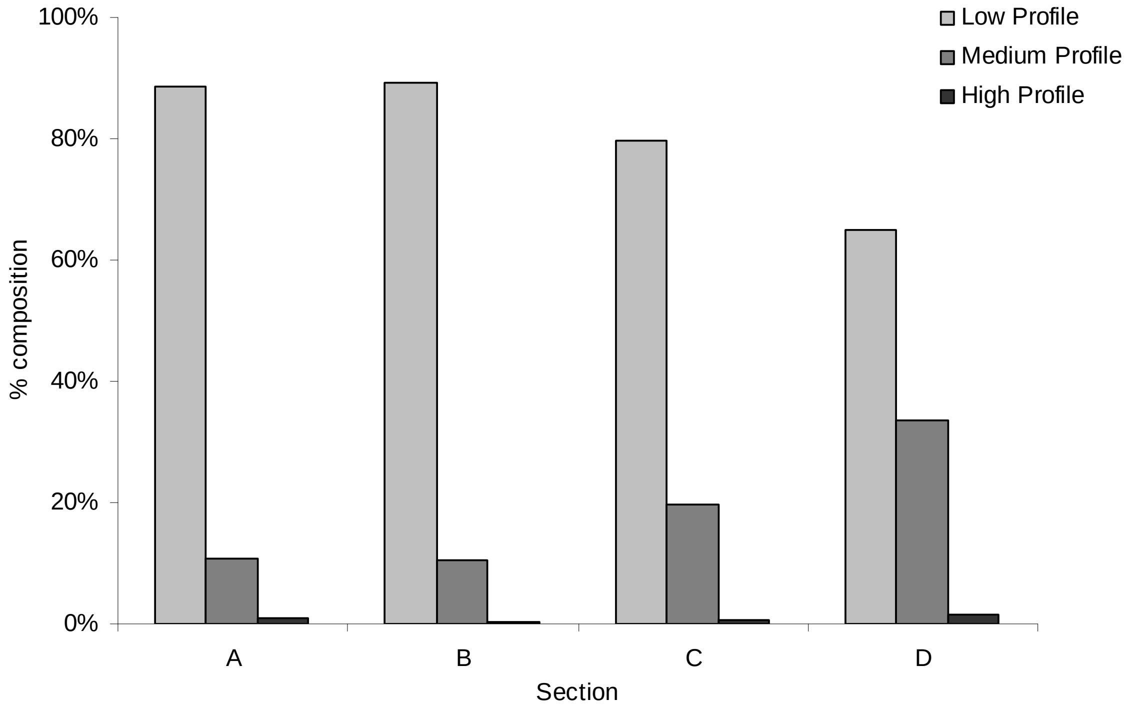

Figure 40. Percentage composition of low profile reef (< 1 m rise and fall), medium profile reef (1 – 4 m rise and fall) and high profile reef (> 4 m rise and fall) by section for reef substrate between Bicheno and St Helens.

3.2. The Tamar River to Swan Island

The Tamar River to Swan Island survey zone extends west from Tree Point south of Musselroe Bay to Low Head at the mouth of the Tamar River. This region is within the NRM North jurisdiction and the habitat mapping of this area completes the SeaMap Tasmania database for the entire north coast between the two NRM regions of Cradle Coast and North. Figure 41 indicates the six (A-F) analysis regions that have been subset for the coastline from Tree Point to Low Head. The maps generated in this region cover a total of 28,590.86 ha (or 258.90 km^2) of seabed from the coastline 1 m depth to 45 m depth (Figure 42). The survey area is has been clipped to 1.5kms from the coastline. Figure 43-75 show the habitat maps at 1:25,000 of the region depicting the distribution of cobble, reef, sand and seagrass across this survey zone. The RAMSAR listed site of the Ringarooma River was identified and reported with separate statistics in section B.

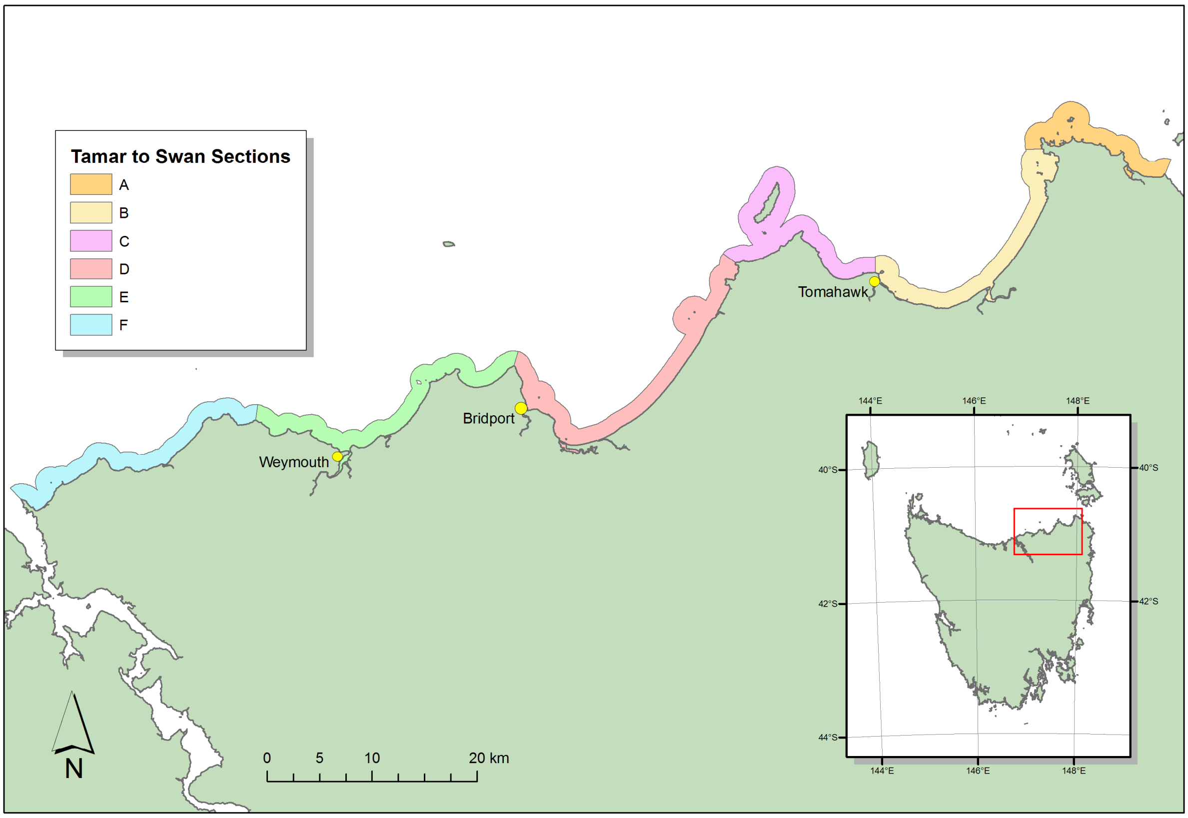

Figure 41. Location map showing analysis and reporting sections for Tamar River to Swan Island.

3.2.1. Bathymetry and habitat maps from Tamar River to Swan Island

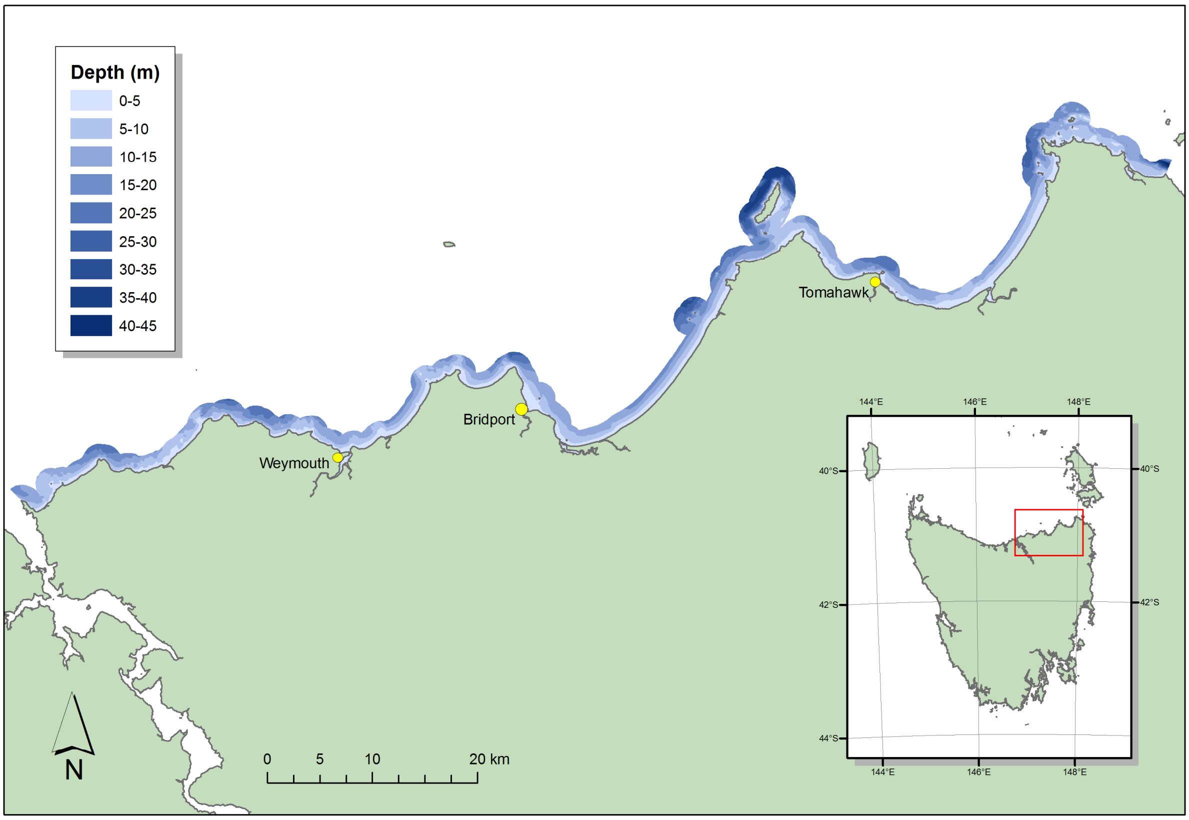

Figure 42. Map of bathymetry for Tamar River to Swan Island, interpolated from acoustic data.

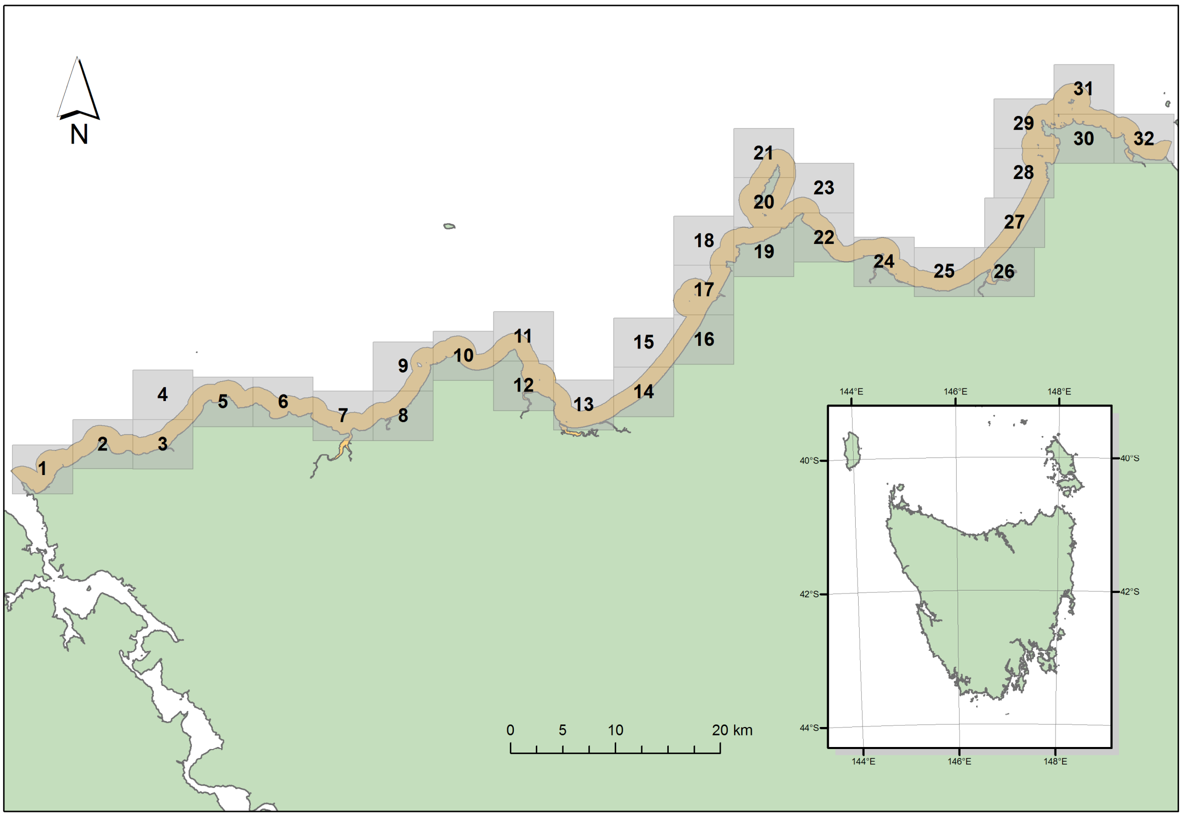

Figure 43. Index map of 1:25 000 habitat maps for Tamar River to Swan Island map series.

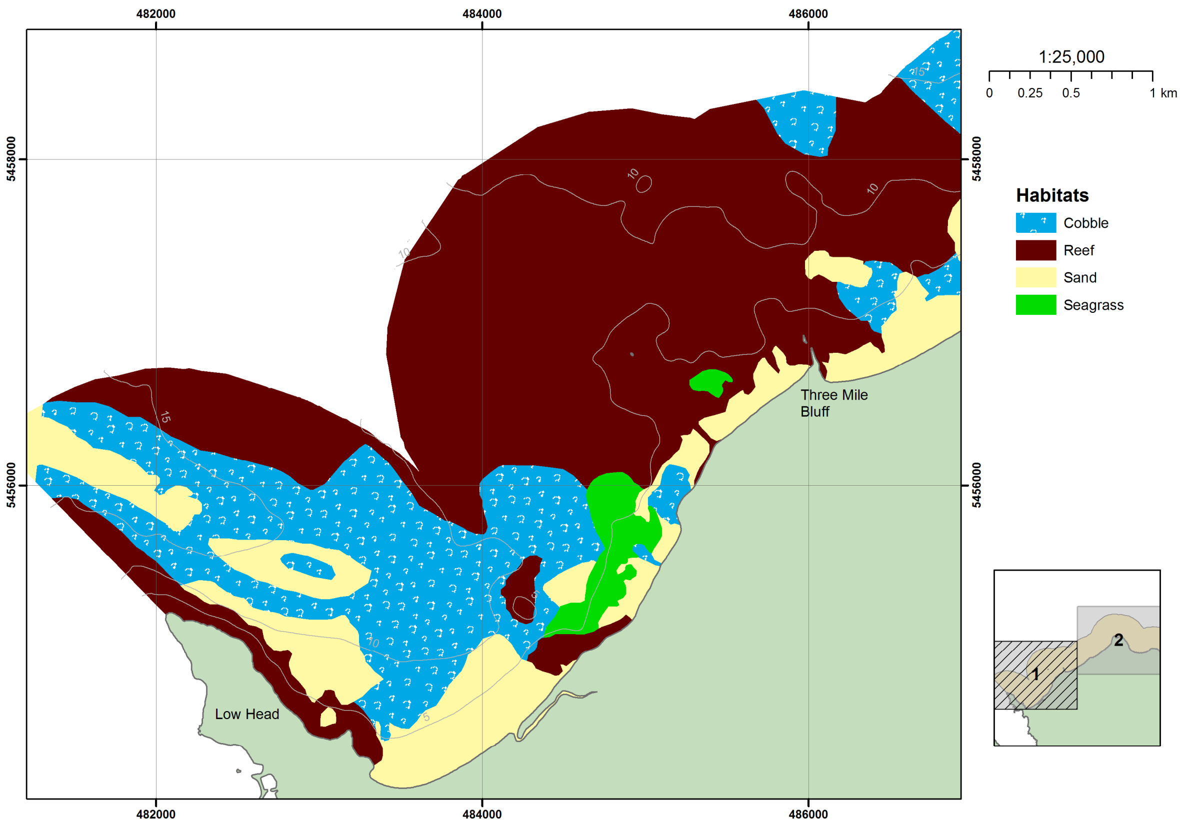

Figure 44. Tamar River to Swan Island map series map 1 showing habitats and bathymetry for Low Head to Three Mile Bluff.

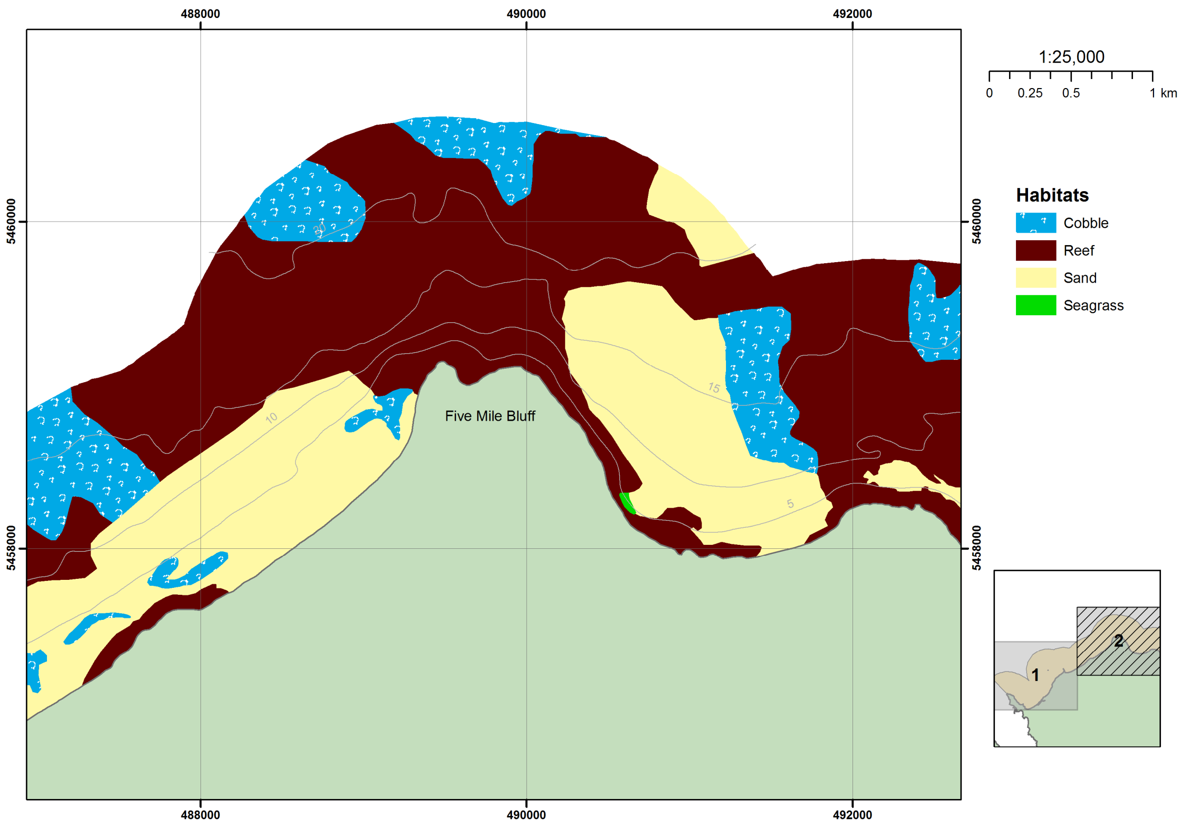

Figure 45. Tamar River to Swan Island map series map 2 showing habitats and bathymetry around Five Mile Bluff.

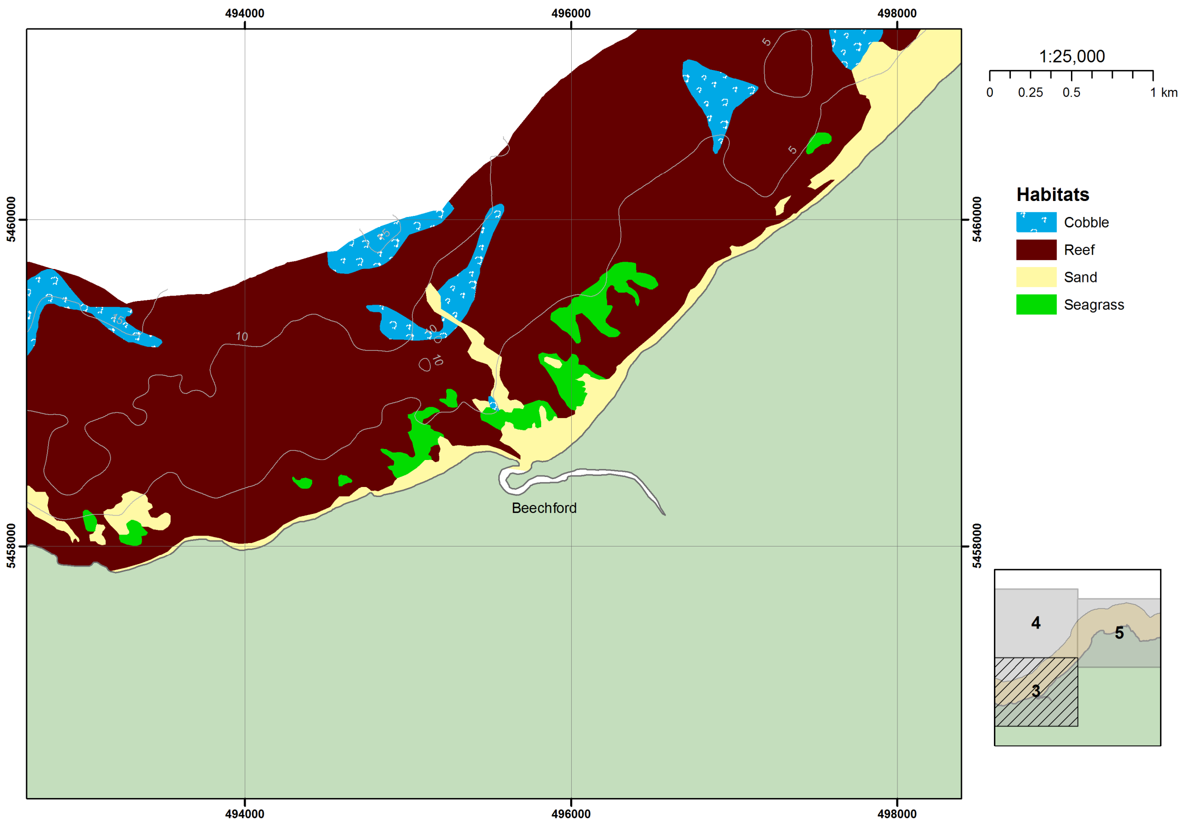

Figure 46. Tamar River to Swan Island map series map 3 showing habitats and bathymetry off Beechford.

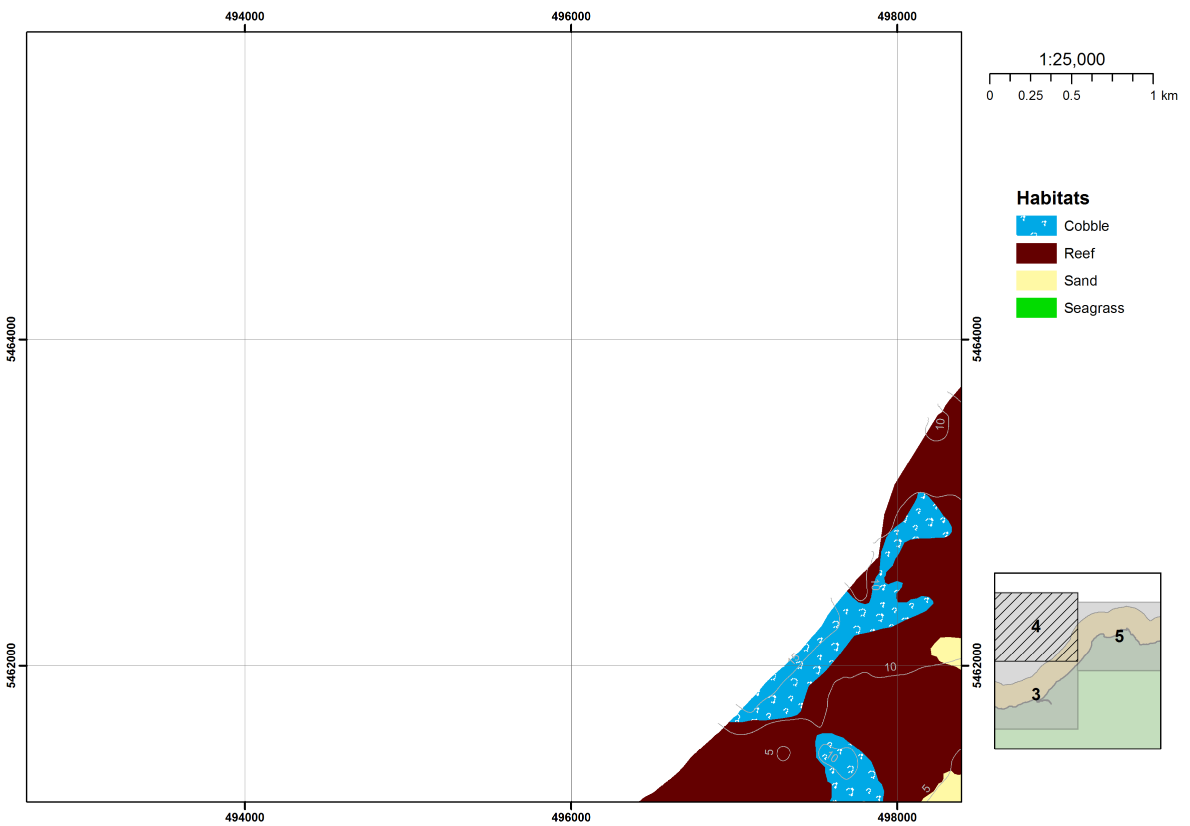

Figure 47. Tamar River to Swan Island map series map 4 showing habitats and bathymetry offshore of Beechford.

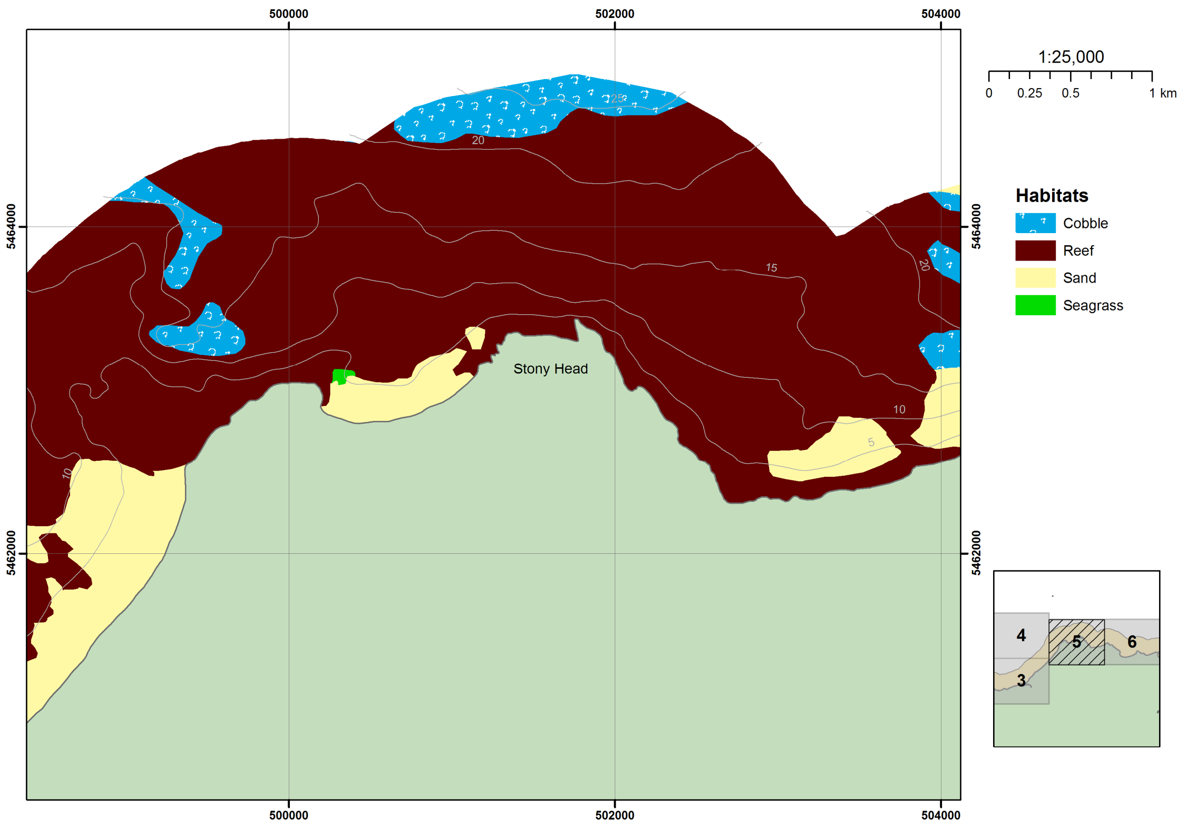

Figure 48. Tamar River to Swan Island map series map 5 showing habitats and bathymetry around Stony Head.

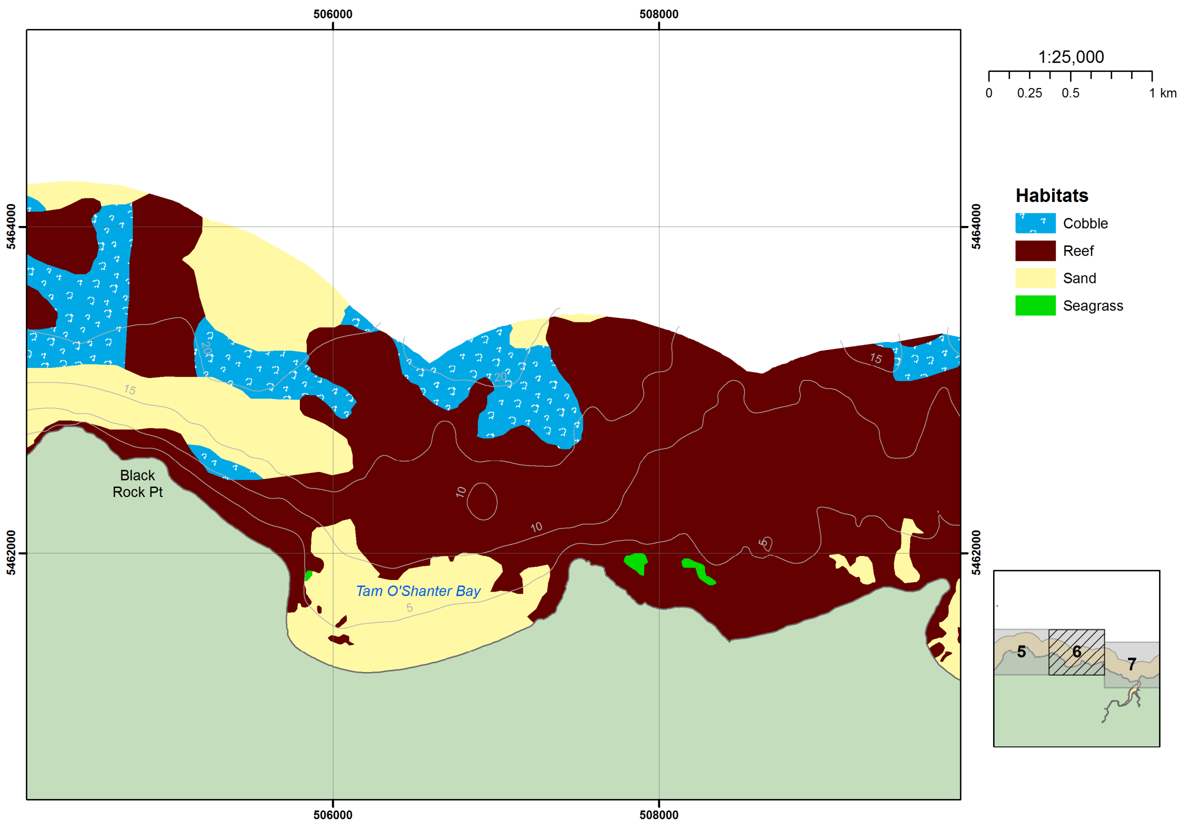

Figure 49. Tamar River to Swan Island map series map 6 showing habitats and bathymetry for Tam O'Shanter Bay.

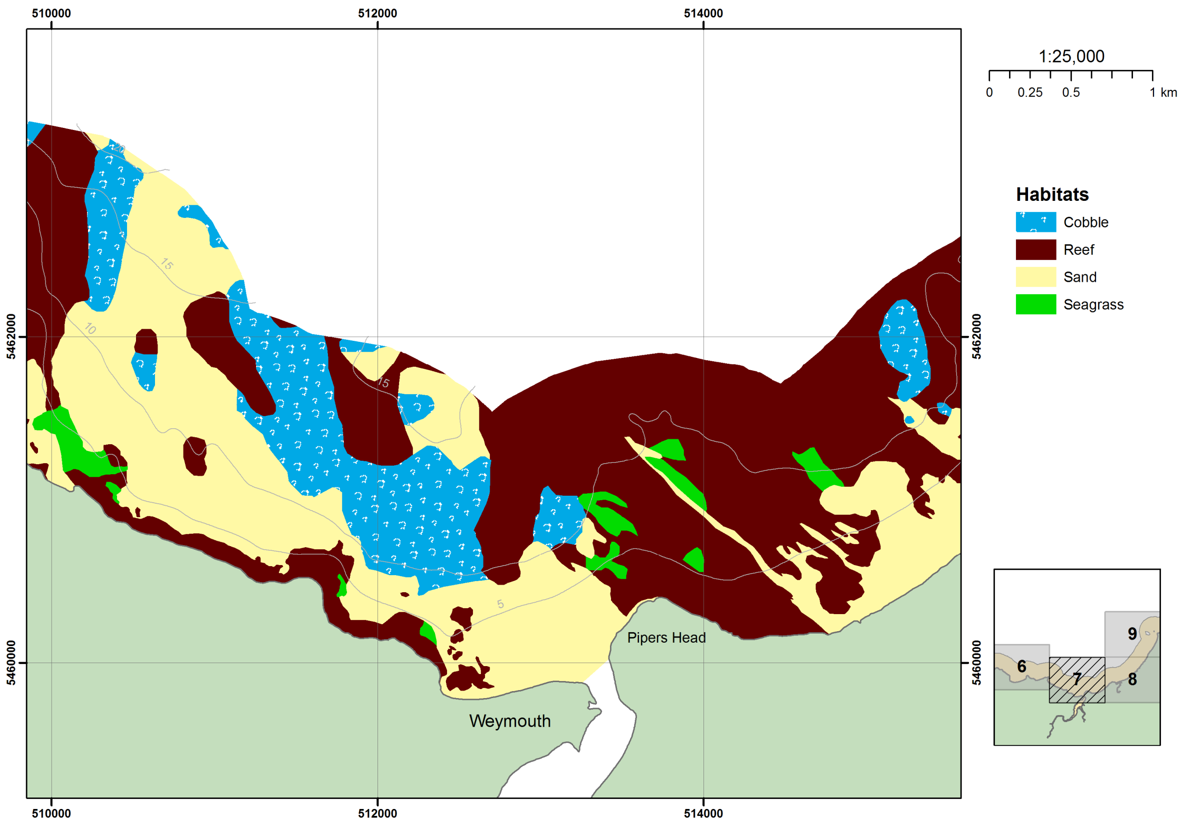

Figure 50. Tamar River to Swan Island map series map 7 showing habitats and bathymetry off Weymouth.

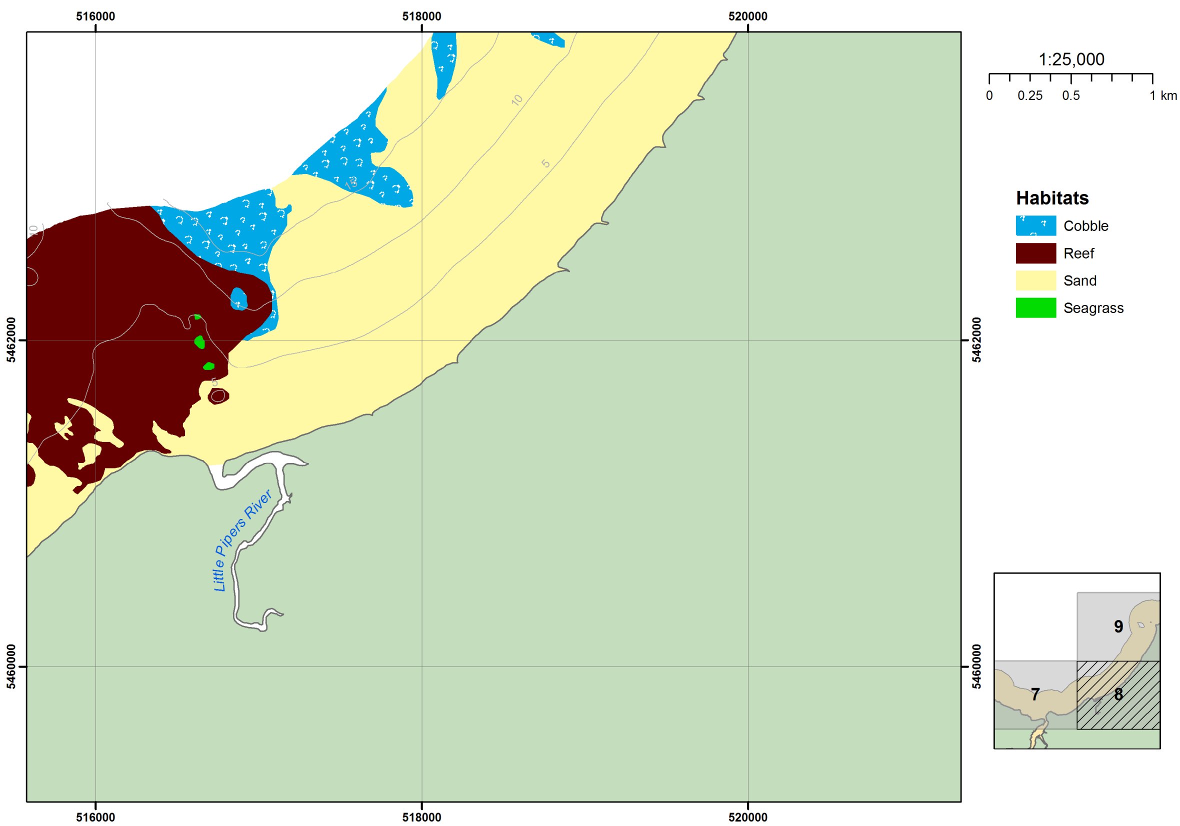

Figure 51. Tamar River to Swan Island map series map 8 showing habitats and bathymetry off the Little Pipers River.

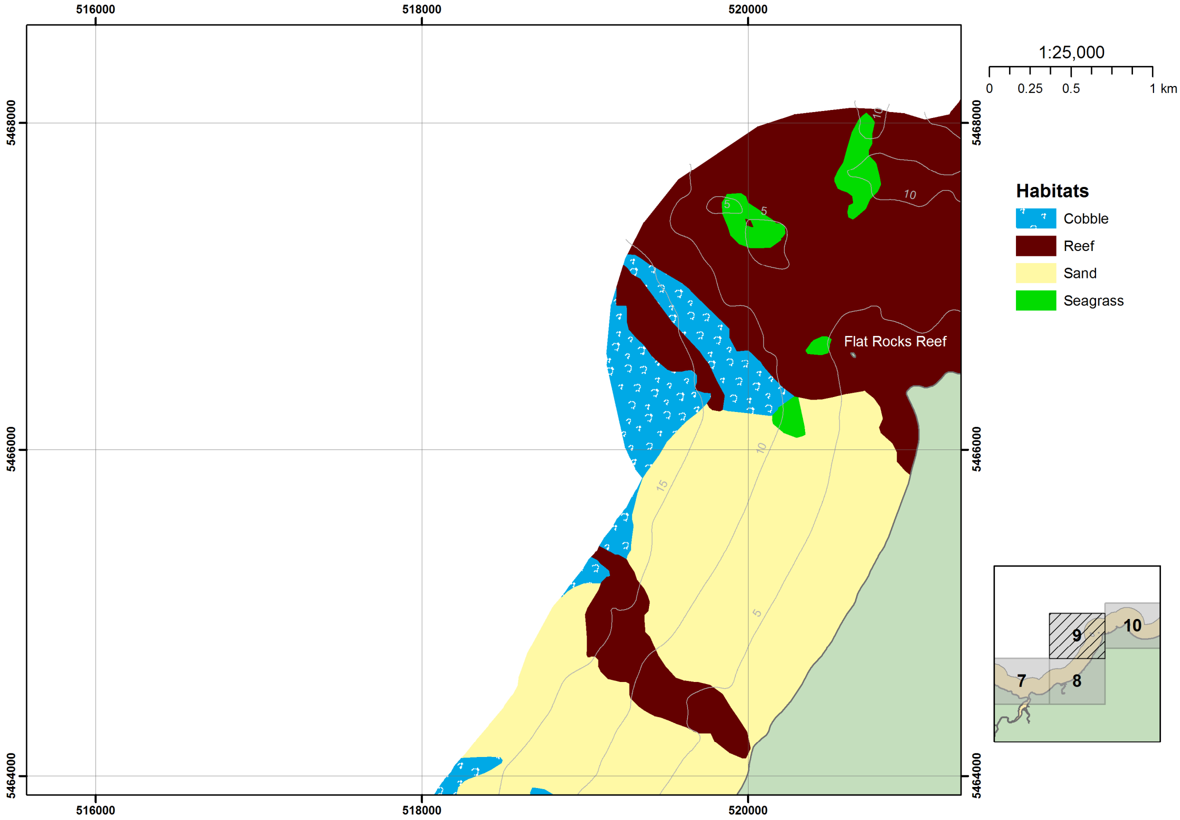

Figure 52. Tamar River to Swan Island map series map 9 showing habitats and bathymetry around Flat Rocks Reef.

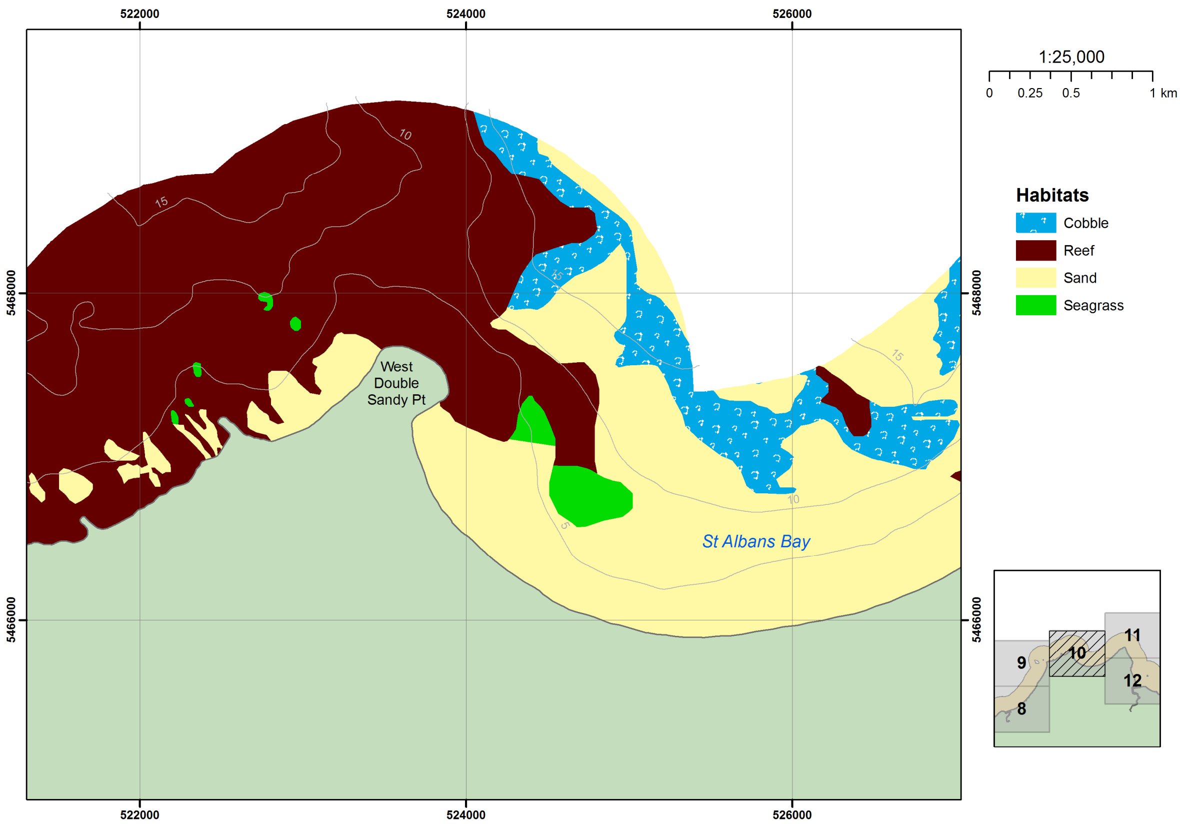

Figure 53. Tamar River to Swan Island map series map 10 showing habitats and bathymetry for West Double Sandy Point and St Albans Bay.

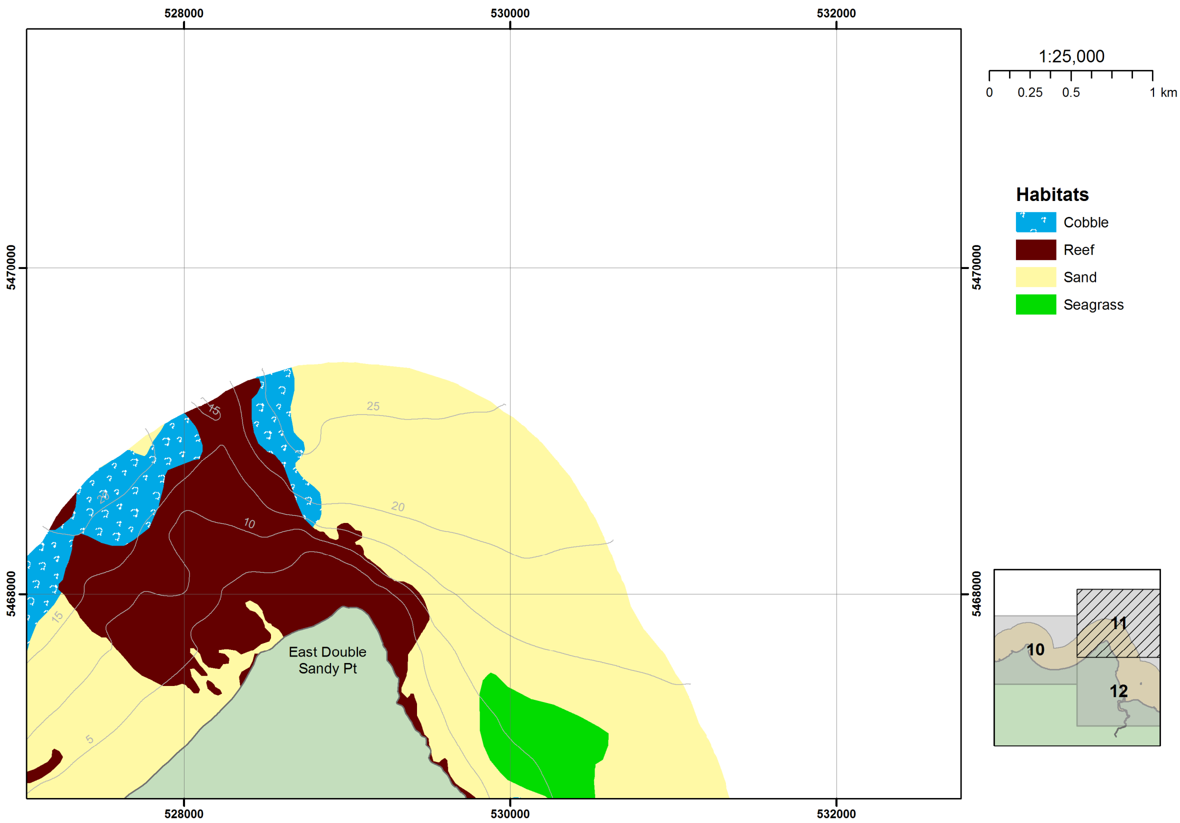

Figure 54. Tamar River to Swan Island map series map 11 showing habitats and bathymetry off East Double Sandy Point.

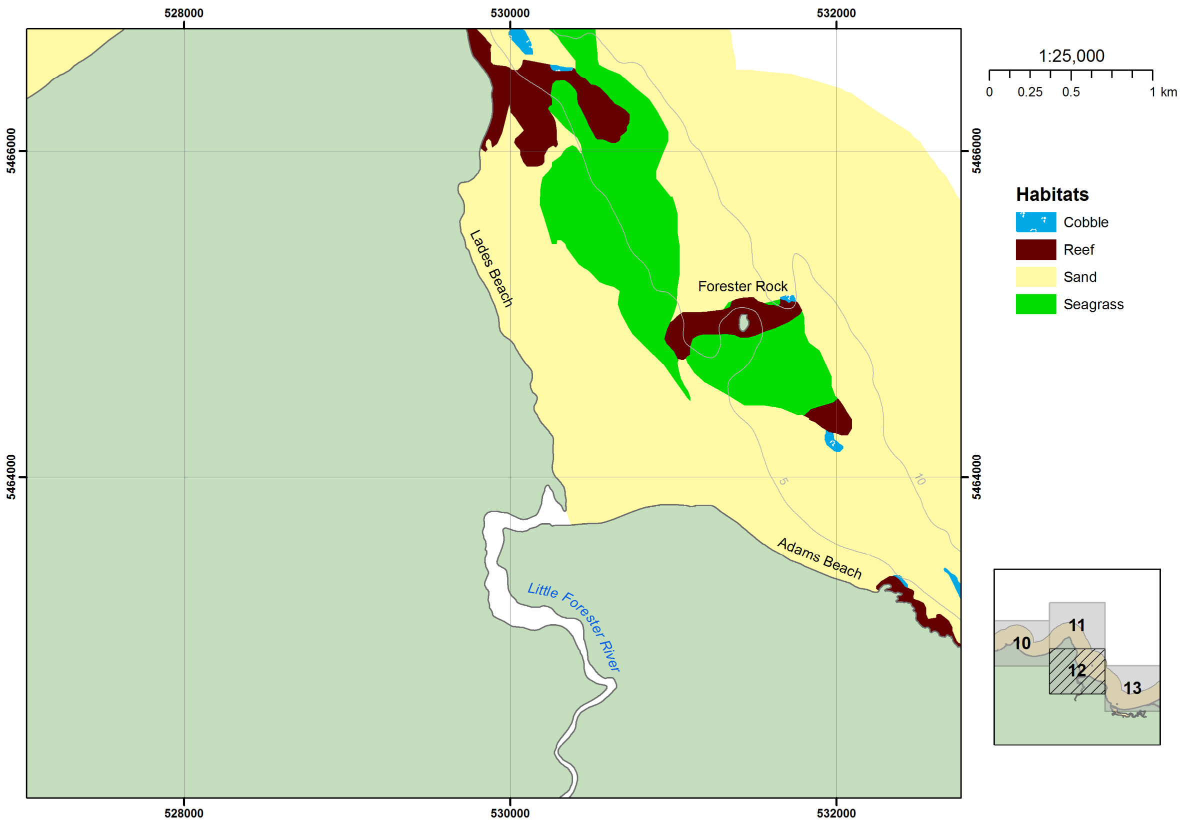

Figure 55. Tamar River to Swan Island map series map 12 showing habitats and bathymetry around Forester Rock.

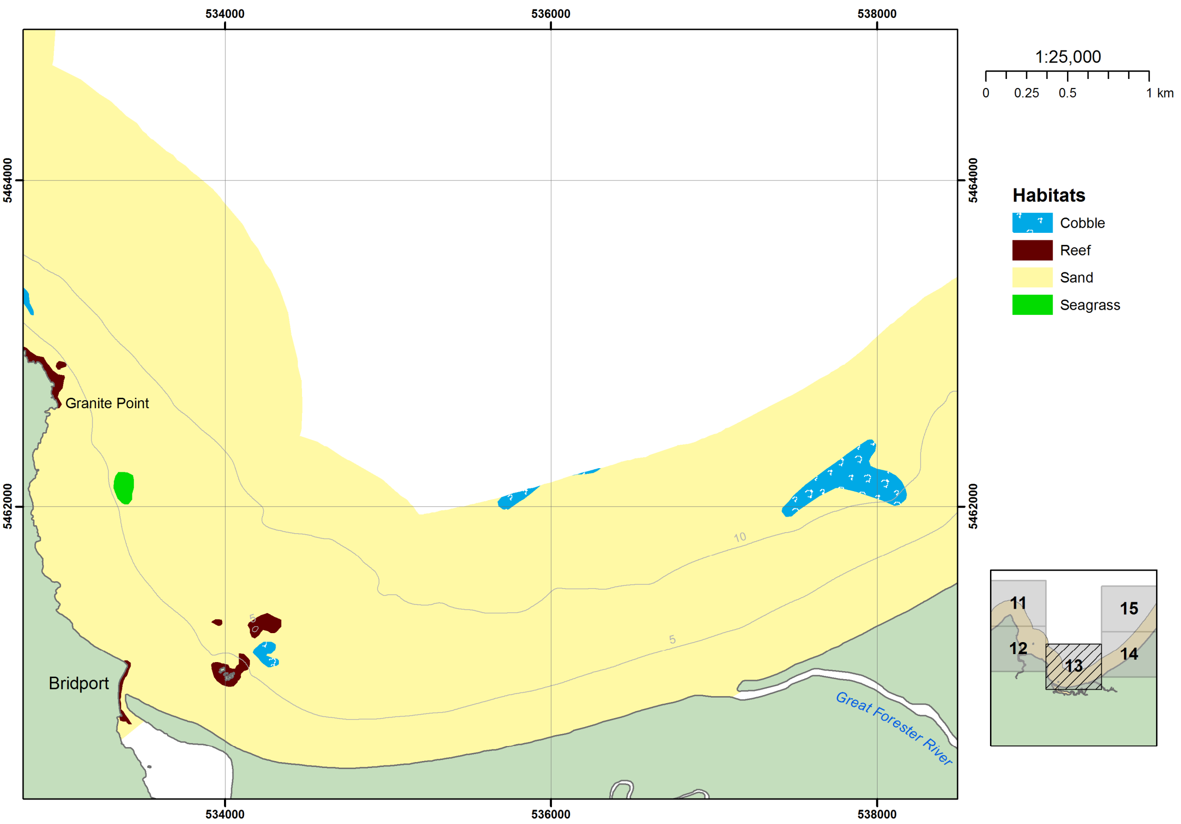

Figure 56. Tamar River to Swan Island map series map 13 showing habitats and bathymetry off Granite Point and Bridport.

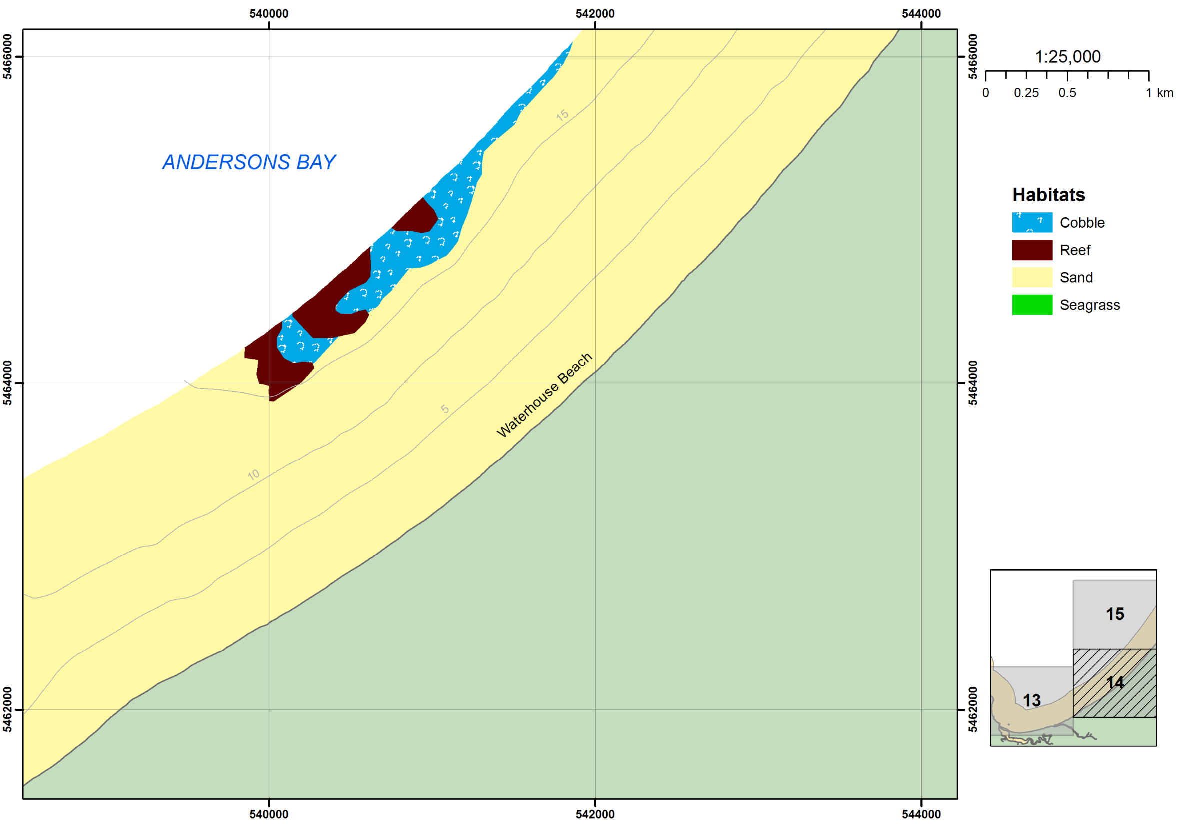

Figure 57. Tamar River to Swan Island map series map 14 showing habitats and bathymetry off Waterhouse Beach.

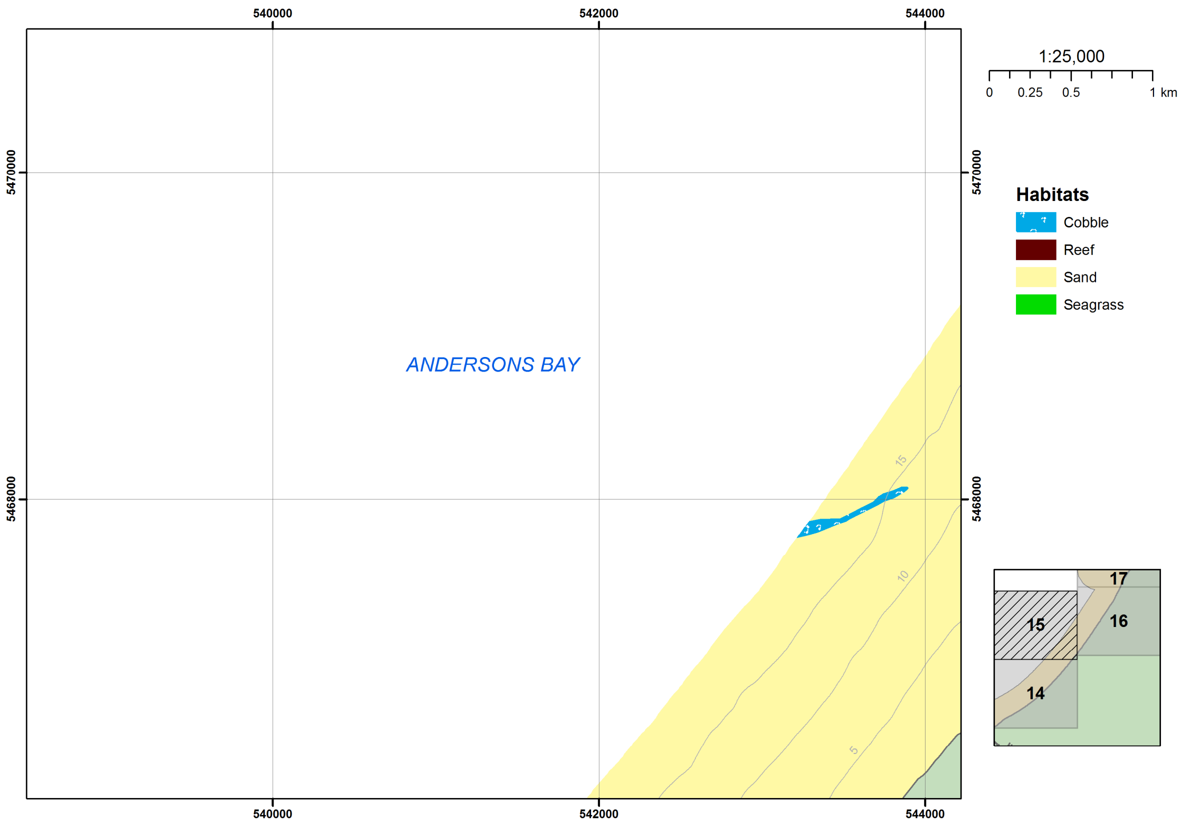

Figure 58. Tamar River to Swan Island map series map 15 showing habitats and bathymetry off Waterhouse Beach.

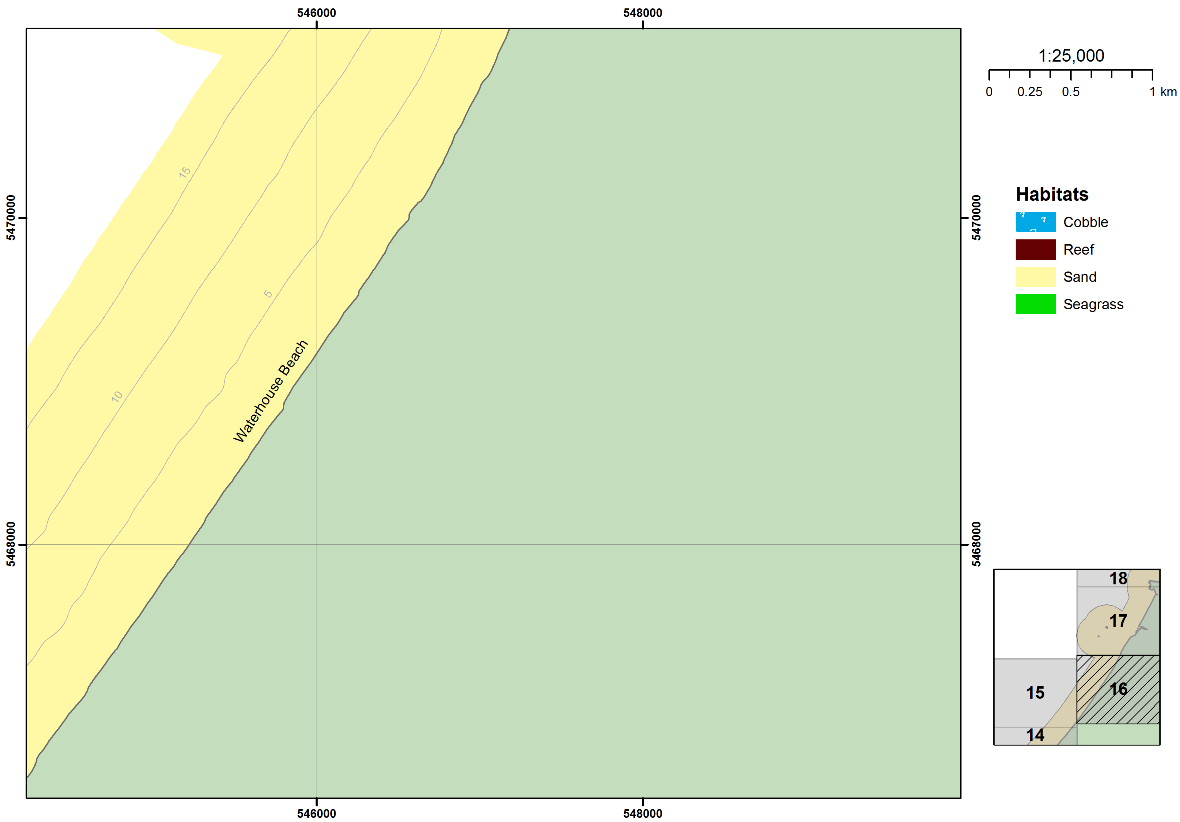

Figure 59. Tamar River to Swan Island map series map 16 showing habitats and bathymetry off Waterhouse Beach.

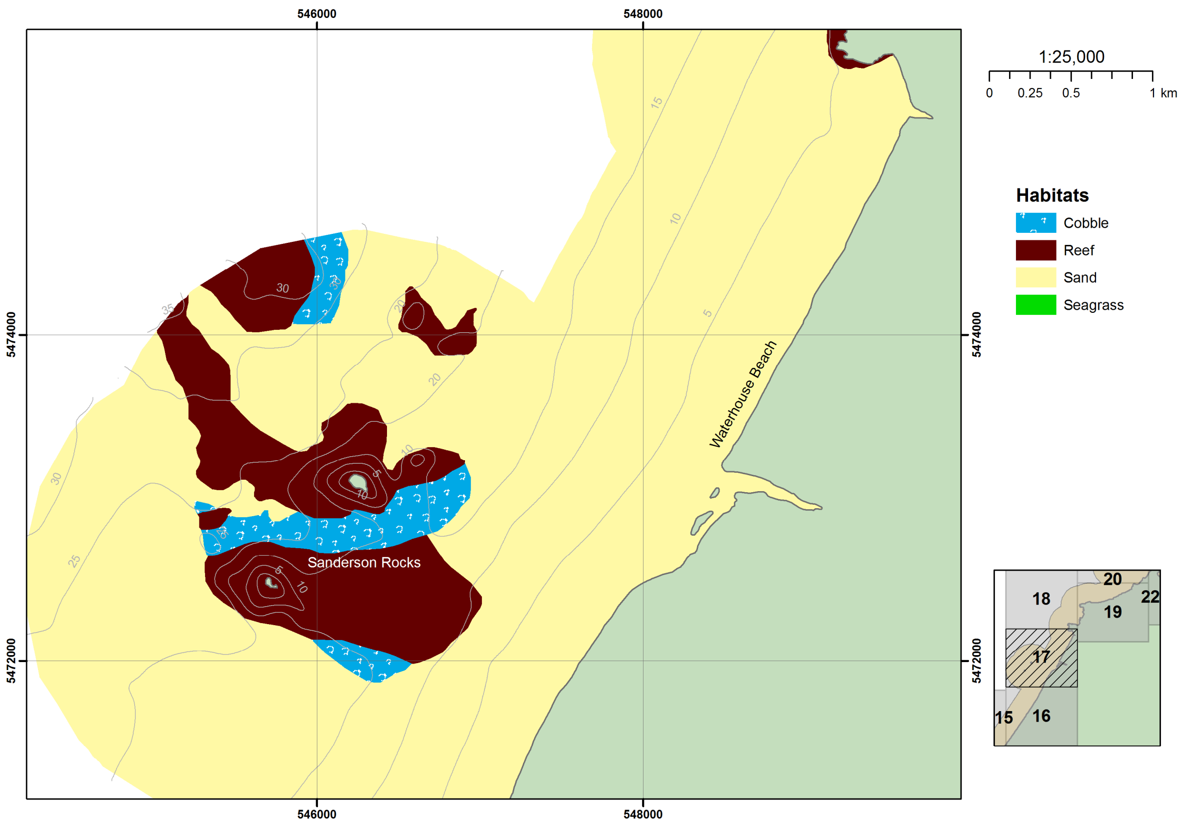

Figure 60. Tamar River to Swan Island map series map 17 showing habitats and bathymetry around Sanderson Rocks.

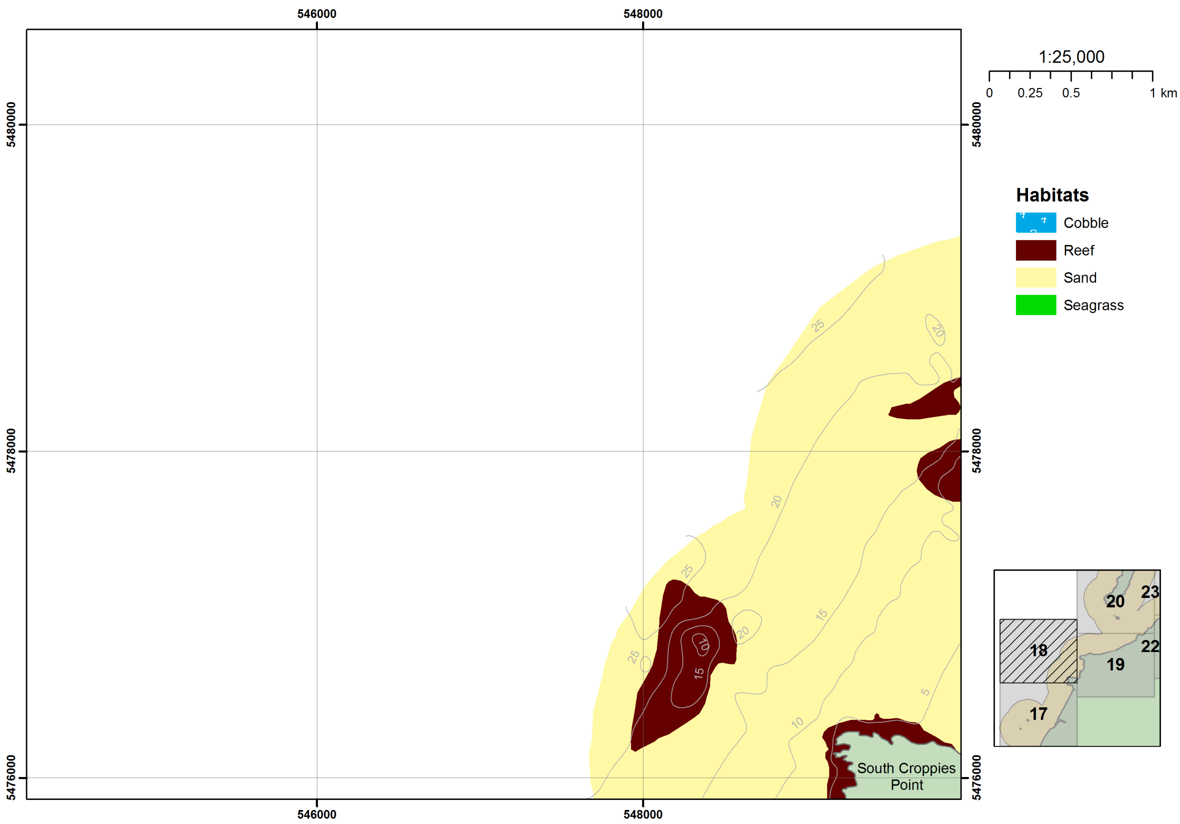

Figure 61. Tamar River to Swan Island map series map 18 showing habitats and bathymetry off South Croppies Point.

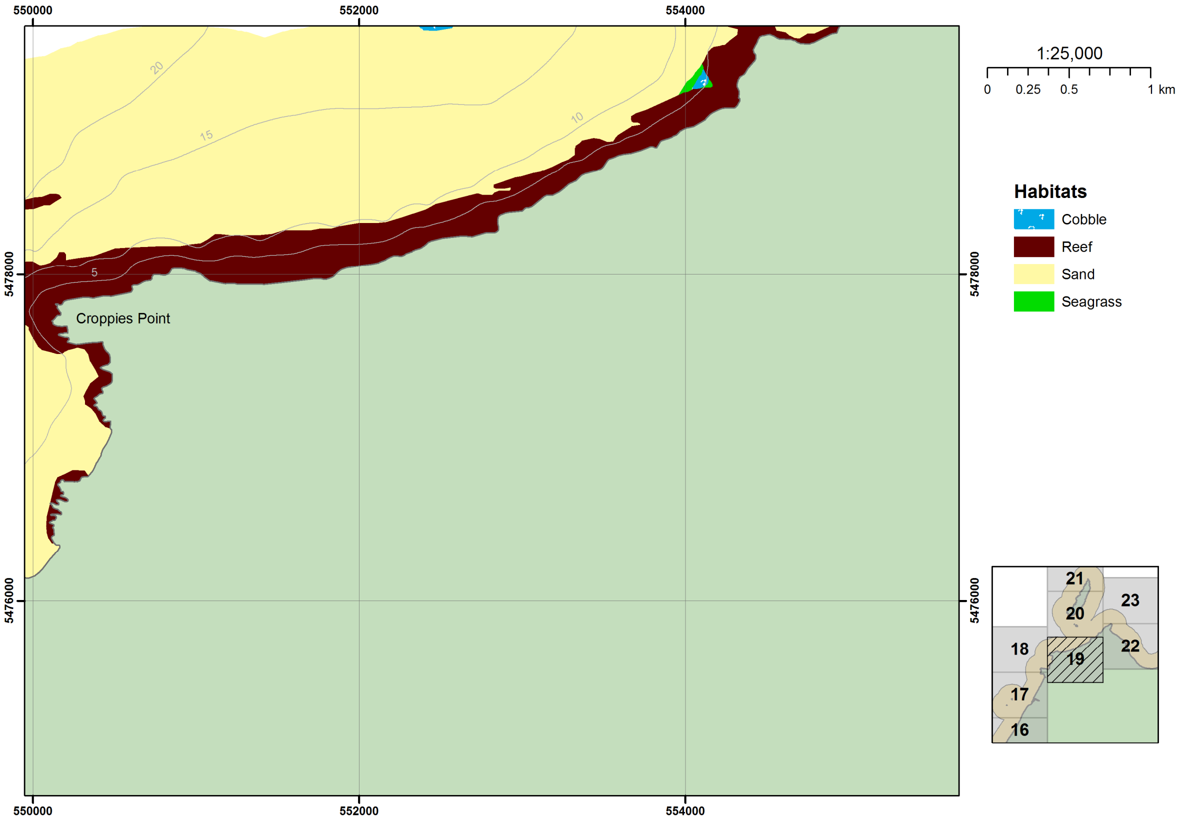

Figure 62. Tamar River to Swan Island map series map 19 showing habitats and bathymetry off Croppies Point.

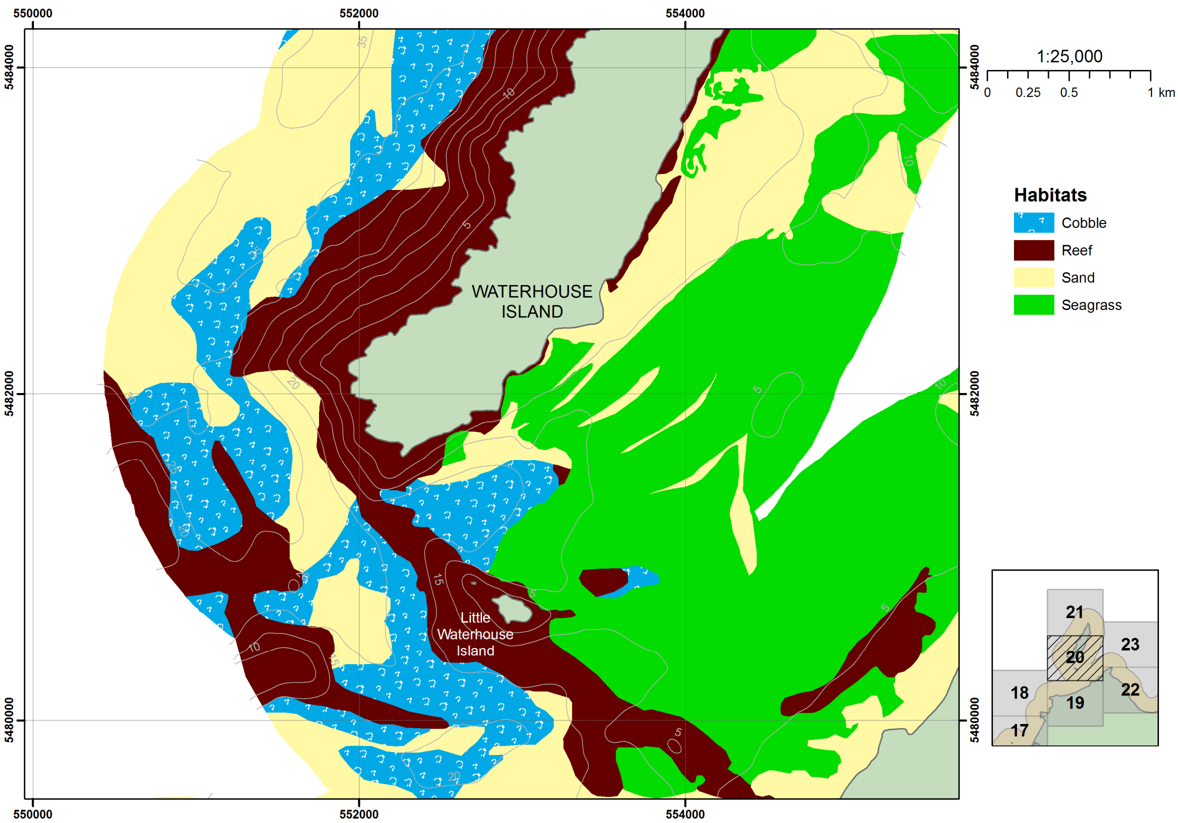

Figure 63. Tamar River to Swan Island map series map 20 showing habitats and bathymetry around southern Waterhouse Island.

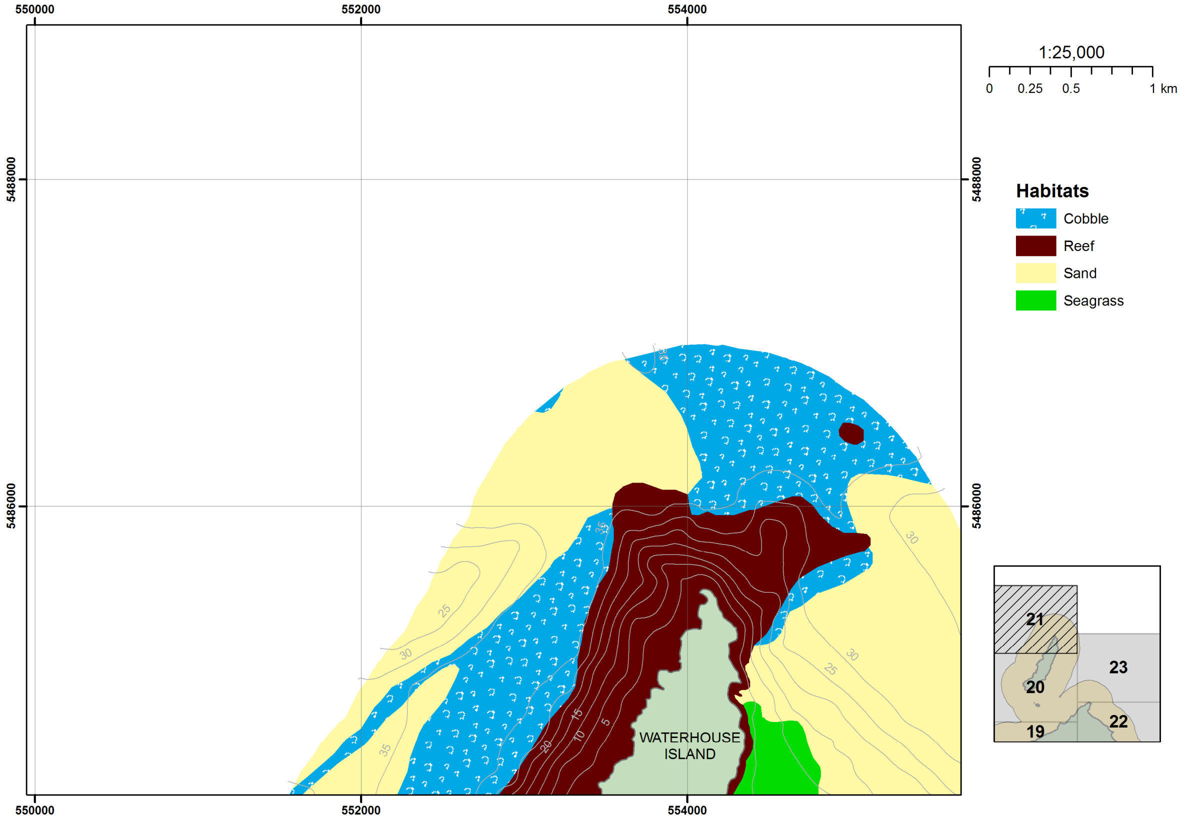

Figure 64. Tamar River to Swan Island map series map 21 showing habitats and bathymetry around northern Waterhouse Island.

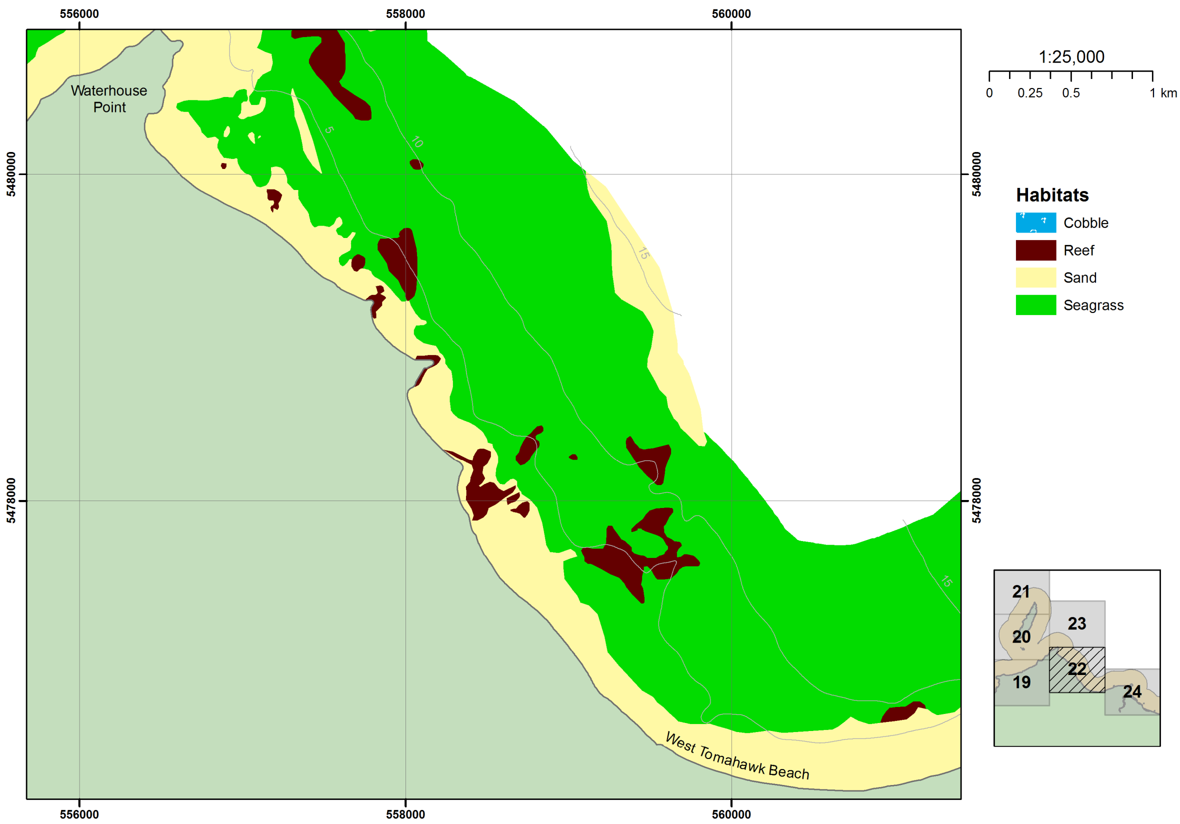

Figure 65. Tamar River to Swan Island map series map 22 showing habitats and bathymetry off Waterhouse Point and West Tomahawk Beach.

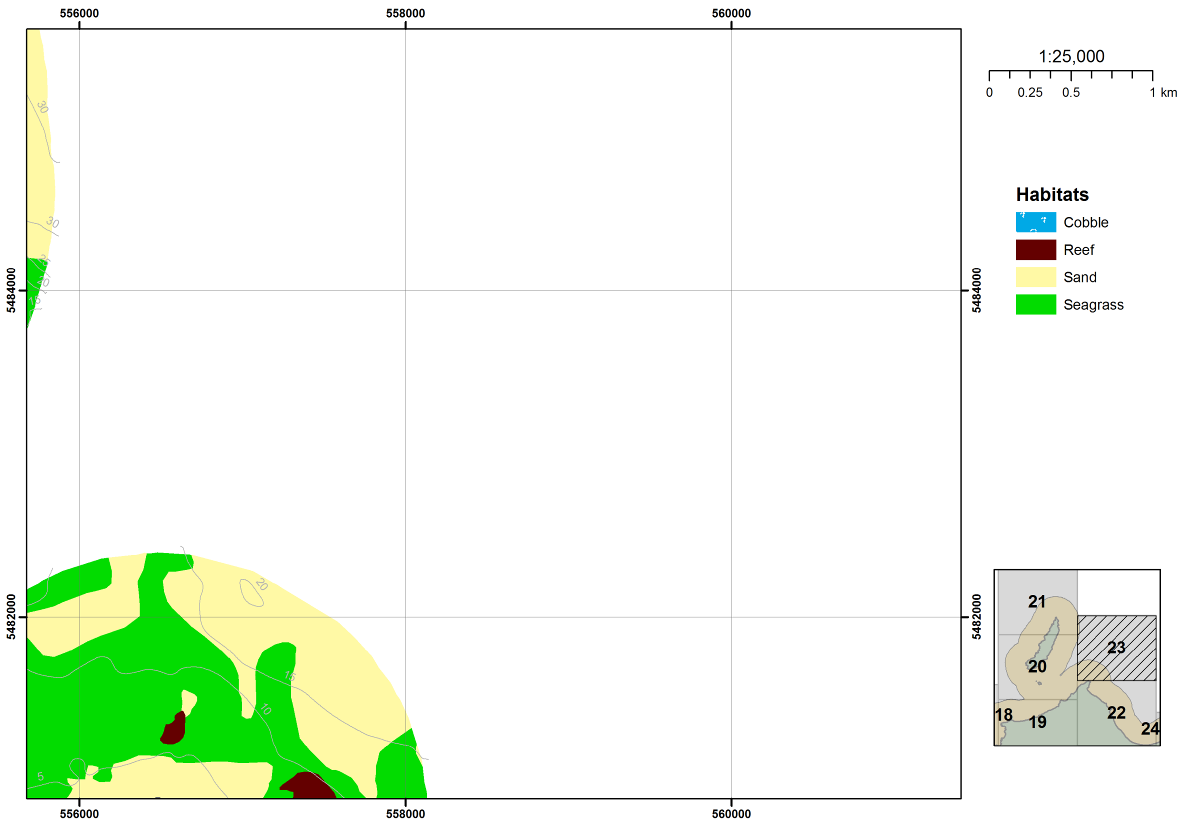

Figure 66. Tamar River to Swan Island map series map 23 showing habitats and bathymetry off Waterhouse Point.

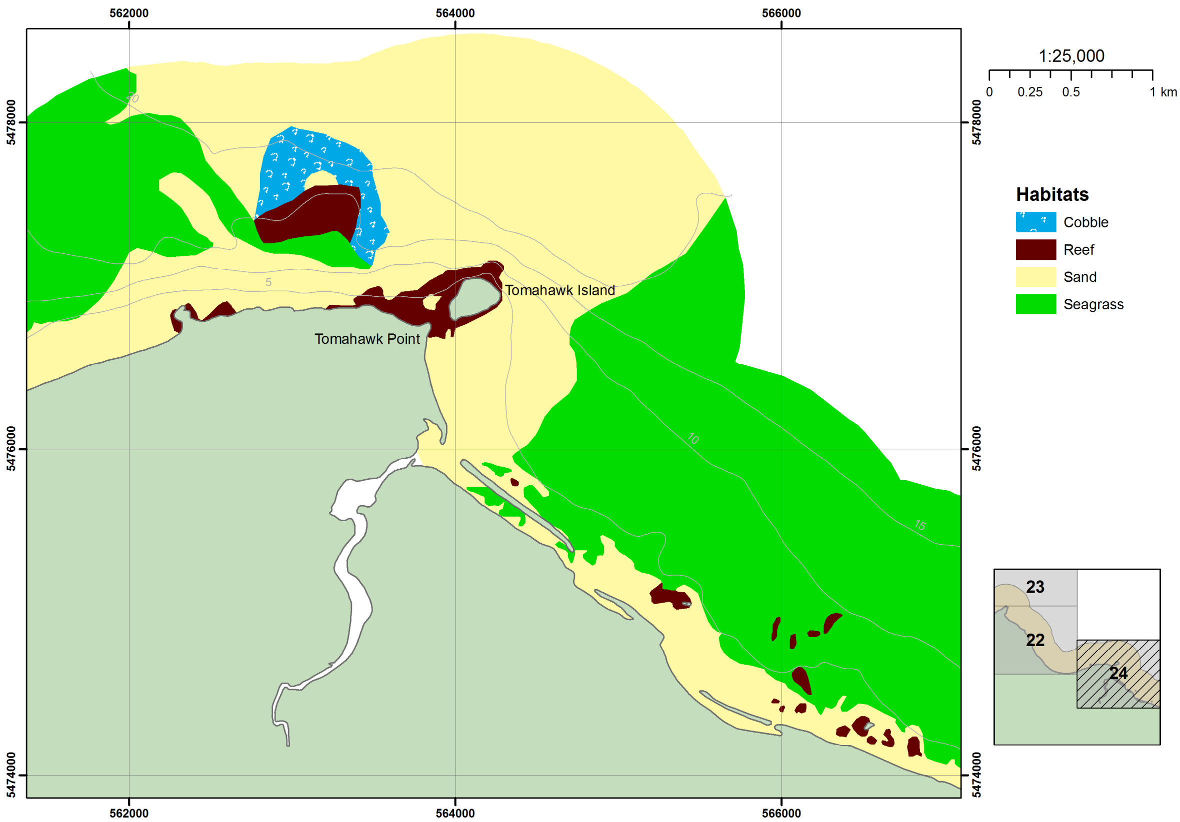

Figure 67. Tamar River to Swan Island map series map 24 showing habitats and bathymetry off Tomahawk Island.

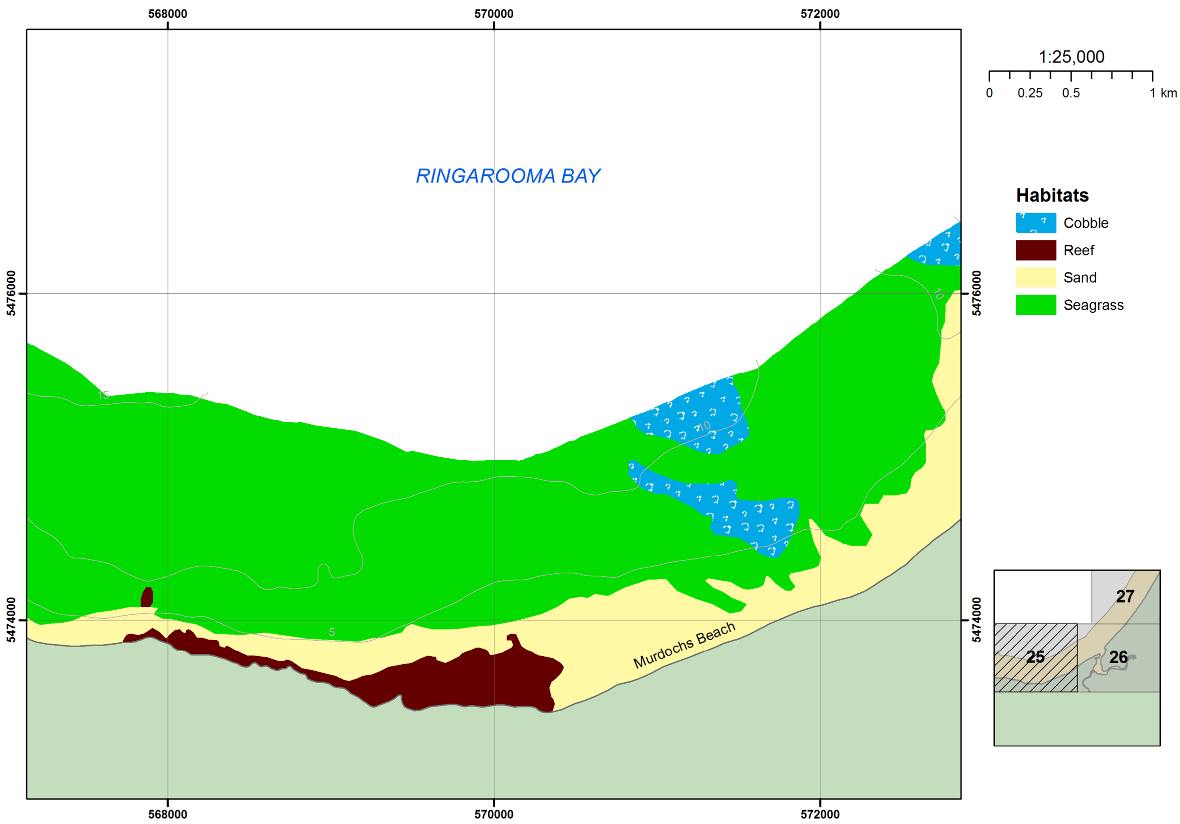

Figure 68. Tamar River to Swan Island map series map 25 showing habitats and bathymetry off Murdochs Beach.

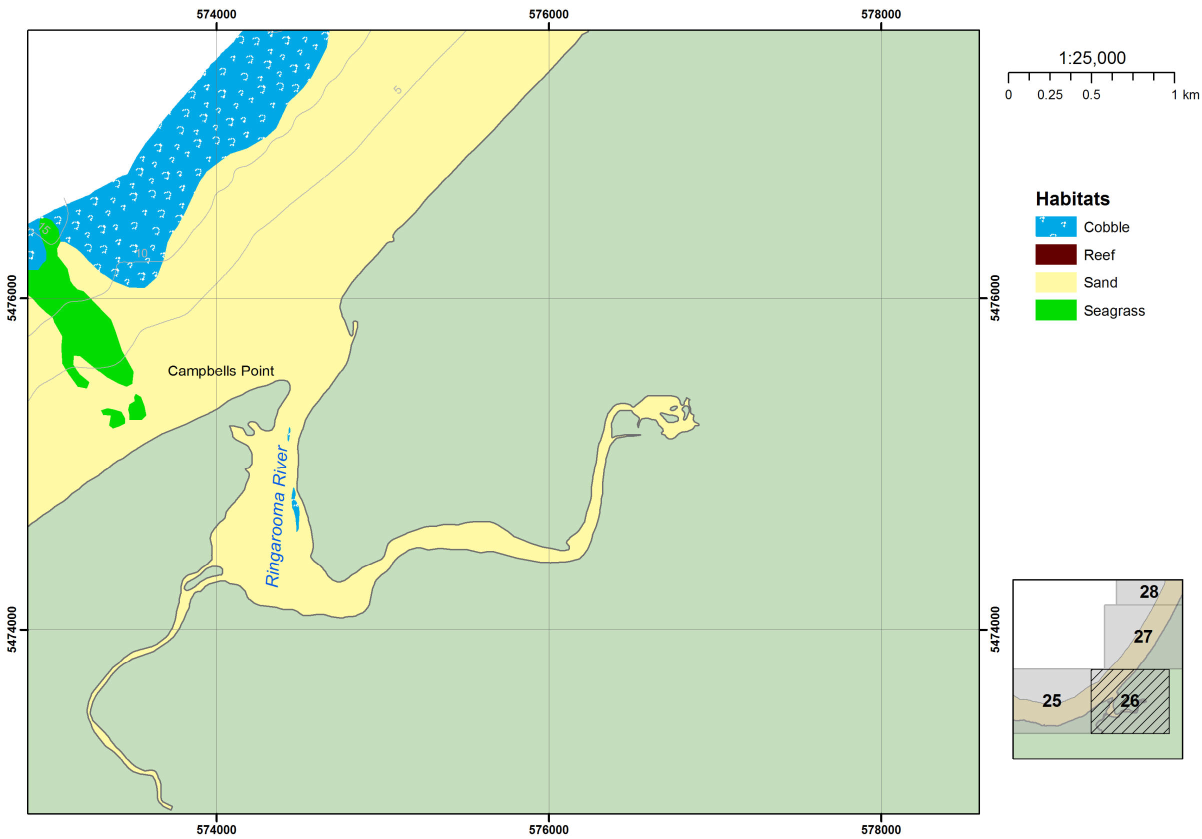

Figure 69. Tamar River to Swan Island map series map 26 showing habitats and bathymetry off Campbells Point

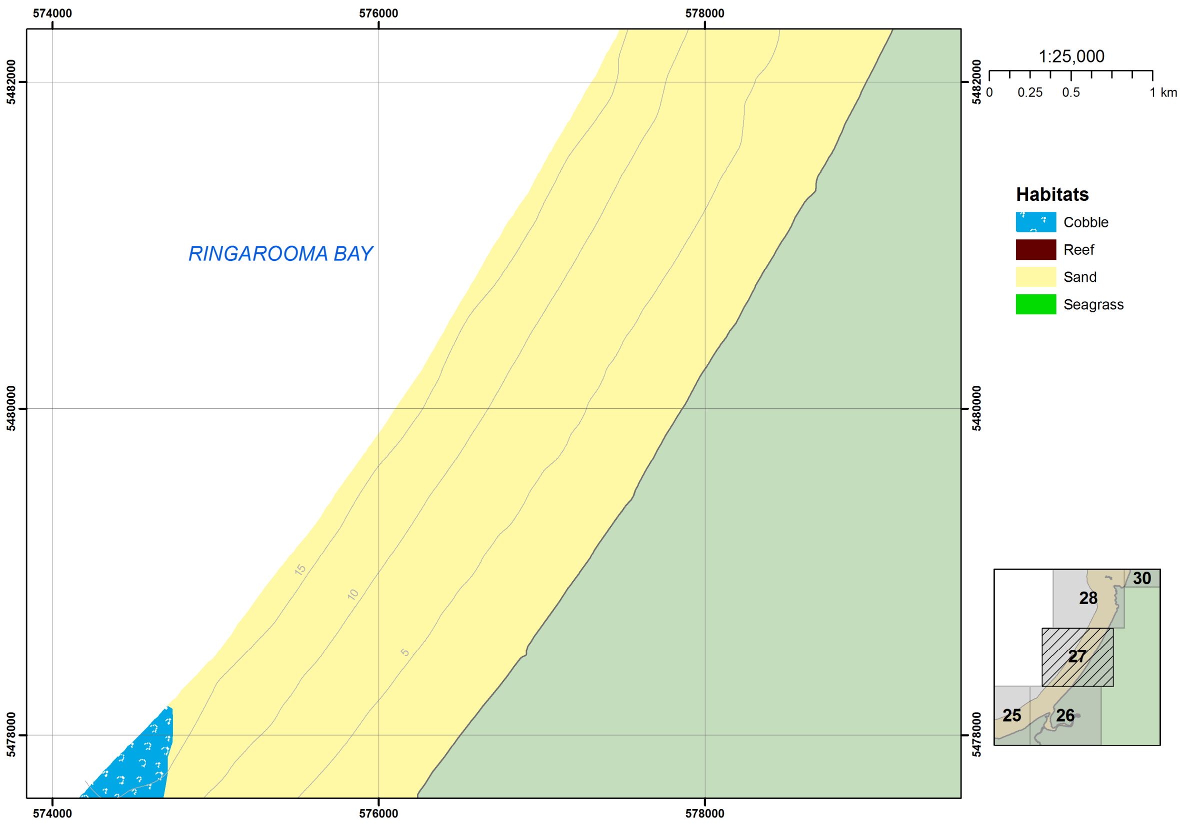

Figure 70. Tamar River to Swan Island map series map 27 showing habitats and bathymetry off Boobyalla Beach.

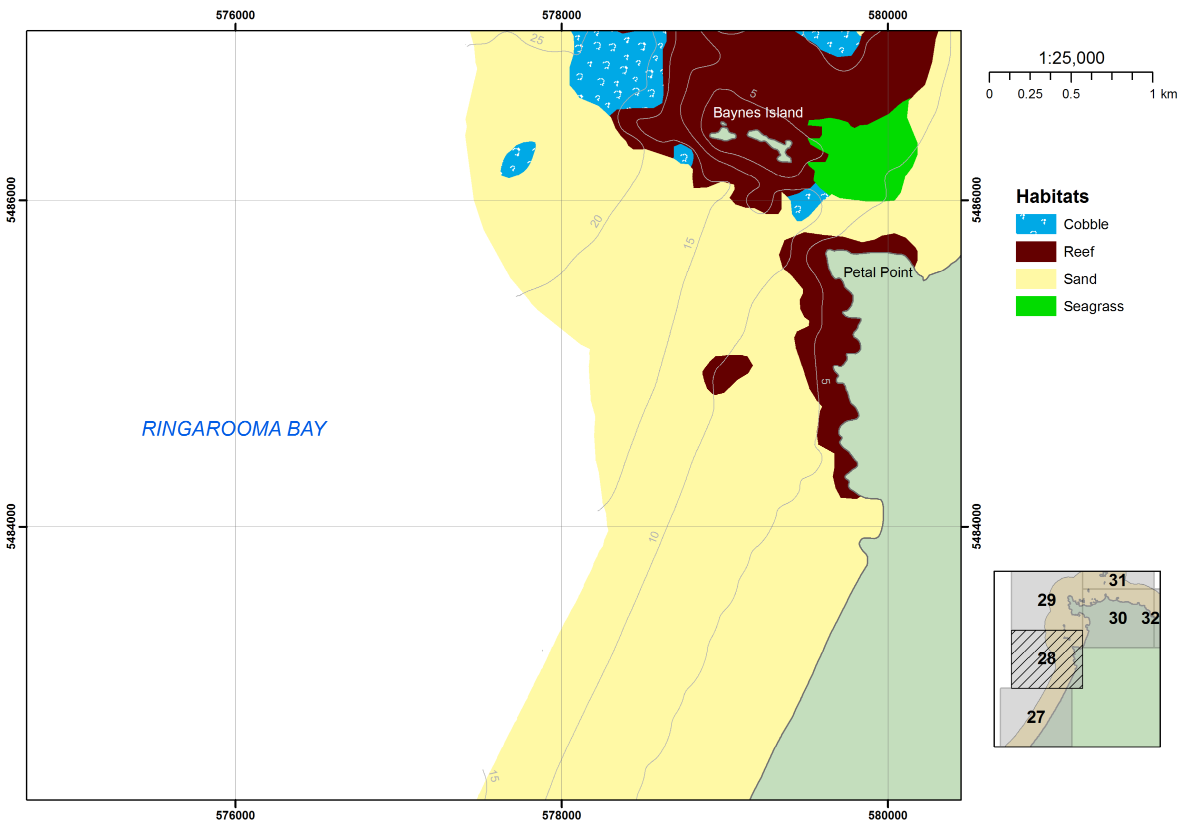

Figure 71. Tamar River to Swan Island map series map 28 showing habitats and bathymetry south of Baynes Island and Petal Point.

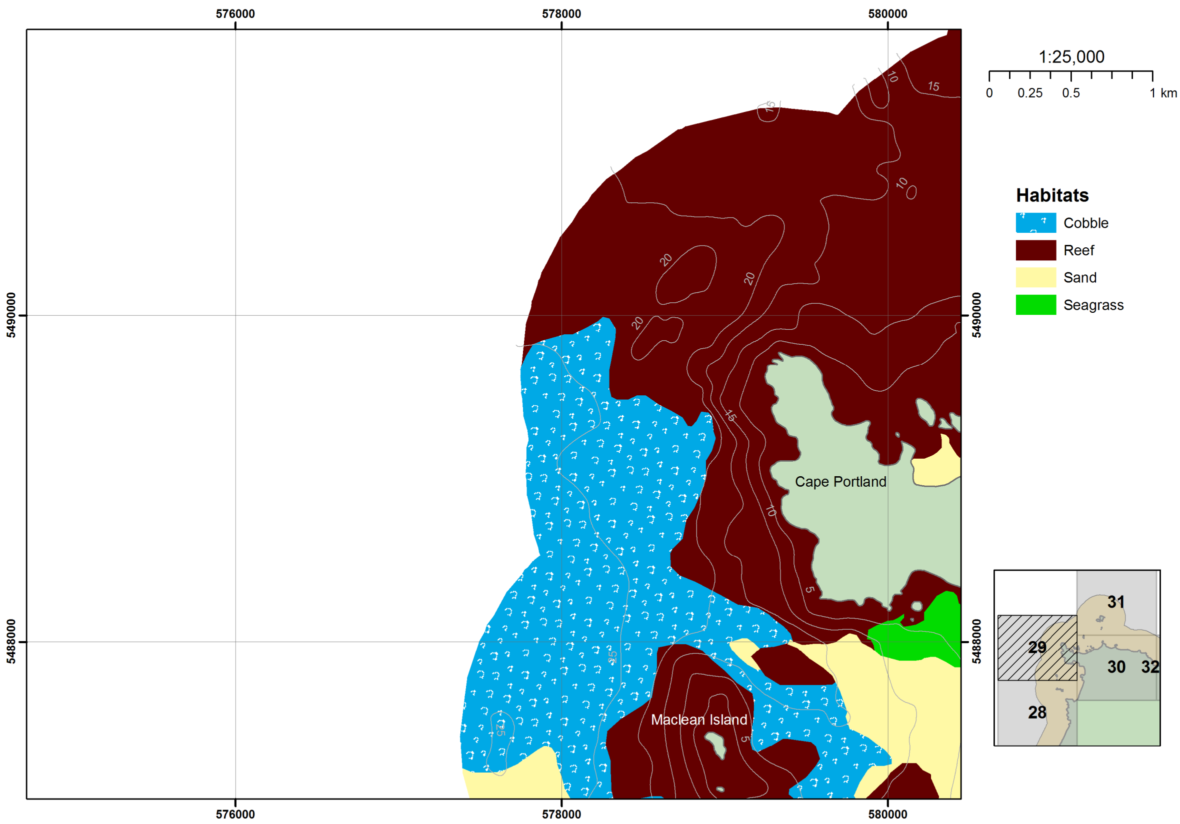

Figure 72. Tamar River to Swan Island map series map 29 showing habitats and bathymetry around Cape Portland.

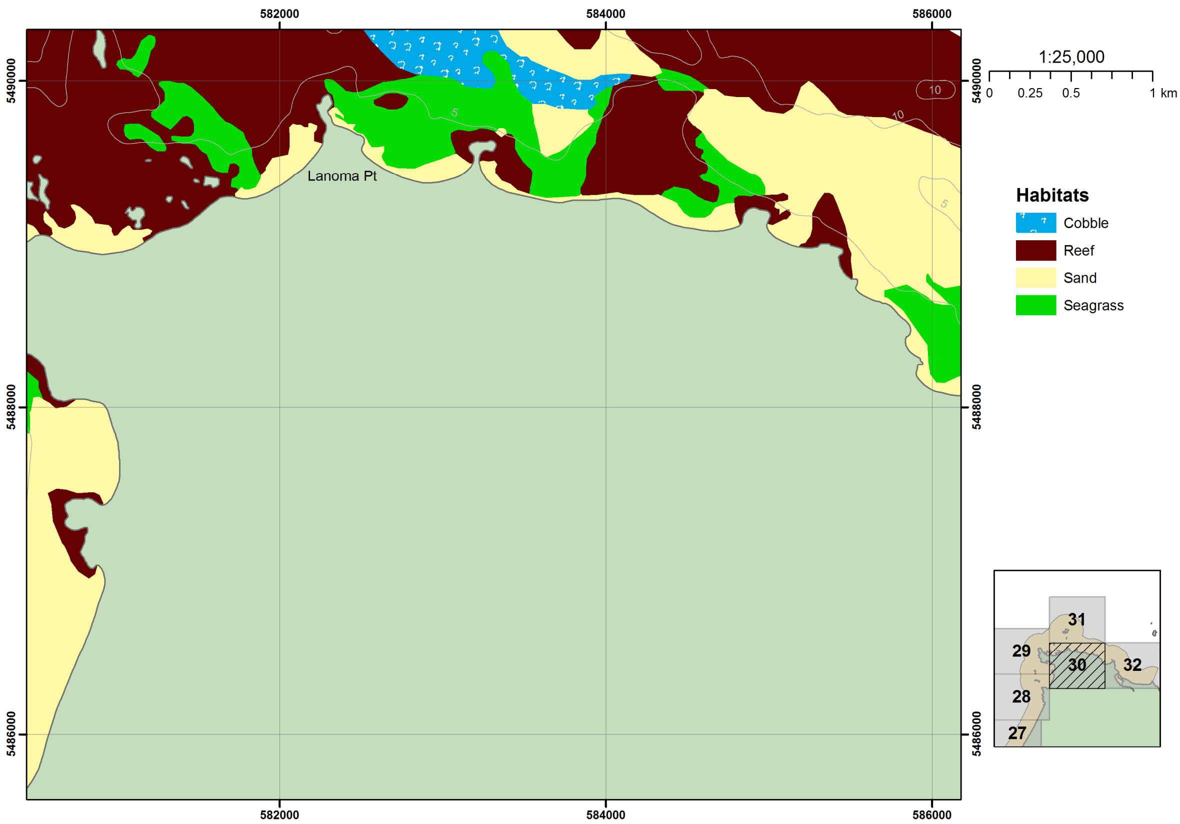

Figure 73. Tamar River to Swan Island map series map 30 showing habitats and bathymetry for Foster Inlet and Lanoma Point.

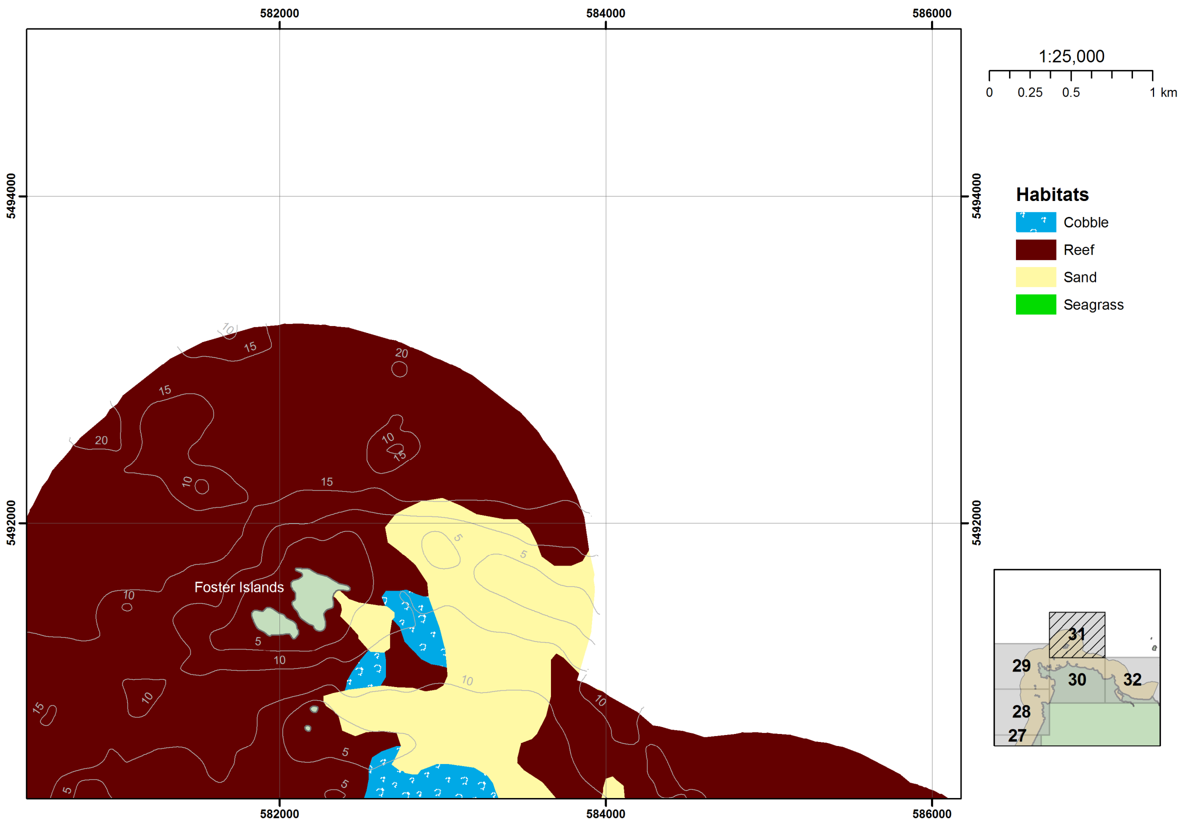

Figure 74. Tamar River to Swan Island map series map 31 showing habitats and bathymetry around Foster Island.

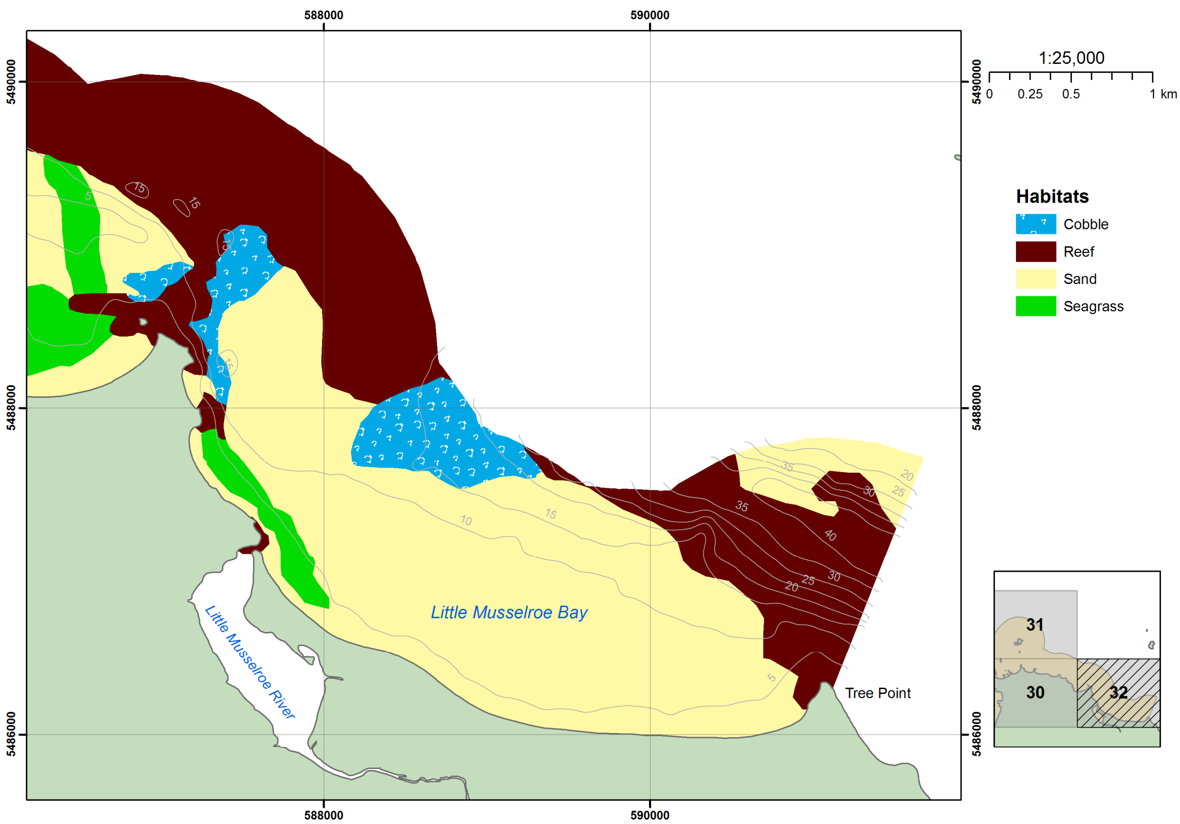

Figure 75. Tamar River to Swan Island map series map 32 showing habitats and bathymetry for Little Musselroe Bay.

3.2.2. Section A

Section A characterises the subregion from Tree Point South of Musselroe Bay to Cape Portland. The surveyed zone covers an area of 3252.38 (32.52 km^2) of seabed between 0 and 25+ m water depth.

3.2.2.1. Habitat Distribution Section A

Four dominant habitat types were present in this section of coastline, cobble, reef, sand and seagrass (Table 13). The majority of reef habitat in this section occurred in the 10 – 20 m depth. Seagrass was mostly present in depths below 10 m in the North West corner of Little Mussleroe Bay and intermixed with reef off Lanoma Point.

The result of the accuracy assessment of section A (Table 14) was 93.18% indicating that there was confident separation between these four habitat classes acoustically when validated with the video transects. Some uncertainty existed between the boundaries of sand and seagrass but this is characteristic of the fuzzy edge of seagrass beds where the density of seagrass reduces over a short distance and the boundary is not sharp.

Table 13. Habitat distribution by depth for Section A Tree Point to Cape Portland

DEPTH	SUBSTRATE				TOTAL
	Cobble (ha)	Reef (ha)	Sand (ha)	Seagrass (ha)	
0-5	1.45	282.68	171.57	90.85	**546.55**
5-10	57.62	301.97	481.00	78.17	**918.77**
10-15	47.68	710.42	180.78	1.15	**940.04**
15-20	24.88	444.62	33.03	0.00	**502.53**
20-25	73.54	134.62	14.09	0.00	**222.26**
25+	36.78	70.10	15.37	0.00	**122.25**
TOTAL	**241.95**	**1944.41**	**895.85**	**170.18**	**3252.39**
Percentage	*7.44%*	*59.78%*	*27.54%*	*5.23%*	

Table 14. Error analysis of habitats within Section A Tree Point to Cape Portland.

Video Class	Map Class					User Total	User Accuracy
	Cobble	Reef	Sand	Seagrass	Silt		
Cobble	0	35	0	0	0	**35**	0.00%
Reef	0	1806	0	0	0	**1806**	100.00%
Sand	0	90	157	16	0	**263**	59.70%
Seagrass	0	0	23	279	0	**302**	92.38%
Silt	0	0	0	0	0	**0**	0.00%
Producer Total	**0**	**1931**	**180**	**295**	**0**	**2406**	
Producer Accuracy	0.00%	93.53%	87.22%	94.58%	0.00%		
Accuracy:	93.18%						
Kappa:	0.817746						

3.2.2.2. Seagrass Distribution Section A

Seagrass in Section A occurred in small patches fringing mostly less than 10 m depth. In 0 – 5 m depth a mix of three species occurred, with *Posidonia australis* comprising around 60 % of the seagrass cover and *Heterozostera tasmanica* and *Amphibolis antarctica* each around 20 % (Figure 76). Below 5 m depth *Posidonia australis* was the only species, comprising 100% of seagrass beds. The small amount of seagrass mapped in the 10 – 10 m depth range was not surveyed with the video, however based on these trends is likely to be *Posidonia australis*.

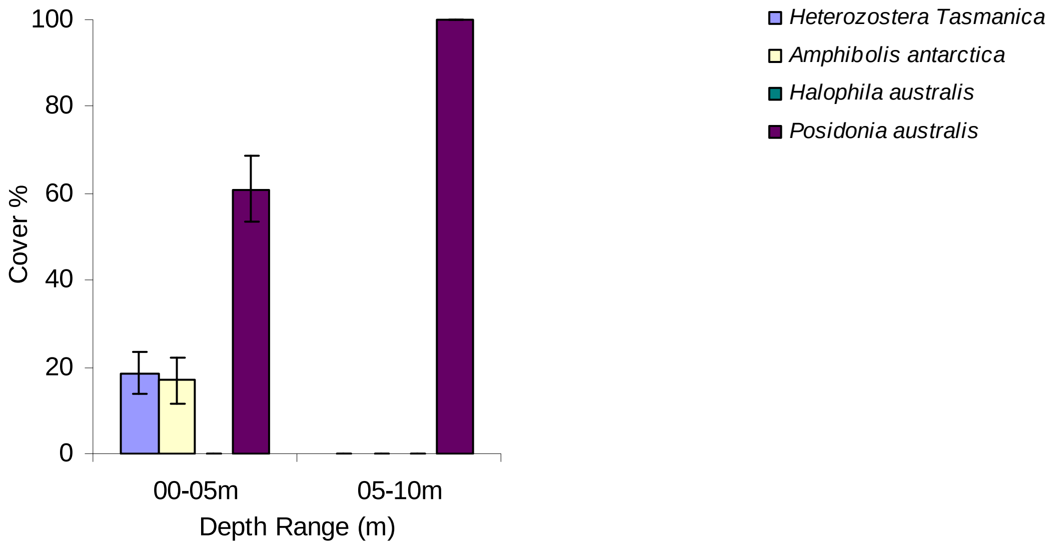

Figure 76. Mean seagrass cover (± s.e.) within seagrass beds by depth strata (5 m bin) for analysis section A.

3.2.2.3. Algal Distribution Section A

The total algal cover in section A, from Swan Island to Cape Portland, was greater than 90 % for the depth range 0 – 15 m then steadily declined to around 65 % by 20 – 25 m depth (Figure 77). In depths less than 5 m, the algal community was dominated by a mix of *Phyllospora comosa*, *Cystophora* spp. and lesser amounts of *Acrocarpia paniculata*, *Caulerpa* spp. and red algae. A small amount of bull kelp, *Durvillaea potatorum*, was present in the 0 – 5 m depth range on the exposed eastern edge of this section. In the 5 – 10 m depth range a mix of algae were present, including *Phyllospora*, *Ecklonia*, *Acrocarpia*, *Sargassum*, *Seirococcus*, *Cystophora*, *Caulerpa* and red algae. A similar mix of algae were present in the 10 – 15 m depth range, however *Phyllospora* and *Ecklonia* were by far the dominant algae in this depth range. Small amounts of sponge and encrusting invertebrates were also observed in this depth range. Below 15 m depth the algal community was dominated by *Phyllospora*, *Ecklonia* and red algae. While below 20 m depth the algal community was dominated by *Ecklonia* and red algae.

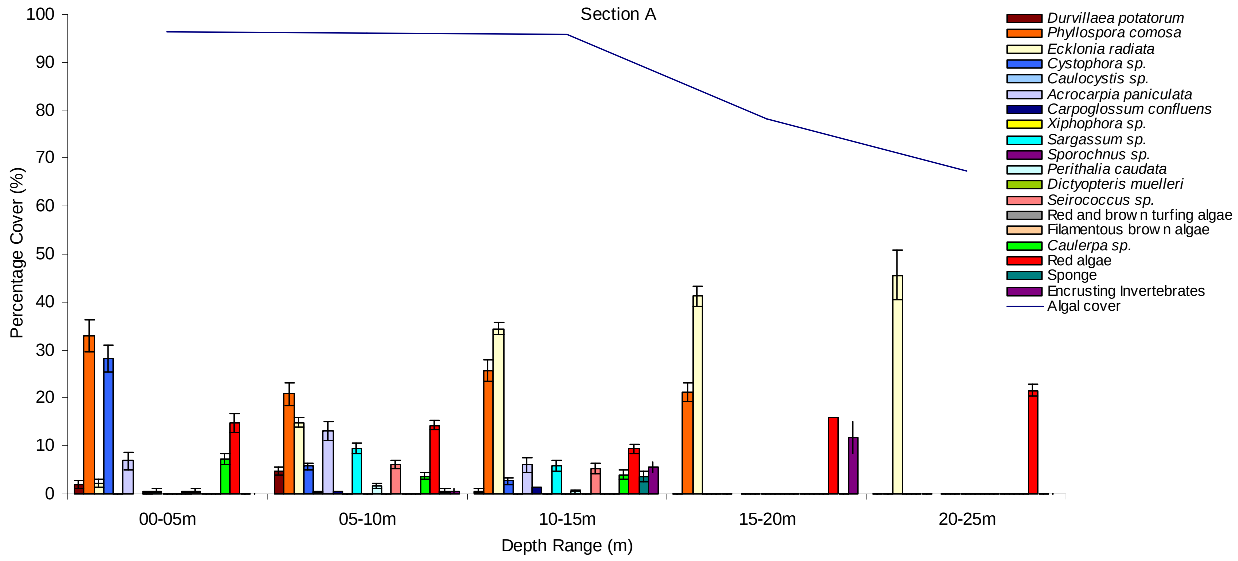

Figure 77. Mean Algal Cover (± s.e.) by depth strata (5 m bin) for analysis section A.

The cobble habitat in section A, from Swan Island to Cape Portland, generally occurred in small patches, as such very little was surveyed with the underwater video. Small amounts of cobble habitat were surveyed using the video in the 5 – 15 m depth range. The algal cover ranged from 70 % in the 5 – 10 m depth range to less than 50 % in the 10 – 15 m depth range. In the 5 – 10 m depth range the algal structure consisted of a mix of red algae, *Ecklonia*, *Sargassum* and *Caulerpa*, with small amounts of *Cystophora*, *Carpoglossum* , *Xiphophora* and *Sierococcus*. In the 10 – 15 m depth range red algae comprised the majority of algal cover, with small amounts of *Ecklonia*, *Cystophora*, *Sargassum* and *Perithalia*.

3.2.3. Section B

3.2.3.1. Habitat Distribution Section B

The distribution of habitats in section B (Table 15) Cape Portland to Tomahawk was dominated by sand and seagrass habitat with 25.6% of the survey area of 4686 ha beds of *Amphibolis Antarctica* and *Posidonia australis.* The consolidated seabed areas were made up equally of reef and cobble habitats with reef not being identified below 25 m.

The accuracy assessment of section B (Table 16) was lower than for Section A due to the presence of large areas of seagrass. Some uncertainty existed between being able to acoustically detect seagrass effectively when it is intermixed with cobble habitat. The patchiness and mosaic of both habitats makes boundary definition very difficult if not impossible to define at a scale of 1:25,000. Cobble had the lowest producer's accuracies of this section owing to the patchy nature of it being interspersed with the seagrass and also the reef habitat. The overall result is still a reliable estimate although given the interpolation of the boundaries of such patchy habitat types the reliability is reduced when compared to other sections along this length of coastline.

Table 15. Habitat distribution by depth for Section B Cape Portland to Tomahawk.

DEPTH	SUBSTRATE				TOTAL
	Cobble (ha)	Reef (ha)	Sand (ha)	Seagrass (ha)	
0-5	1.38	154.34	1063.90	117.88	**1337.51**
5-10	29.90	128.41	637.44	567.58	**1363.34**
10-15	150.03	62.02	418.08	400.93	**1031.05**
15-20	47.15	38.66	211.59	114.08	**411.48**
20-25	72.10	19.76	321.80	0.50	**414.16**
25+	111.26	0.00	17.85	0.00	**129.11**
TOTAL	**411.81**	**403.18**	**2670.67**	**1200.98**	**4686.65**
Percentage	*8.79%*	*8.60%*	*56.98%*	*25.63%*	

Table 16. Error analysis of habitats within Section B Cape Portland to Tomahawk.

Video Class	Map Class					User Total	User Accuracy
	Cobble	Reef	Sand	Seagrass	Silt		
Cobble	130	0	0	5	0	**135**	96.30%
Reef	11	506	52	118	0	**687**	73.65%
Sand	0	3	258	96	0	**357**	72.27%
Seagrass	184	47	7	770	0	**1008**	76.39%
Silt	0	0	0	0	0	**0**	0.00%
Producer Total	**325**	**556**	**317**	**989**	**0**	**2187**	
Producer Accuracy	40.00%	91.01%	81.39%	77.86%	0.00%		
Accuracy:	76.09%						
Kappa:	0.648						

3.2.3.2. Seagrass Distribution Section B

Seagrass in Section B occurred as several small beds in Foster Inlet and an extensive bed on the western end of Ringarooma Bay. *Amphibolis antarctica* was the dominant species of seagrass between 0 and 15 m depth, comprising between 67 and 92 % of seagrass cover (Figure 78). *Posidonia australis* occurred below 5 m depth, and increased with depth to comprise 100 % of seagrass beds below 15 m depth.

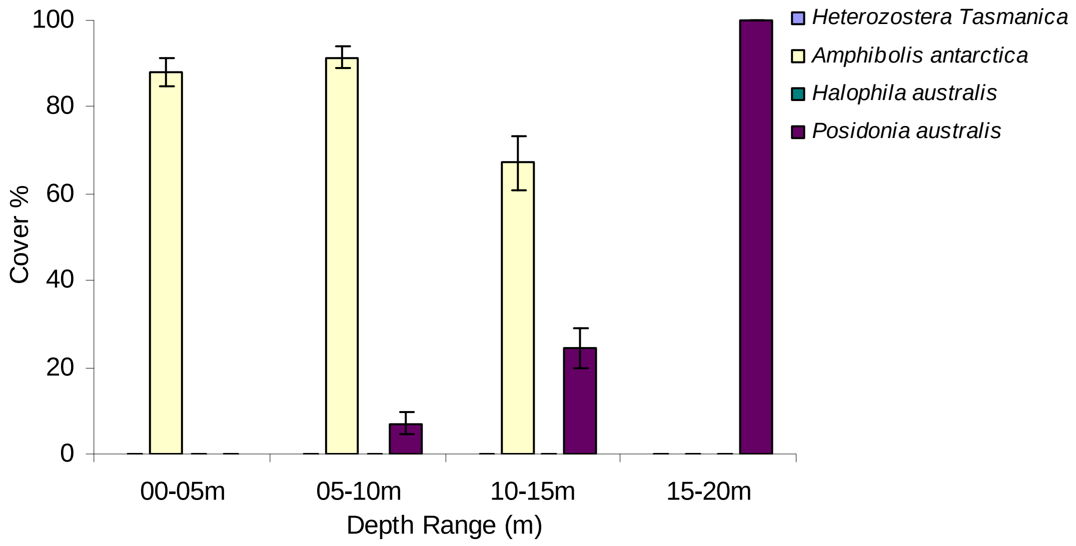

Figure 78. Mean seagrass cover (± s.e.) within seagrass beds by depth strata (5 m bin) for analysis section B.

3.2.3.3. Algal Distribution Section B

The total algal cover in section B, from Cape Portland to Tomahawk, remained around 100 % from 0 to 15 m depth, and then decreased to around 70 % below 15 m depth (Figure 79). The 0 – 5 m depth range was dominated by a mix of *Phyllospora*, *Cystophora*, *Acrocarpia* and *Sargassum*, with lesser amounts of *Ecklonia*, *Caulocystis*, *Caulerpa*, *Seirococcus*, red algae, *Xiphophora* sp. and *Dichtyopteris muelleri*. In the 5 – 10 m depth range *Cystophora*, *Acrocarpia* and *Sargassum* were the dominant algae species. Small amounts of *Phyllospora*, *Ecklonia*, *Caulocystis*, *Seirococcus*, *Caulerpa* and red algae were also present in this depth range. In the 10 – 15 m depth range *Acroacarpia*, *Sargassum*, *Caulerpa* and red algae were the dominant algal groups. Small amounts of *Ecklonia*, *Cystophora*, *Perithalia*, *Dichtyopteris* and *Seirococcus* were also present in this depth range. Below 15 m depth the algal community was dominated by *Sargassum* and red algae, with a small amount of *Caulerpa*. Sponge was present in small amounts in the 10 – 15 m depth range and increased to around 25 % below 15 m depth.

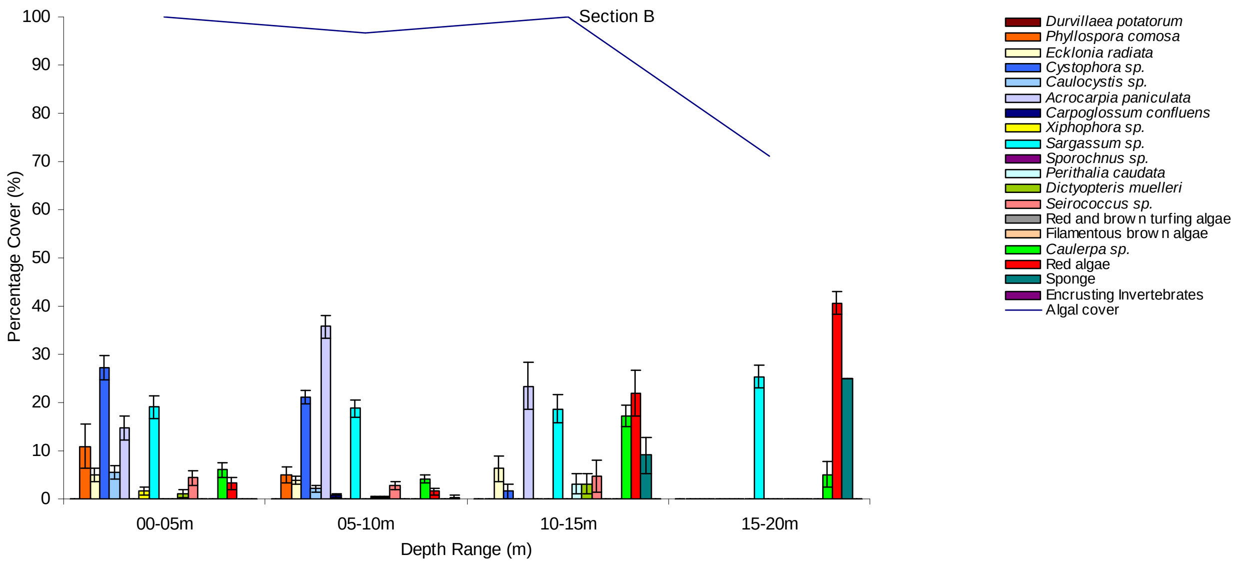

Figure 79. Mean Algal Cover (± s.e.) by depth strata (5 m bin) for analysis section B.

The cobble habitat in section B, from Cape Portland to Tomahawk was confined to depths below 10 m. Video surveys collected data from cobble habitat between 10 and 20 m depth. The algal cover on the cobble was below 40 % in 10 – 15 m depth and decreased to less than 30 % by 15 – 20 m depth. The algal cover was dominated by red algae in the 10 – 15 m depth range, with a mix of red algae and *Sargassum* in 15 – 20 m depth. Small amounts of encrusting invertebrates were also present in the 15 – 20 m depth range.

3.2.3.4 Ringarooma Lower Floodplain

The RAMSAR listed site of the Ringarooma lower floodplain was mapped at low tide on the 15th May 2008. The average depth of the river was less than 1 m. The distribution of habitats (Table 17) showed the presence of cobble and sand habitats. Seagrass beds were not identified.

Table 17. Habitat distribution within the Ringarooma lower floodplain.

DEPTH	SUBSTRATE		TOTAL
	Cobble (ha)	Sand (ha)	
TOTAL	**0.69**	**104.53**	**105.22**
Percentage	*0.66%*	*99.34%*	

3.2.4. Section C

3.2.4.1. Habitat Distribution Section C

The survey area of section C (Table 18) covered a total of 4951.91 ha (49.51 km^2) from the west of Tomahawk Beach to east of Waterhouse Island. Extensive areas of seagrass were present which made up 33.5% of the habitats surveyed in this region.

The accuracy assessment of section C (Table 19) showed some boundary confusion with identifying the sand habitats. As the sand was intermixed with patchy areas of cobble and reef and formed narrow gutters on the coastline side of reef systems on West Tomahawk Beach there were times when the interpolation did not accurately capture the complexity of these boundaries. The overall accuracy result of 84.83% however is a very confident estimate of the distribution of habitats in this section.

Table 18. Habitat distribution within Section C west of Tomahawk beach to east of Waterhouse Island.

DEPTH	SUBSTRATE				TOTAL
	Cobble (ha)	Reef (ha)	Sand (ha)	Seagrass (ha)	
0-5	0.07	201.33	383.08	181.75	**766.23**
5-10	3.44	172.17	146.77	856.43	**1178.81**
10-15	14.72	123.21	343.56	503.37	**984.87**
15-20	115.78	101.55	333.38	126.88	**677.59**
20-25	47.92	77.24	246.67	7.08	**378.92**
25+	371.95	105.14	487.92	0.49	**965.50**
TOTAL	**553.89**	**780.64**	**1941.38**	**1676.00**	**4951.91**
Percentage	*11.19%*	*15.76%*	*39.20%*	*33.85%*	

Table 19. Error analysis of habitats within Section C west of Tomahawk beach to East of Waterhouse Island.

Video Class	Map Class					User Total	User Accuracy
	Cobble	Reef	Sand	Seagrass	Silt		
Cobble	865	55	35	2	0	**957**	90.39%
Reef	23	1825	3	154	0	**2005**	91.02%
Sand	27	10	259	161	0	**457**	56.67%
Seagrass	0	141	130	1228	0	**1499**	81.92%
Silt	0	0	0	0	0	**0**	0.00%
Producer Total	**915**	**2031**	**427**	**1545**	**0**	**4918**	
Producer Accuracy	94.54%	89.86%	60.66%	79.48%	0.00%		
Accuracy:	84.93%						
Kappa:	0.782						

3.2.4.2. Seagrass Distribution Section C

Section C contained extensive seagrass beds to the east of Waterhouse Island and around to West Tomahawk Beach. *Amphibolis antarctica* was the dominant species in 0 – 10 m depth with between 65 and 87 % of all seagrass being this species (Figure 80). *Posidonia australis* occurred between 0 and 15 m depth initially in low amounts in less than 5 m depth (<10 %) and increasing to be the only species below 10 m depth. Small amounts of *Heterozostera tasmanica* and *Halophila australis* were found in 5 – 10 m depth. Although seagrass occurred between 15 and 25m depth, it was not surveyed using the underwater video, so percentage cover could not be estimated for this depth range.

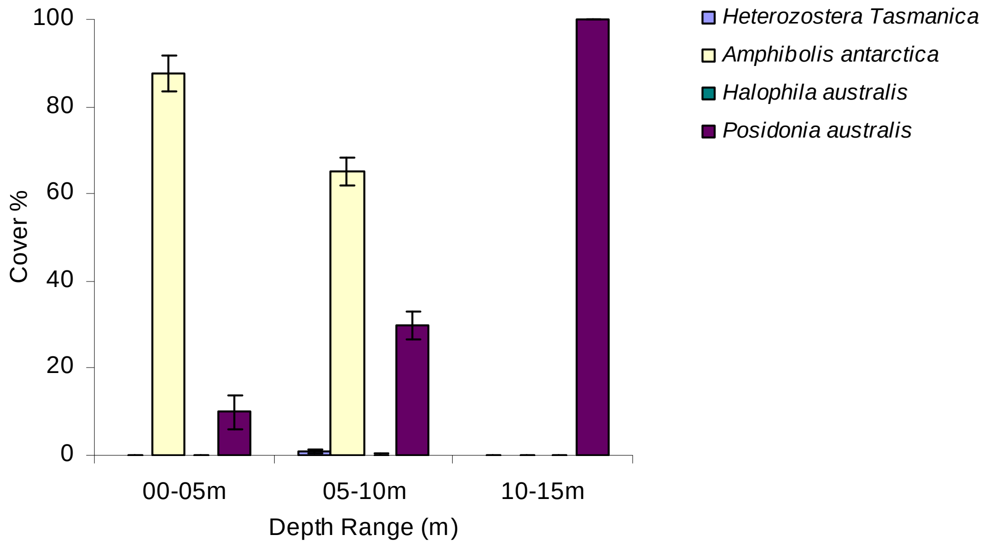

Figure 80. Mean seagrass cover (± s.e.) within seagrass beds by depth strata (5 m bin) for analysis section C.

3.2.4.3. Algal Distribution Section C

The total algae cover in section C, from Tomahawk to Croppies Point, was between 89 and 97 % to 15 m depth, algal cover then reduced to 25 % by 30 m depth (Figure 81). In the 0 – 5 m depth range the algal community was dominated by a mix of Phyllospora, *Cystophora*, *Caulocystis* and *Acrocarpia*, with lesser amounts of *Sargassum*, *Perithalia*, *Seirococcus*, *Caulerpa*, red and brown turfing algae, and red algae. In the 5 – 10 m depth range Phyllospora was the dominant algae, the remainder of the algal community comprised a mix of species including *Cystophora*, *Caulocystis*, *Acrocarpia*, *Seirococcus*, *Caulerpa* and red algae. In the 10 – 15 m depth range *Seirococcus* was the dominant algae, with the remainder of the algal community comprising a mix of species including *Ecklonia*, *Caulocystis*, *Acrocarpia*, *Carpoglossum*, *Sargassum*, *Perithalia*, *Caulerpa* and red algae. Below 15 m depth red algae became the dominant algal group. *Carpoglossum*, *Sargassum*, *Seirococcus*, *Caulerpa* were also present to 20 m depth, while *Ecklonia* was present to 30 m depth. Sponge and encrusting invertebrates were present in small quantities below 10 m and became the dominant biota below 20 m depth, with sponges comprising the majority of the cover.

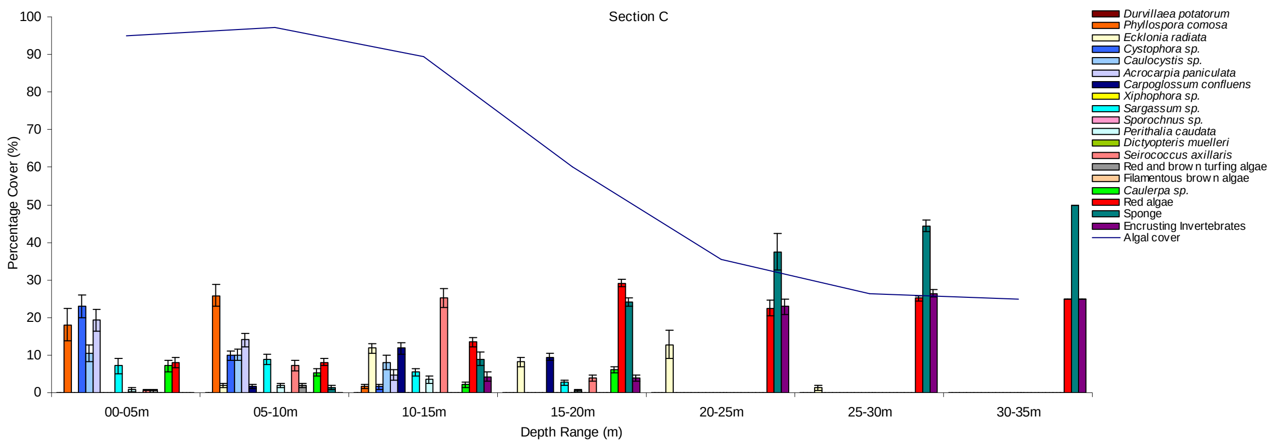

Figure 81. Mean Algal Cover (± s.e.) by depth strata (5 m bin) for analysis section C.

The cobble habitat in section C, from Tomahawk to Croppies Point, was extensive at depth below 15 m. The algal cover on the cobble habitat was between 75 and 85 percent between 15 and 25 m depth, and then decreased to 12 % in 25 – 30 m depth before increasing to 85 % for 30 – 35 m depth. No algae were observed below 35 m depth. In all depths red algae were a dominant component of the algal community. In 15 – 20 m depth small amounts of *Sargassum*, *Sporonchus*, *Dictyopteris* and *Caulerpa* were also present. In 20 – 25 m depth small amounts of *Caulocystis* and red and brown turfing algae were observed. In 25 – 30 m very little algae was observed, with only small amounts of red algae present. In 30 – 35 m depth large amounts of both red and brown turfing algae and brown filamentous algae were observed alongside the red algae. Small amounts of sponge and encrusting invertebrates were observed at all depths on cobble, with sponge comprising over 55 % of cover in 25 – 30 m depth.

3.2.5. Section D

3.2.5.1. Habitat Distribution Section D

Habitat mapping in section D covered a survey area of 6162.42 ha (61.62 km^2) from Croppies Point to East Sandy Point (Table 20). This area included the expanse of sandy seabed of Waterhouse Beach with few interspersed areas of reef off Sanderson Rock and some small seagrass beds off Bridport.

The accuracy assessment of section D (Table 21) showed the consistency for uncertainty to be present when mapping seagrass where it occurs in proximity to reef systems such as around Forester Rock. Overall the accuracy of the maps in this section was 83.92% which is a confident result for the mixture of four habitat classes interpolated from single beam acoustics.

Table 20. Habitat distribution within Section D Croppies Point to East Sandy Point.

DEPTH	SUBSTRATE				TOTAL
	Cobble (ha)	Reef (ha)	Sand (ha)	Seagrass (ha)	
0-5	0.19	76.70	1287.91	52.10	**1416.91**
5-10	5.93	50.26	1341.80	89.30	**1487.30**
10-15	29.67	87.89	1632.02	30.58	**1780.17**
15-20	61.36	75.41	703.03	0.00	**839.80**
20-25	9.28	34.94	324.66	0.00	**368.88**
25+	13.33	63.51	192.54	0.00	**269.37**
TOTAL	**119.76**	**388.71**	**5481.96**	**171.99**	**6162.42**
Percentage	*1.94%*	*6.31%*	*88.96%*	*2.79%*	

Table 21. Error analysis of habitats within Section D Croppies Point to East Sandy Point.

Video Class	Map Class					User Total	User Accuracy
	Cobble	Reef	Sand	Seagrass	Silt		
Cobble	0	38	0	0	0	**38**	0.00%
Reef	0	1860	14	0	0	**1874**	99.25%
Sand	31	161	691	48	0	**931**	74.22%
Seagrass	3	296	3	548	0	**850**	64.47%
Silt	0	0	0	0	0	**0**	0.00%
Producer Total	**34**	**2355**	**708**	**596**	**0**	**3693**	
Producer Accuracy	0.00%	78.98%	97.60%	91.95%	0.00%		
Accuracy:	83.92%						
Kappa:	0.728						

3.2.5.2. Seagrass Distribution Section D

Seagrass in section D was confined to a large bed to the east of East Point. This bed comprised a mix of both *Amphibolis antarctica* and *Posidonia australis* between 0 and 15 m depth. *A. antarctica* comprised around 30 % of seagrass in 0 – 5 and 10 – 15 m depth, and around 50 % cover in 5 – 10 m depth (Figure 82). *Posidonia australis* initially comprised over 70 % of seagrass cover in 0 – 5 m depth and decreased to just over 50 % below 5 m depth.

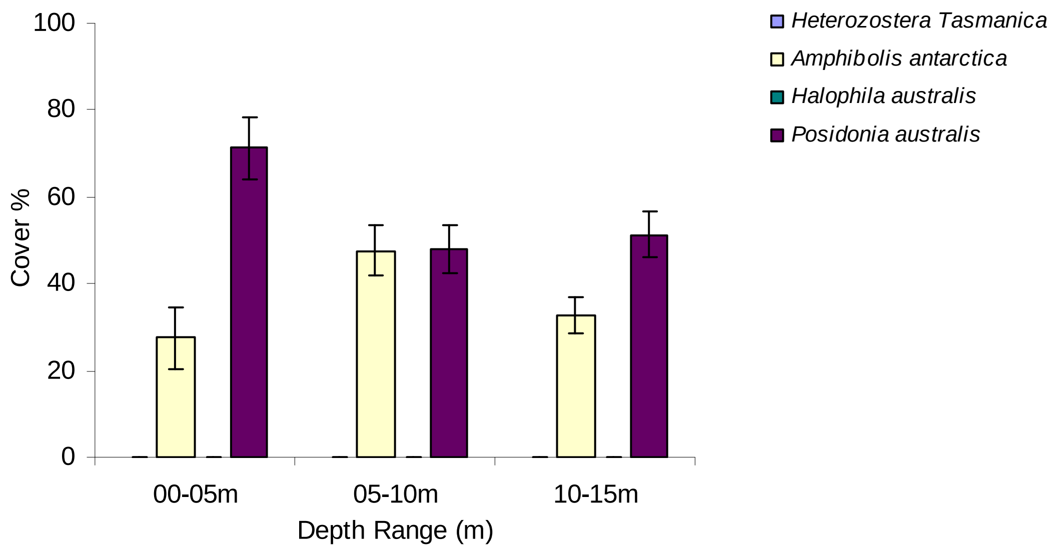

Figure 82. Mean seagrass cover (± s.e.) within seagrass beds by depth strata (5 m bin) for analysis section D.

3.2.5.3. Algal Distribution Section D

The total algal cover in section D, from Croppies Point to East Sandy Point, was between 89 and 98 % from 0 to 20 m depth then decreased to 57 % by 20 – 25 m depth (Figure 83). The 0 – 5 m depth range was dominated by *Cystophora* and *Acrocarpia*, with small amounts of several species including *Phyllospora*, *Ecklonia*, *Caulocystis*, *Sargassum*, *Seirococcus*, *Caulerpa*, red and brown turfing algae and red algae. In the 5 – 10 m depth range the algal community was dominated by *Cystophora*, *Caulocystis* and Acrocarpia, with small amounts of *Ecklonia*, *Carpoglossum*, *Sargassum*, *Perithalia*, *Seirococcus*, *Caulerpa*, red and brown turfing algae, and red algae. In the 10

– 15 m depth range *Acrocarpia* and red algae were dominant, with lesser amounts of *Ecklonia*, *Acrocarpia*, *Carpoglossum*, *Sargassum*, *Perithalia*, *Seirococcus* and *Caulerpa*. Below 15 m depth red algae were the dominant group, with small amounts of *Acrocarpia* and *Carpoglossum* to 20 m, and *Sargassum* and *Caulerpa* to 25 m depth. Sponge and encrusting invertebrates were present in small amounts in 10 – 15 m depth, and increased to become a relatively common component of the biota by 20 – 25 m depth, comprising over 45 % of the substrate cover.

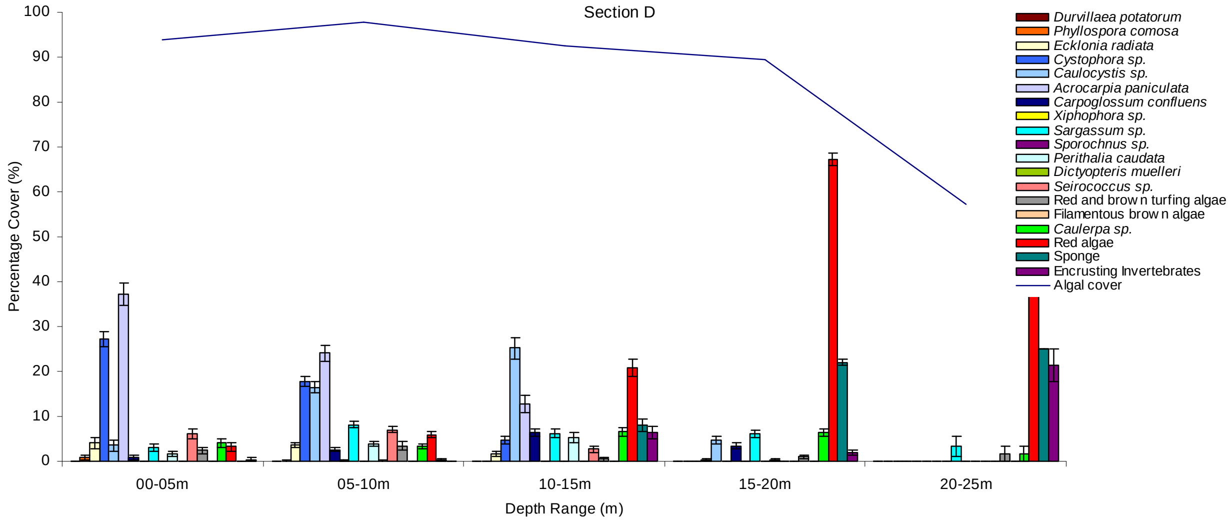

Figure 83. Mean Algal Cover (± s.e.) by depth strata (5 m bin) for analysis section D.

The cobble in section D, from Croppies point to East Sandy Point, only occurred in small patches, generally below than 15 m depth. Video surveys identified red algae as the dominant algae on the cobble, however due to the small sample size a complete analysis was not possible for this section.

3.2.6. Section E

3.2.6.1. Habitat Distribution Section E

Habitat maps produced for section E covered a total survey area of 4965.95 ha (49.65 km^2) from East Sandy Point to Stony Head (Table 22). From the total habitats surveyed in this subregion 47% consisted of reef habitat. A large reef system was present off Pipers head and also off Tam O'Shanter Bay where reef was identified from the coastline to 1.5 kms from shore in 15 m water depth. A small area of seagrass was present in numerous patches interspersed with the reef system off Little Pipers River, Pipers Head and Tam O'Shanter Bay which explains the low accuracy rates for seagrass detection in the error analysis (Table 23). Both reef and seagrass are characteristically 'hard' on the echo sounder trace and being able to define the boundaries accurately when the seagrass is growing amongst the reef and cobble habitat made identification difficult.

Table 22. Habitat distribution within Section E East Sand Point to Stony Head.

DEPTH	SUBSTRATE				TOTAL
	Cobble (ha)	Reef (ha)	Sand (ha)	Seagrass (ha)	
0-5	0.00	471.93	708.03	20.70	**1200.66**
5-10	9.52	868.60	518.63	48.29	**1445.04**
10-15	265.56	719.28	414.32	6.67	**1405.83**
15-20	224.59	235.46	225.89	0.00	**685.94**
20-25	70.74	40.52	85.16	0.00	**196.42**
25+	5.95	0.00	26.12	0.00	**32.06**
TOTAL	**576.36**	**2335.79**	**1978.14**	**75.67**	**4965.95**
Percentage	*11.61%*	*47.04%*	*39.83%*	*1.52%*	

Table 23. Error analysis of habitats within Section E East Sand Point to Stony Head.

Video Class	Map Class					User Total	User Accuracy
	Cobble	Reef	Sand	Seagrass	Silt		
Cobble	385	332	15	0	0	**732**	52.60%
Reef	104	4353	28	393	0	**4878**	89.24%
Sand	107	242	808	0	0	**1157**	69.84%
Seagrass	0	1054	362	233	0	**1649**	14.13%
Silt	0	0	0	0	0	**0**	0.00%
Producer Total	**596**	**5981**	**1213**	**626**	**0**	**8416**	
Producer Accuracy	64.60%	72.78%	66.61%	37.22%	0.00%		
Accuracy:	68.67%						
Kappa:	0.428						

3.2.6.2. Seagrass Distribution Section E

Section E contained numerous small seagrass beds, often interspersed amongst reef and cobble habitat. *Amphibolis antarctica* was the only species occurring in 0 – 5 m depth where it comprised around 86 % cover within seagrass beds (Figure 84). The amount of *A. antarctica* decreased with depth to comprise around 17 % of seagrass in 10 – 15 m depth. *Posidonia australis* was found between 5 and 15 m depth, and increased from 35 % of seagrass in 5 – 10 m depth to 60 % of seagrass in 10 – 15 m depth. Less than 5 % of seagrass in the 10 – 15 m depth range was *Heterozostera tasmanica*.

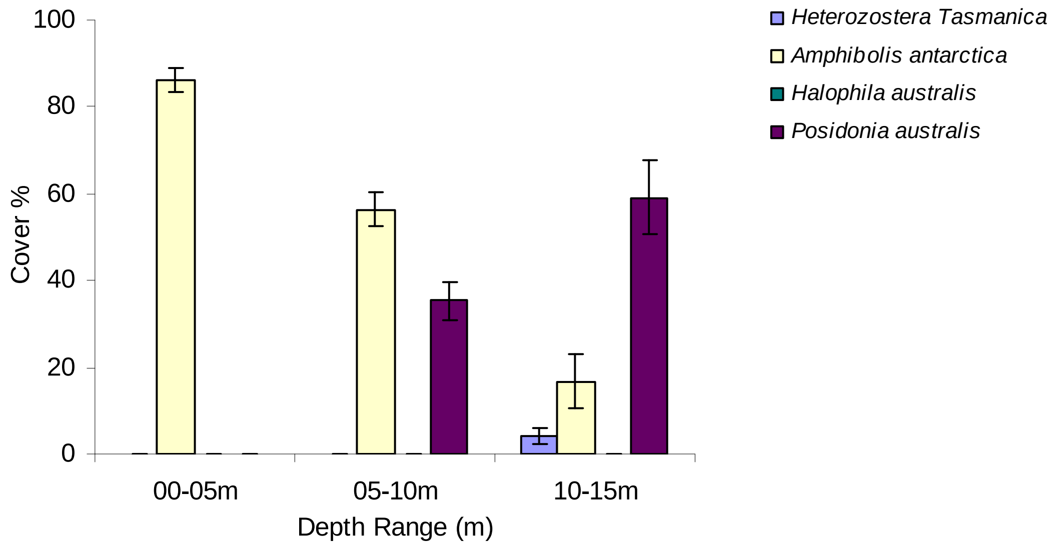

Figure 84. Mean seagrass cover (± s.e.) within seagrass beds by depth strata (5 m bin) for analysis section E.

3.2.6.3 Algal Distribution Section E

The total algal cover in section E, from East Sandy Point to Stony Head, displayed a gradual decline from 100 % cover in 0 – 5 m depth to around 75 % cover in 15 – 20 m depth (Figure 85). The 0 – 5 m depth range was dominated by *Cystophora* and *Acrocarpia*, with small amounts of *Ecklonia*, *Caulocystis*, *Sargassum*, *Seirococcus*, *Caulerpa*, red and brown turfing algae, and red algae. In the 5 – 10 m depth range the community became more evenly mixed, with *Cystophora*, Acrocarpia and red algae all comprising between 15 and 20 % cover, with small amounts of *Ecklonia*, *Caulocystis*, *Sargassum*, *Seirococcus*, *Caulerpa*, red and brown turfing algae, and filamentous brown algae. Below 10 m depth red algae were the dominant group, with increasing amounts of filamentous brown algae. Small amounts of *Cystphora*, *Caulocystis*, *Acrocarpia*, *Sargassum*, *Sporochnus*, and *Caulerpa* were also present below 10 m depth. Sponge and encrusting invertebrates were present below 5 metres depth and became more common with depth, to comprise approximately 30 % of the substrate cover in 15 – 20 m depth.

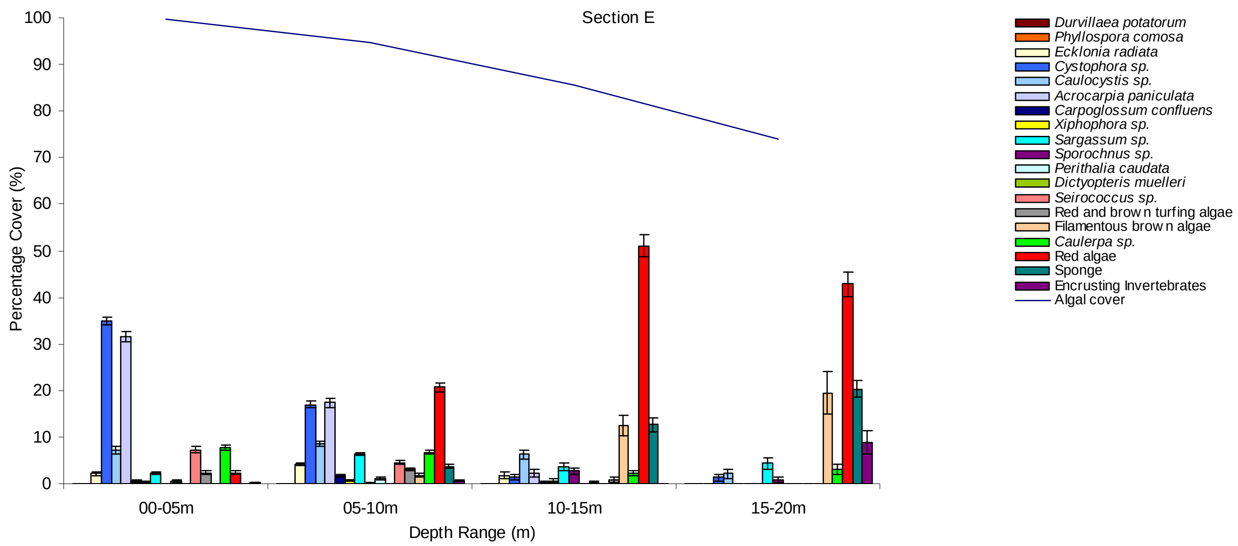

Figure 85. Mean Algal Cover (± s.e.) by depth strata (5 m bin) for analysis section E.

The cobble in section E, Sandy Point to Stony Head, occurred in patches between 5 and 25 m depth.

The total algal cover was between 80 and 90 % between 5 – 15 m depth, before decreasing to around 67% in 15 – 20 m depth. Red algae were the dominant group in 5 – 15 m depth. Small amounts of *Cystophora*, *Caulocystis*, *Sargassum*, *Sporochnus*, filamentous brown algae and *Caulerpa* were also present in this depth range. Below 15 m depth the algal community was dopminated by a mix of red algae and brown filamentous algae, with smaller amounts of *Sargassum* and *Sporochnus*. Small amounts of sponge were present below 10 m depth.

3.2.7. Section F

3.2.7.1. Habitat Distribution Section F

Section F characterised the subregion from Stony head to Low Head covering a survey area of 4,571.55 ha (45.71 km^2) (Table 24). A large reef system occurred in a continuous band from Stony Head to Low Head which was fringed by an inshore band of sand to 5 m with the reef continuing out to the 1.5 km boundary in 20 – 25 m water depth. Seagrass was present in the 0-10 m depth zone off Beechford and west of Three Mile Bluff intermixed once again with the reef system. Subsection F had the lowest accuracy results for all sections A-F from Swan Island through to Low Head. The mixture of habitats between cobble and reef and cobble and seagrass made boundary definition very difficult (Table 25).

Table 24. Habitat distribution within Section F Stony Head to Low Head.

DEPTH	SUBSTRATE				TOTAL
	Cobble (ha)	Reef (ha)	Sand (ha)	Seagrass (ha)	
0-5	28.82	450.86	343.57	48.55	**871.79**
5-10	110.00	1078.86	206.48	18.01	**1413.36**
10-15	265.51	783.97	119.61	0.00	**1169.09**
15-20	151.79	546.02	80.31	0.00	**778.12**
20-25	95.99	205.30	23.59	0.00	**324.89**
25+	14.30	0.00	0.00	0.00	**14.30**
TOTAL	**666.41**	**3065.01**	**773.56**	**66.56**	**4571.55**
Percentage	*14.58%*	*67.05%*	*16.92%*	*1.46%*	

Table 25. Error analysis of habitats within Section F Stony Head to Low Head.

Video Class	Map Class					User Total	User Accuracy
	Cobble	Reef	Sand	Seagrass	Silt		
Cobble	725	550	64	50	0	**1389**	52.20%
Reef	526	1906	0	246	0	**2678**	71.17%
Sand	616	113	361	26	0	**1116**	32.35%
Seagrass	500	207	97	446	0	**1250**	35.68%
Silt	0	0	0	0	0	**0**	0.00%
Producer Total	**2367**	**2776**	**522**	**768**	**0**	**6433**	
Producer Accuracy	30.63%	68.66%	69.16%	58.07%	0.00%		
Accuracy:	53.44%						
Kappa:	0.338						

3.2.7.2 Seagrass Distribution Section F

Seagrass in section F occurred as numerous small beds often amongst the inshore reef and cobble. *Amphibolis antarctica* was the dominant species between 0 and 15 m depth, with 90 – 95 % cover in 0 – 10 m depth before falling to just over 60 % cover in 10 – 15 m depth (Figure 86). In 10 – 15 m depth *Posidonia australis* comprised around 20 % seagrass cover.

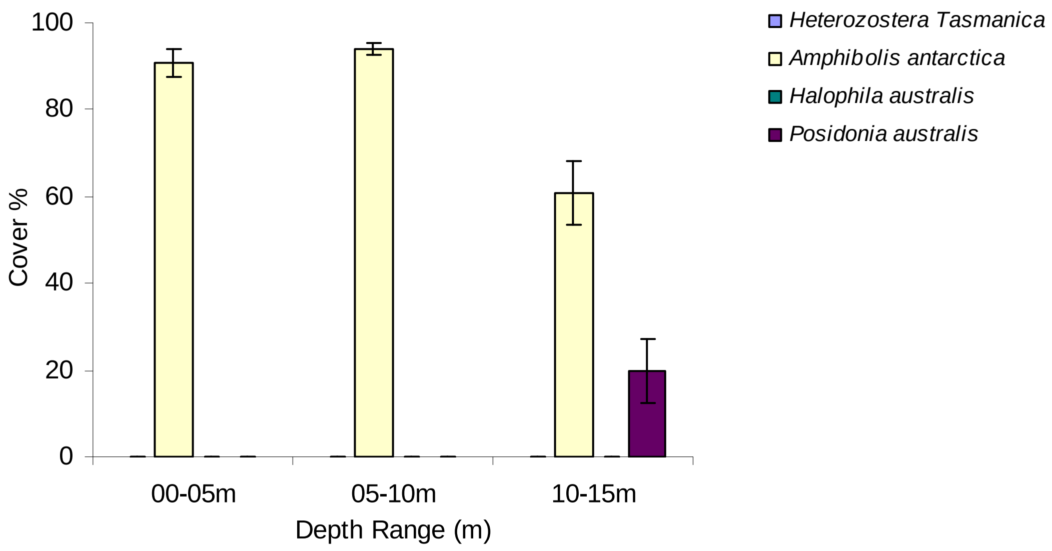

Figure 86. Mean seagrass cover (± s.e.) within seagrass beds by depth strata (5 m bin) for analysis section F.

3.2.7.3 Algal Distribution Section F

The total algal cover in section F, Stony head to Low Head, was greater than 95 % cover to 10 m depth, and then gradually reduced to around 70 % cover by 15 – 20 m depth (Figure 87). The 0 – 5 m depth range was dominated by *Cystophora* and *Acrocarpia*, with lesser amounts of several species including *Caulocystis*, *Xiphophora*, *Dichtyopteris*, *Caulerpa*, red and brown turfing algae, and red algae. In the 5 – 10 m depth range *Cystophora*, *Acrocarpia*, and red and brown turfing algae were the dominant component of the algae community, with lesser amounts of *Caulocystis*, *Xiphophora*, *Sargassum*, *Seirococcus*, *Caulerpa*, and red algae. Below 10 m depth red algae was the dominant algal group. Small amounts of *Ecklonia*, *Cystophora*, *Caulocystis*, *Carpoglossum*, *Sargassum*, *Caulerpa* and, and red and brown turfing algae were present to 15 m depth, with *Acrocarpia*, *Sargassum*, *Sporonchus*, *Caulerpa* and red and brown turfing algae in 15 – 20 m depth. Small amounts of sponge were present below 5 m, increasing to around 30 % by 15 – 20 m depth.

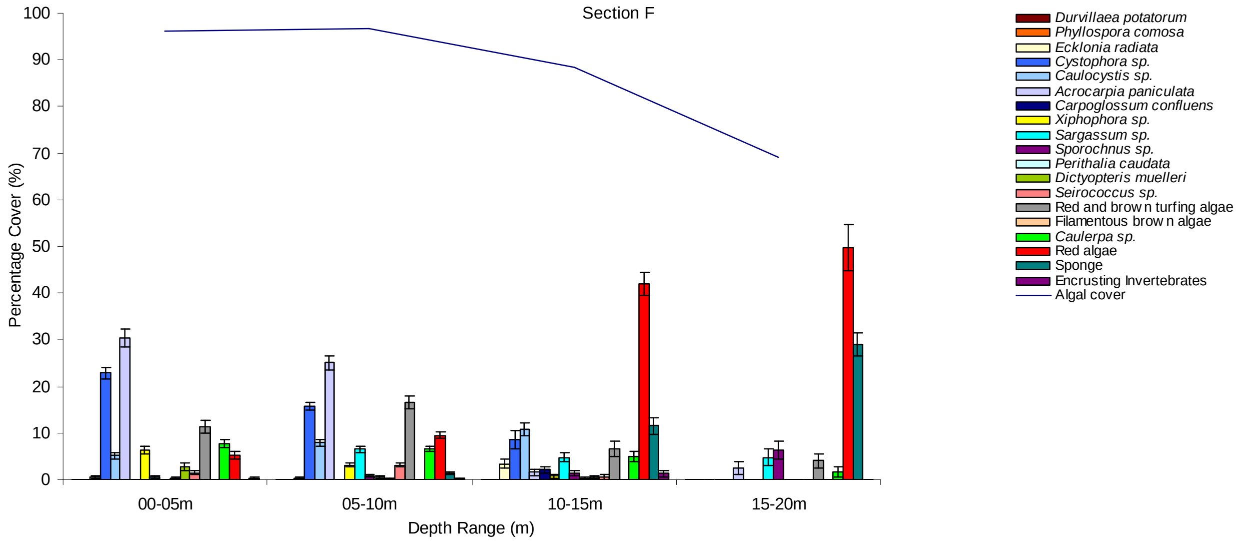

Figure 87. Mean Algal Cover (± s.e.) by depth strata (5 m bin) for analysis section F.

Section F, Stony Head to Low Head, had numerous patches of cobble, often interspersed amongst reef. The cobble extended between 0 and 25 m, with the majority of cobble surveyed in 10 – 25 m depth. The algal cover in the 10 m depth was around 75 % and gradually decreased to around 70 % by 25 m depth. Between 10 and 20 m depth a mix of red and brown turfing algae and red algae dominated the cobble substrate. Small amounts of *Caulocystis*, *Xiphophora* and *Acrocarpia* occurred between 10 – 15 m depth, small amounts of *Sargassum* between 10 – 20 m depth, and small amounts of *Sporochnus* between 10 and 25 m depth. Sponge was found in small amounts in 10 – 15 m depth, and increased to become a major component of the biota in 15 – 25 m depth.

3.2.8 Tamar River to Swan Island Summary

The summary statistics for the entire region from Tree Point to Low Head are presented in Tables 26 -28. The majority of the habitat in the 1.5km buffer zone from the coastline was dominated by both reef and sand habitat with significant areas of seagrass present interspersed amongst the reef habitat. Sand habitat comprised 48% of the area of 28,590 ha and reef 31.19%. The majority of the reef habitat was found within subsections E and F in the depth range 5-15 meters.

The error analysis (Table 29) of the entire region from Tree Point to Low Head shows a combined accuracy result of 72.72% which is reliable for the combination of habitats and the complexity of the boundaries sampled from single beam acoustics. The lowest producer's accuracy result was generated for cobble habitat. This result may be explained by the confusion of seagrass and cobble to be identified acoustically and also due to the intermixed nature of these habitats that at the 1:25000 scale, it was impossible to be able to cartographically represent these habitats using linear boundaries.

Table 26. Distribution of habitats (reef and sand) in the region Swan Island to the Tamar River.

DEPTH	SUBSTRATE				TOTAL
	Cobble (ha)	Reef (ha)	Sand (ha)	Seagrass (ha)	
0-5	31.91	1637.84	3958.06	511.84	**6139.65**
5-10	216.42	2600.27	3332.13	1657.79	**7806.61**
10-15	773.16	2486.79	3108.38	942.71	**7311.04**
15-20	625.55	1441.71	1587.22	240.96	**3895.44**
20-25	369.58	512.39	1015.98	7.58	**1905.52**
25+	553.56	238.75	739.80	0.49	**1532.59**
TOTAL	**2570.18**	**8917.75**	**13741.56**	**3361.37**	**28590.86**
Percentage	*8.99%*	*31.19%*	*48.06%*	*11.76%*	

Table 27. Distribution of habitats by reporting subsection for the region Swan Island to the Tamar River.

HABITAT	SECTION						TOTAL
	A	B	C	D	E	F	
Cobble	241.95	411.81	553.89	119.76	576.36	666.41	**2,570.18**
Reef	1,944.41	403.18	780.64	388.71	2,335.79	3,065.01	**8,917.75**
Sand	895.85	2,670.67	1,941.38	5,481.96	1,978.14	773.56	**13,741.56**
Seagrass	170.18	1,200.98	1,676.00	171.99	75.67	66.56	**3,361.37**
TOTAL	**3,252.39**	**4,686.65**	**4,951.91**	**6,162.42**	**4,965.95**	**4,571.55**	**28,590.86**

Table 28. Percentage of habitat area total by reporting section in the Swan Island to the Tamar River.

HABITAT	SECTION						TOTAL
	A	B	C	D	E	F	
Cobble	0.8%	1.4%	1.9%	0.4%	2.0%	2.3%	9.0%
Reef	6.8%	1.4%	2.7%	1.4%	8.2%	10.7%	31.2%
Sand	3.1%	9.3%	6.8%	19.2%	6.9%	2.7%	48.1%
Seagrass	0.6%	4.2%	5.9%	0.6%	0.3%	0.2%	11.8%
TOTAL	11.4%	16.4%	17.3%	21.6%	17.4%	16.0%	100.0%

Table 29. Error analysis of all habitats from Swan Island to the Tamar River.

Video Class	Map Class					User Total	User Accuracy
	Cobble	Reef	Sand	Seagrass	Silt		
Cobble	2105	1010	114	57	0	**3286**	64.06%
Reef	664	12256	97	911	0	**13928**	88.00%
Sand	781	619	2534	347	0	**4281**	59.19%
Seagrass	687	1745	622	3504	0	**6558**	53.43%
Silt	0	0	0	0	0	**0**	0.00%
Producer Total	**4237**	**15630**	**3367**	**4819**	**0**	**28053**	
Producer Accuracy	49.68%	78.41%	75.26%	72.71%	0.00%		
Accuracy:	72.72%						
Kappa:	0.578436						

3.2.9 Reef and Cobble Profile

The profile of reef in the Swan Island to the mouth of the Tamar River was dominated by low profile reef (Figure 88). Low profile reef accounted for over 95 % of all reef in section F, over 90 % of reef in section B and E, and over 82 % in the remaining sections. Medium profile reef accounted for between 10 % and 17 % in sections A, C and D, while for the remaining sections this was less than 10 %. Section F had the lowest amount of medium profile reef with only 3.5 %. High profile reef was only observed in section D, with less than 0.5 % of all reef in this section classified as high profile reef.

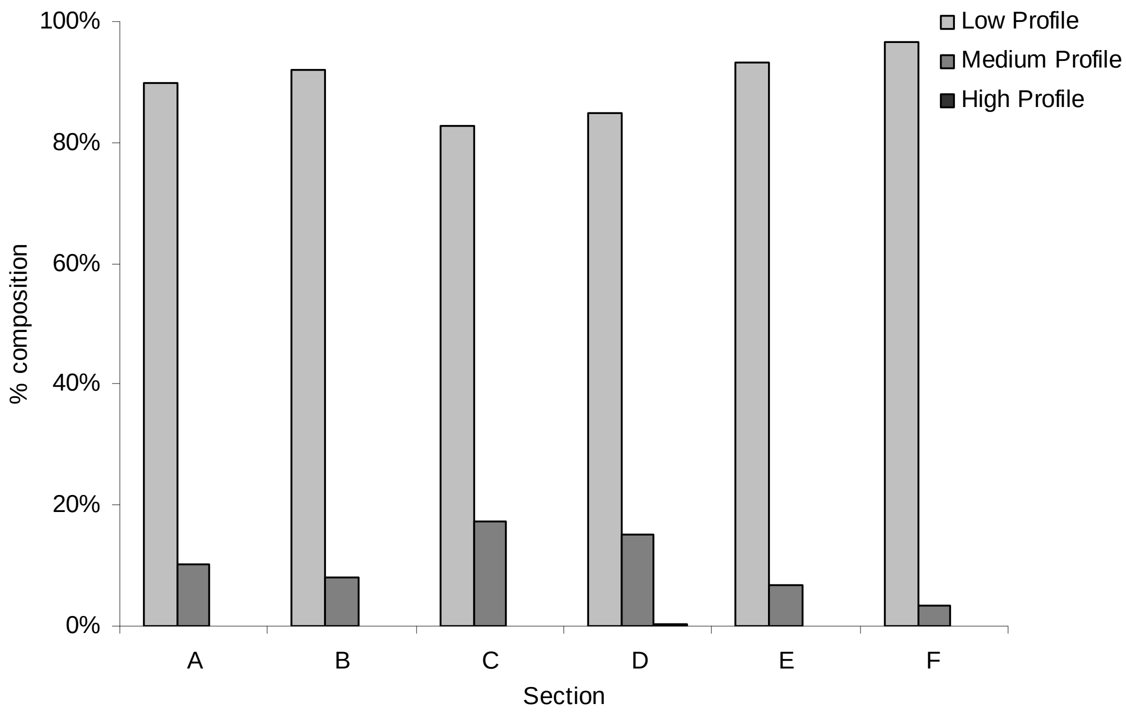

Figure 88. Percentage composition of low profile reef (< 1 m rise and fall), medium profile reef (1 – 4 m rise and fall) and high profile reef (> 4 m rise and fall) for reef substrate by section in the Swan Island to Tamar River mapping region.

The cobble within the Swan Island to Tamar River mapping region was predominantly low profile, with over 98 % of all cobble classified as low profile (Figure 89). This is typical of cobble habitat, which due to its mobile nature will generally exhibit little vertical structuring. The small amounts of medium profile cobble observed probably represent a combination of steeper cobble banks and misclassification of reef substrate as cobble.

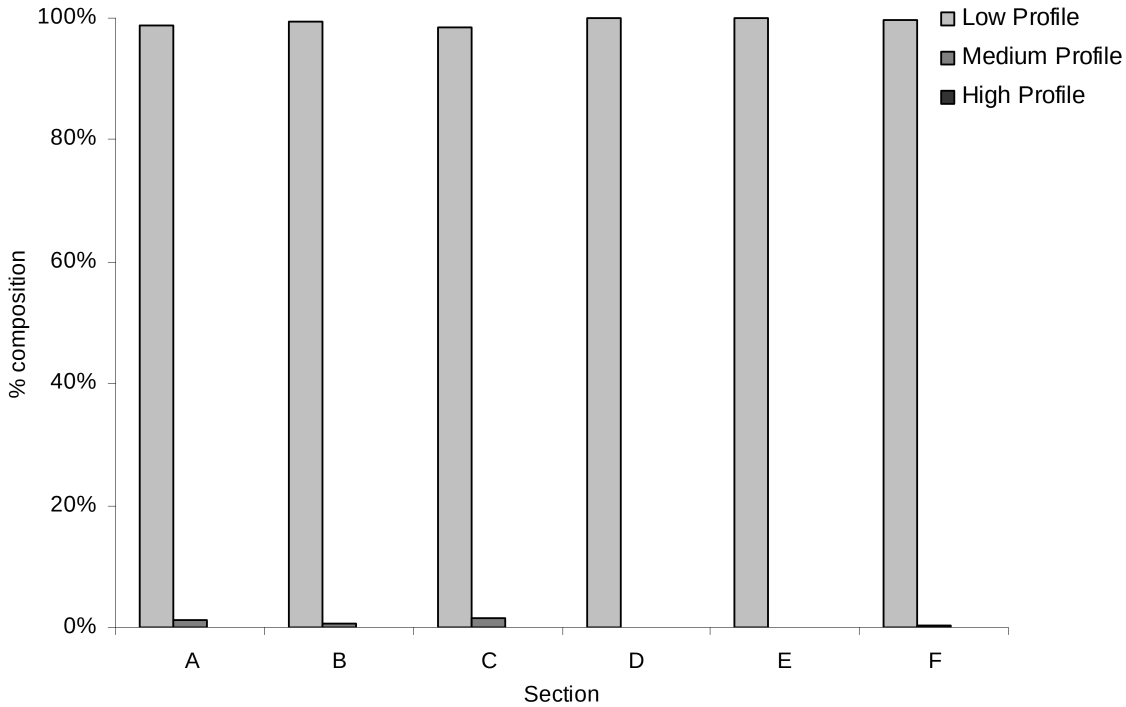

Figure 89. Percentage composition of low profile cobble (< 1 m rise and fall), medium profile cobble (1 – 4 m rise and fall) and high profile cobble (> 4 m rise and fall) for cobble substrate by section in the Swan Island to Tamar River mapping region.

3.2.10 Particle Size Analysis

The particle size analysis for the Swan Island to Tamar River mapping region showed a consistent sediment structure throughout. The majority of sediment samples were classified as fine sand, with a median grain size (Phi 50%) of 2.4 to 2.7 (Figure 90 -Figure 92 and Figure 94 -Figure 100). The only exception was sample 4, which classified as medium sand on the Wentworth scale, with a median particle size of 1.7 on the phi scale (Figure 93).

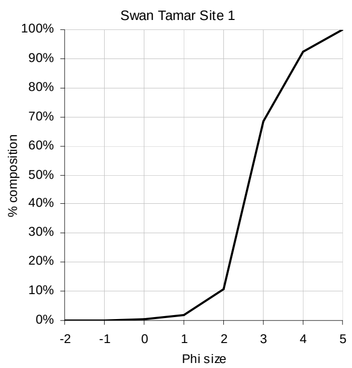

Figure 90. Swan Tamar Site 1, Phi 50% = 2.7, Wentworth classification = fine sand.

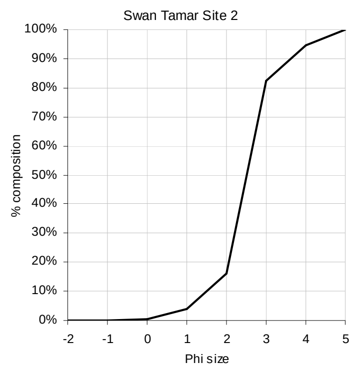

Figure 91. Swan Tamar Site 2, Phi 50% = 2.5, Wentworth classification = fine sand.

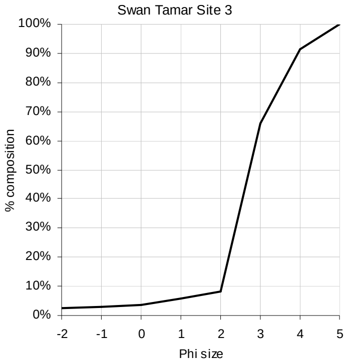

Figure 92. Swan Tamar Site 3, Phi 50% = 2.7, Wentworth classification = fine sand.

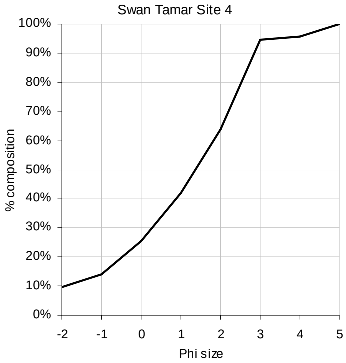

Figure 93. Swan Tamar Site 4, Phi 50% = 1.4, Wentworth classification = medium sand.

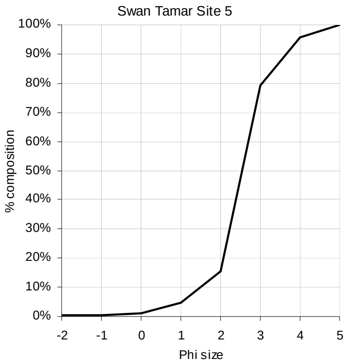

Figure 94. Swan Tamar Site 5, Phi 50% = 2.5, Wentworth classification = fine sand.

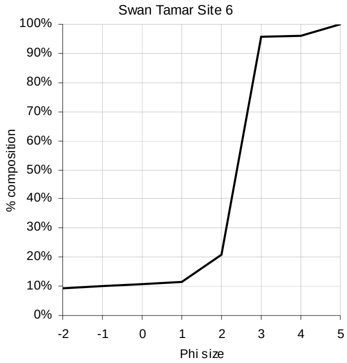

Figure 95. Swan Tamar Site 6, Phi 50% = 2.4, Wentworth classification = fine sand.

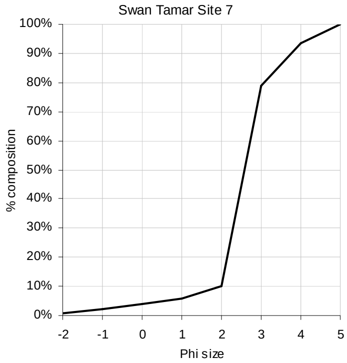

Figure 96. Swan Tamar Site 7, Phi 50% = 2.6, Wentworth classification = fine sand.

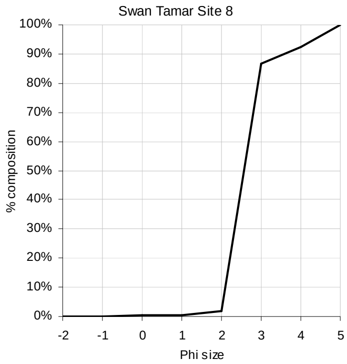

Figure 97. Swan Tamar Site 8, Phi 50% = 2.6, Wentworth classification = fine sand.

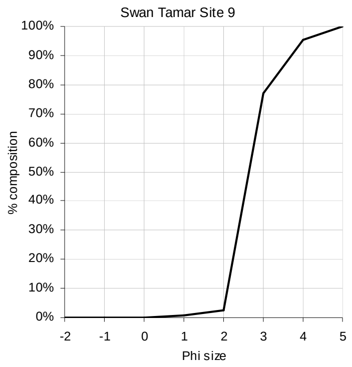

Figure 98. Swan Tamar Site 9, Phi 50% = 2.6, Wentworth classification = fine sand.

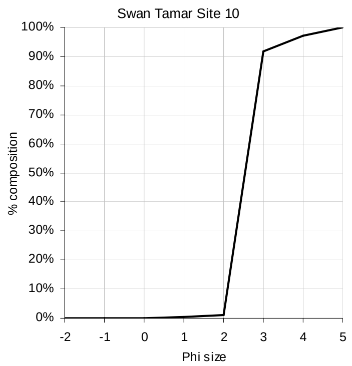

Figure 99. Swan Tamar Site 10, Phi 50% = 2.5, Wentworth classification = fine sand.

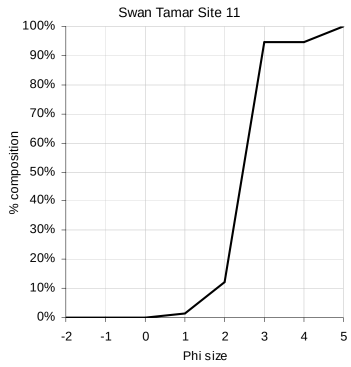

Figure 100. Swan Tamar Site 11, Phi 50% = 2.5, Wentworth classification = fine sand.

3.3. The Tamar Estuary

The Tamar Estuary survey zone extends 1.5 kms out from the mouth of the Tamar Estuary south to Launceston. This region is within the NRM North jurisdiction and the habitat mapping of this area covers a very important estuarine habitat of the state. The mapping of this region is very timely given recent development pressure within the catchment. Figure 101 indicates the two (A and B) analysis regions that have been subset for the estuary. The maps generated in this region cover a total of 4479.26 ha (or 44.79 km^2) of seabed. Figure 102 shows the bathymetric map of the estuary. Figures 103-122 show the habitat maps at 1:25,000 depicting the distribution of cobble, reef, sand, silt, seagrass and intertidal ricegrass across this survey zone.

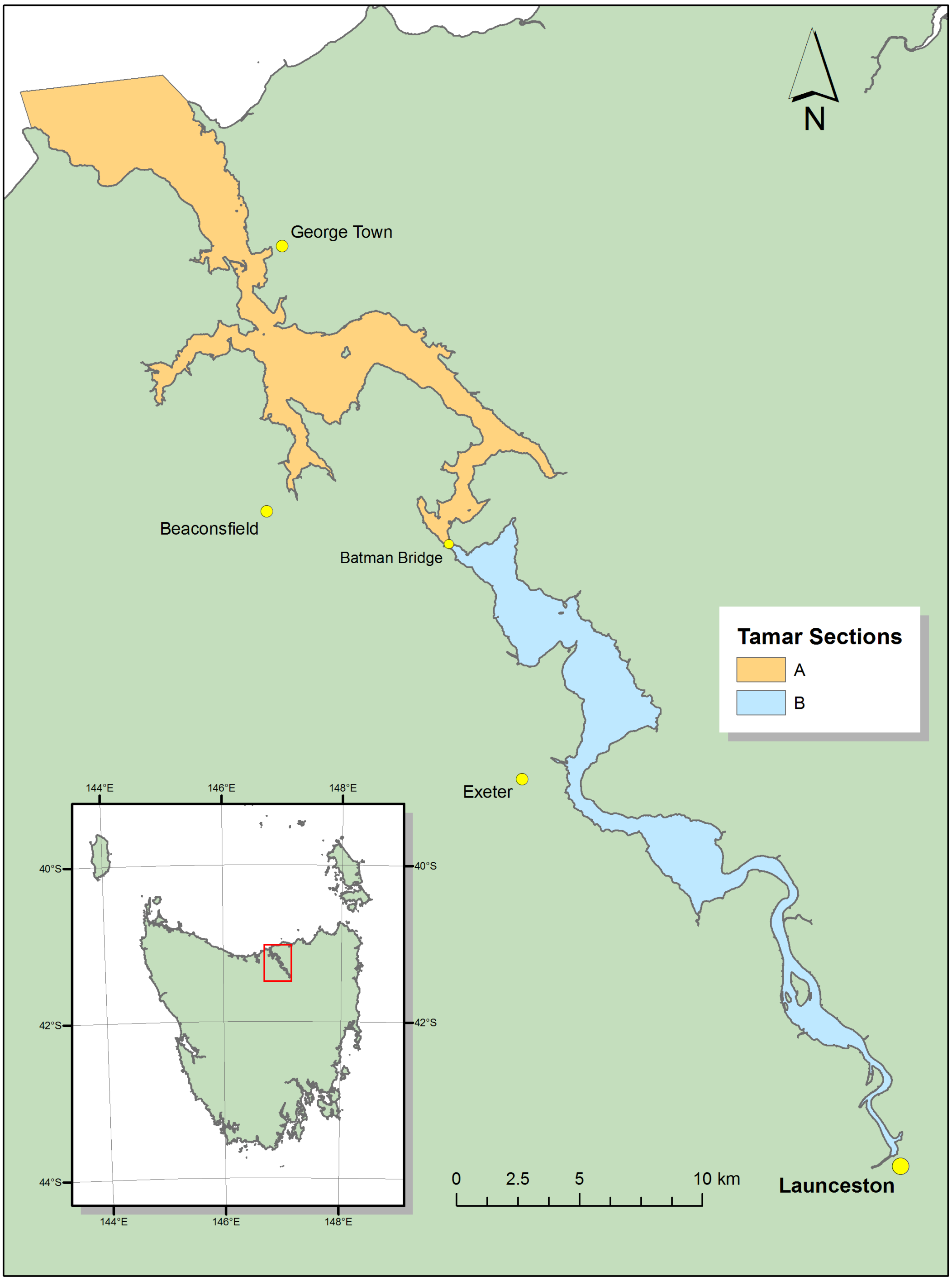

Figure 101. Location map showing analysis and reporting sections for the Tamar River.

3.3.1. Bathymetry and habitat maps of the Tamar Estuary

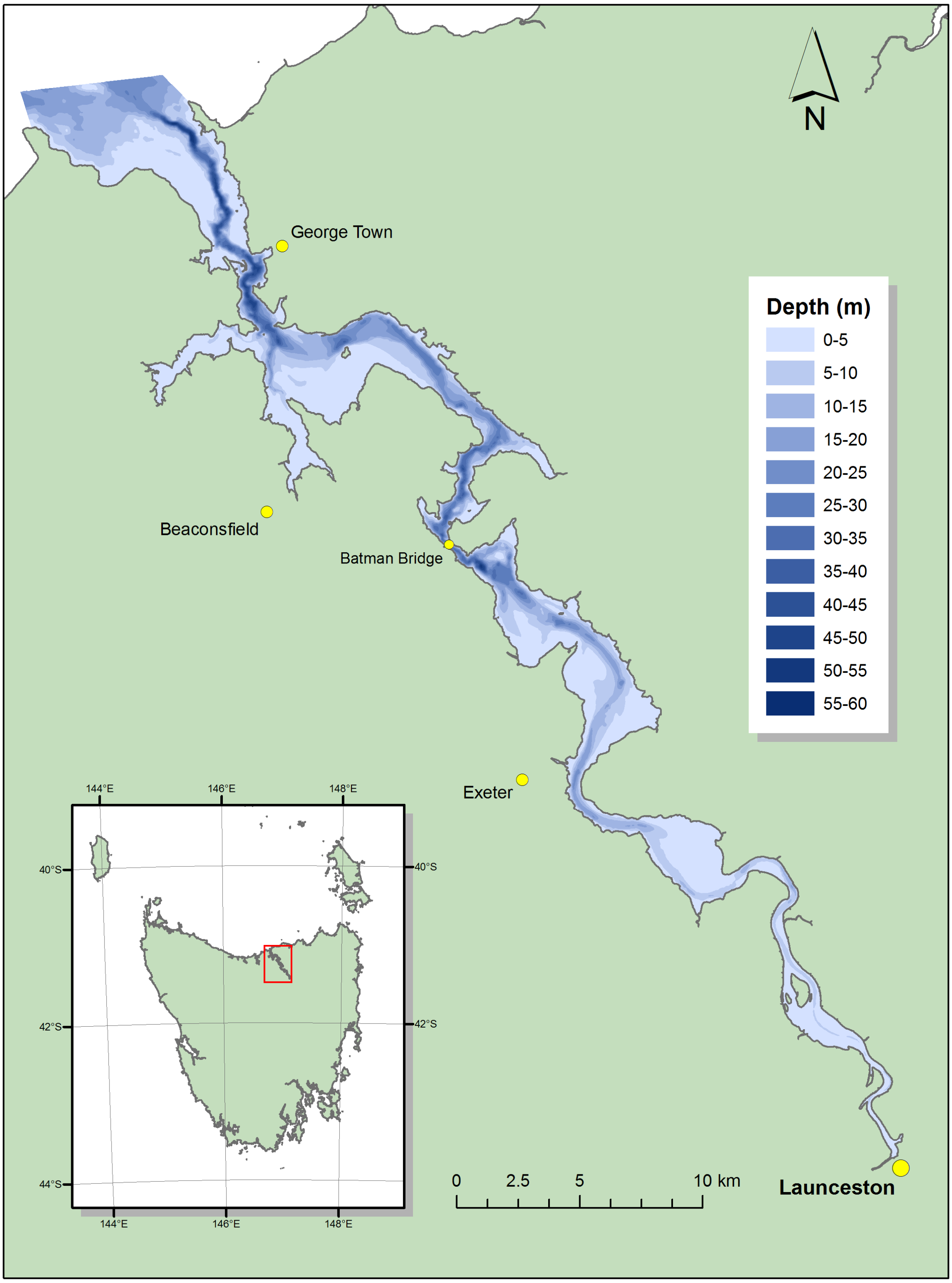

Figure 102. Map of bathymetry from the Tamar River interpolated from acoustic data.

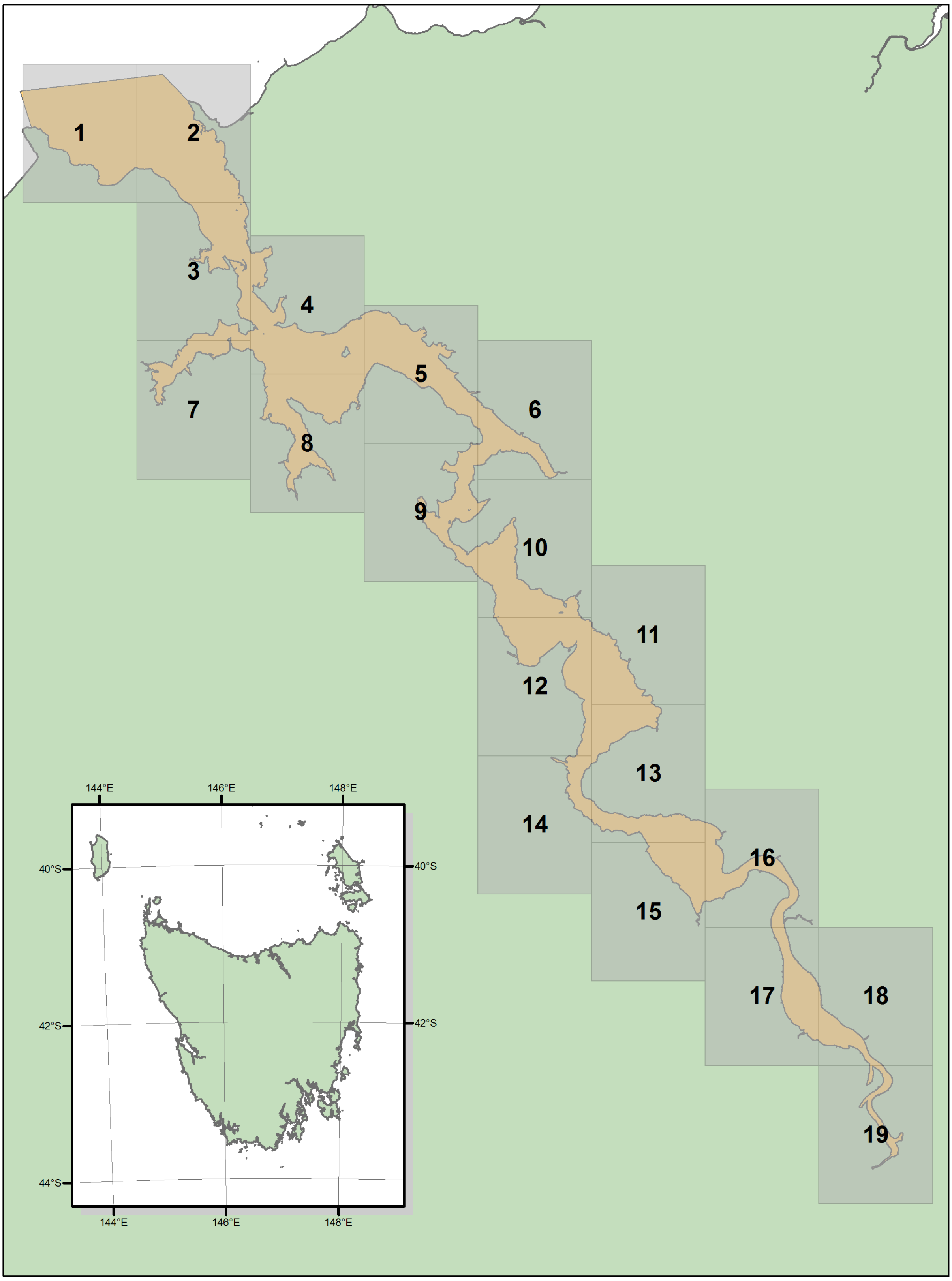

Figure 103 .Index map of 1:25 000 habitat maps for the Tamar River map series.

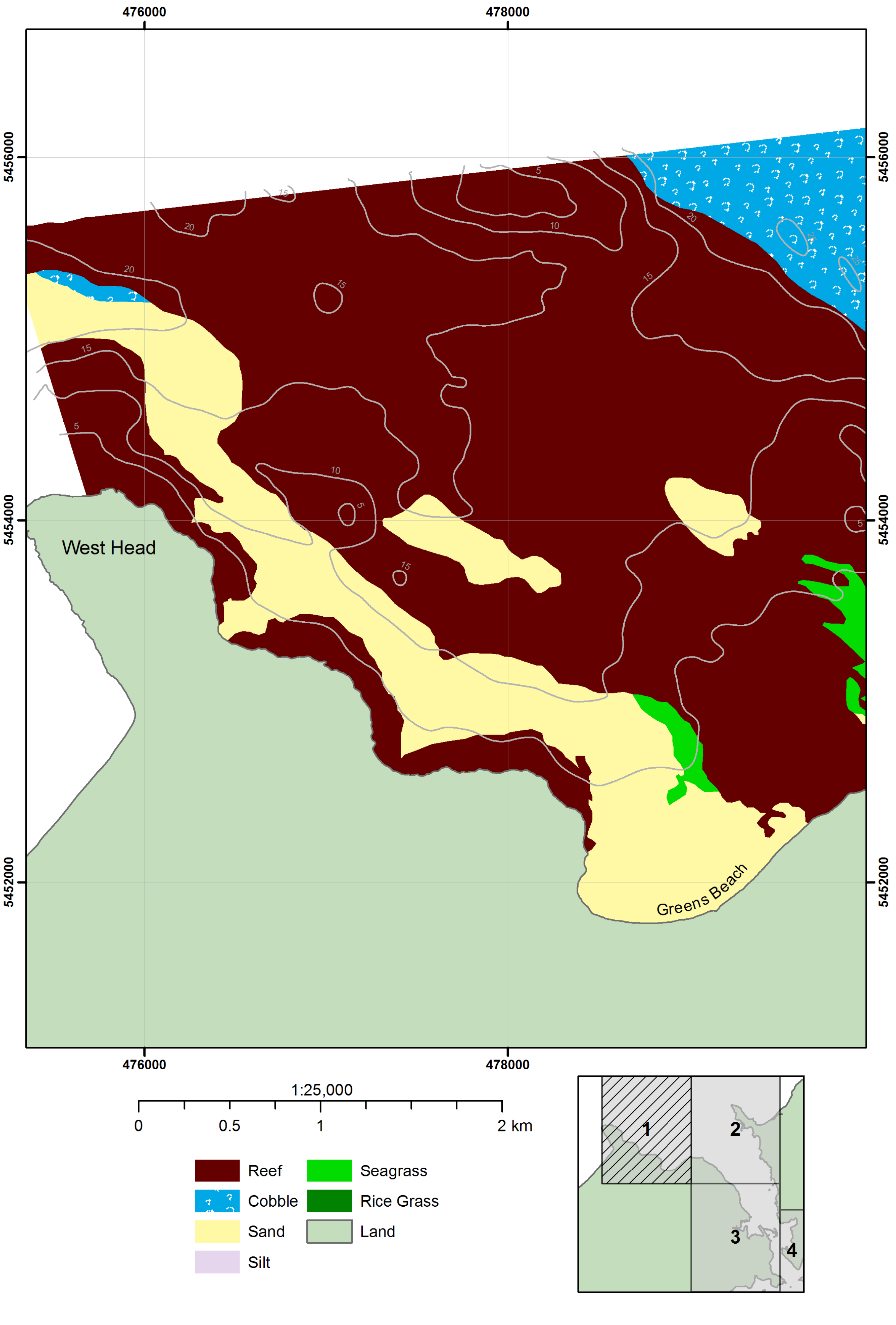

Figure 104. Tamar River map series map 1 showing bathymetry and habitats off West Head and Greens Beach.

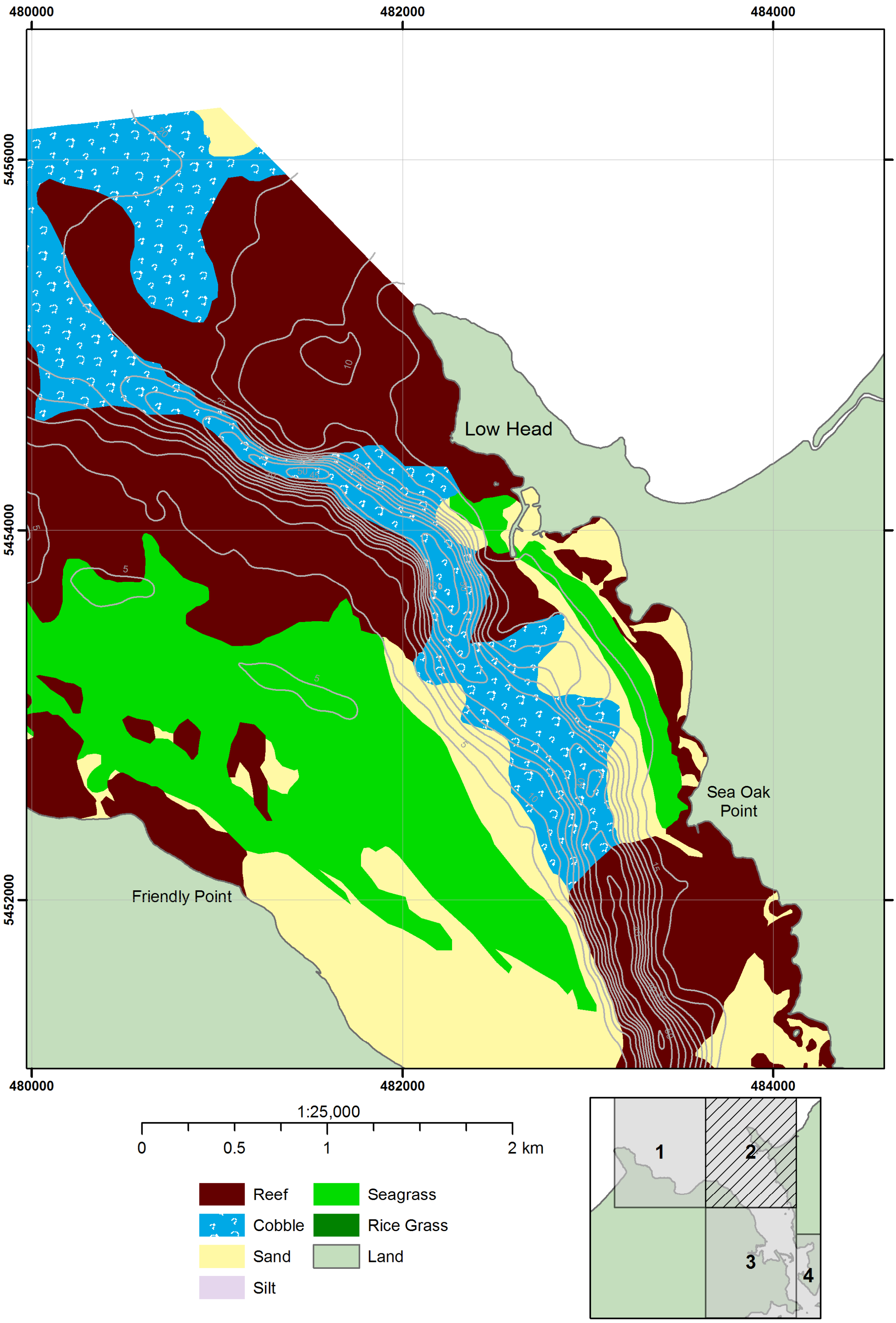

Figure 105. Tamar River map series map 2 showing bathymetry and habitats between Low Head and Friendly Point.

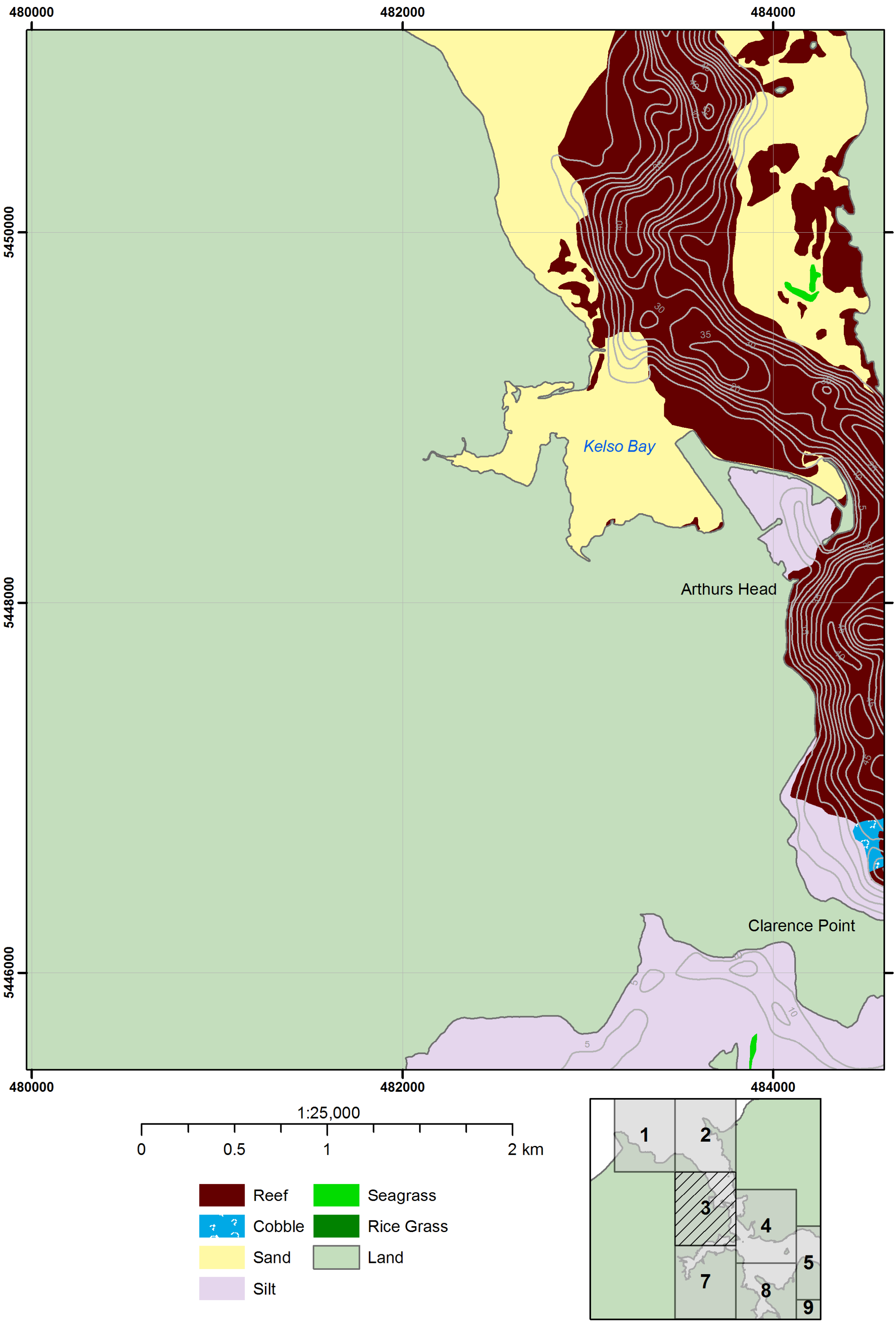

Figure 106. Tamar River map series map 3 showing bathymetry and habitats off Kelso Bay and Clarence Point.

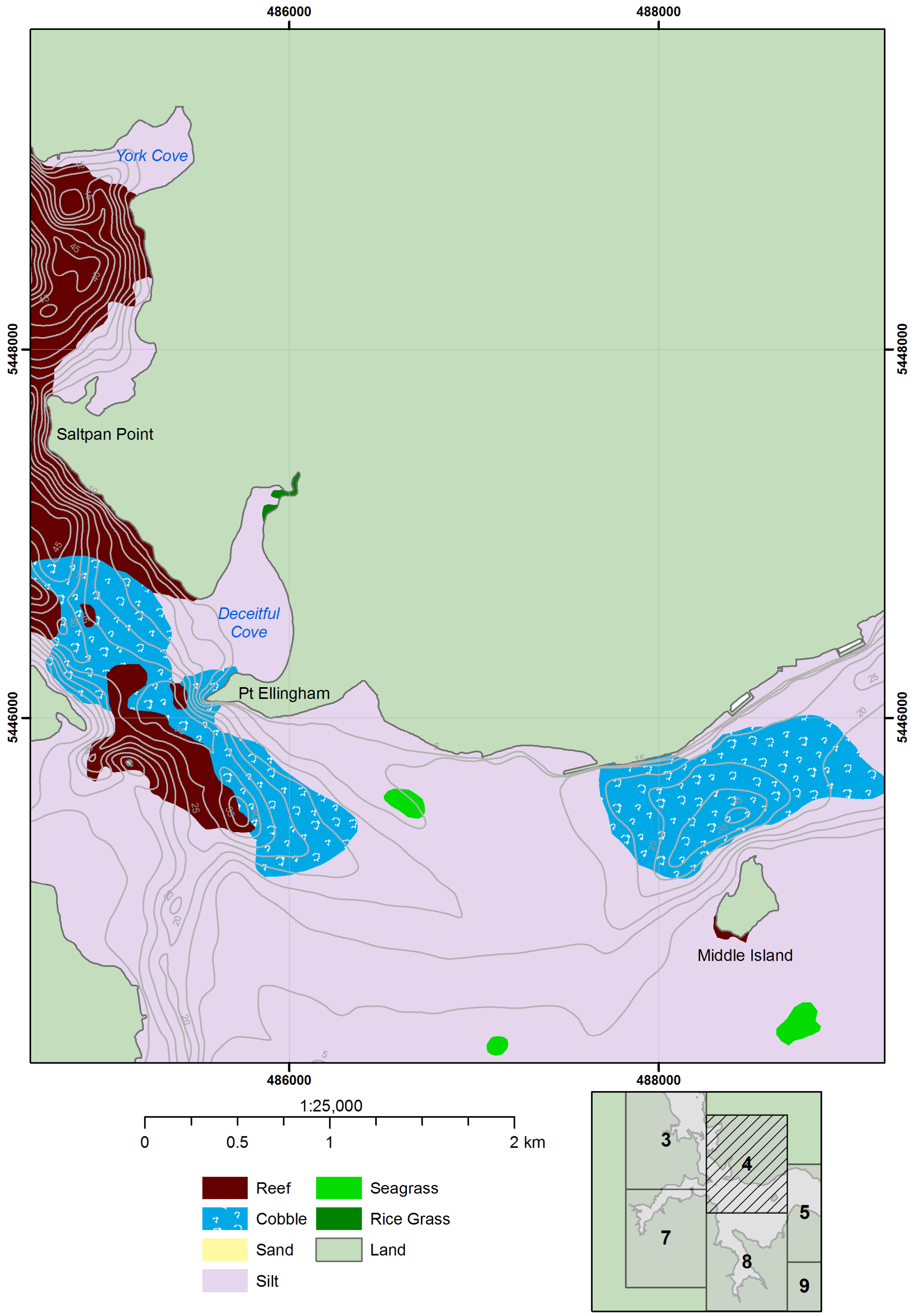

Figure 107. Tamar River map series map 4 showing bathymetry and habitats in Port Dalrymple.

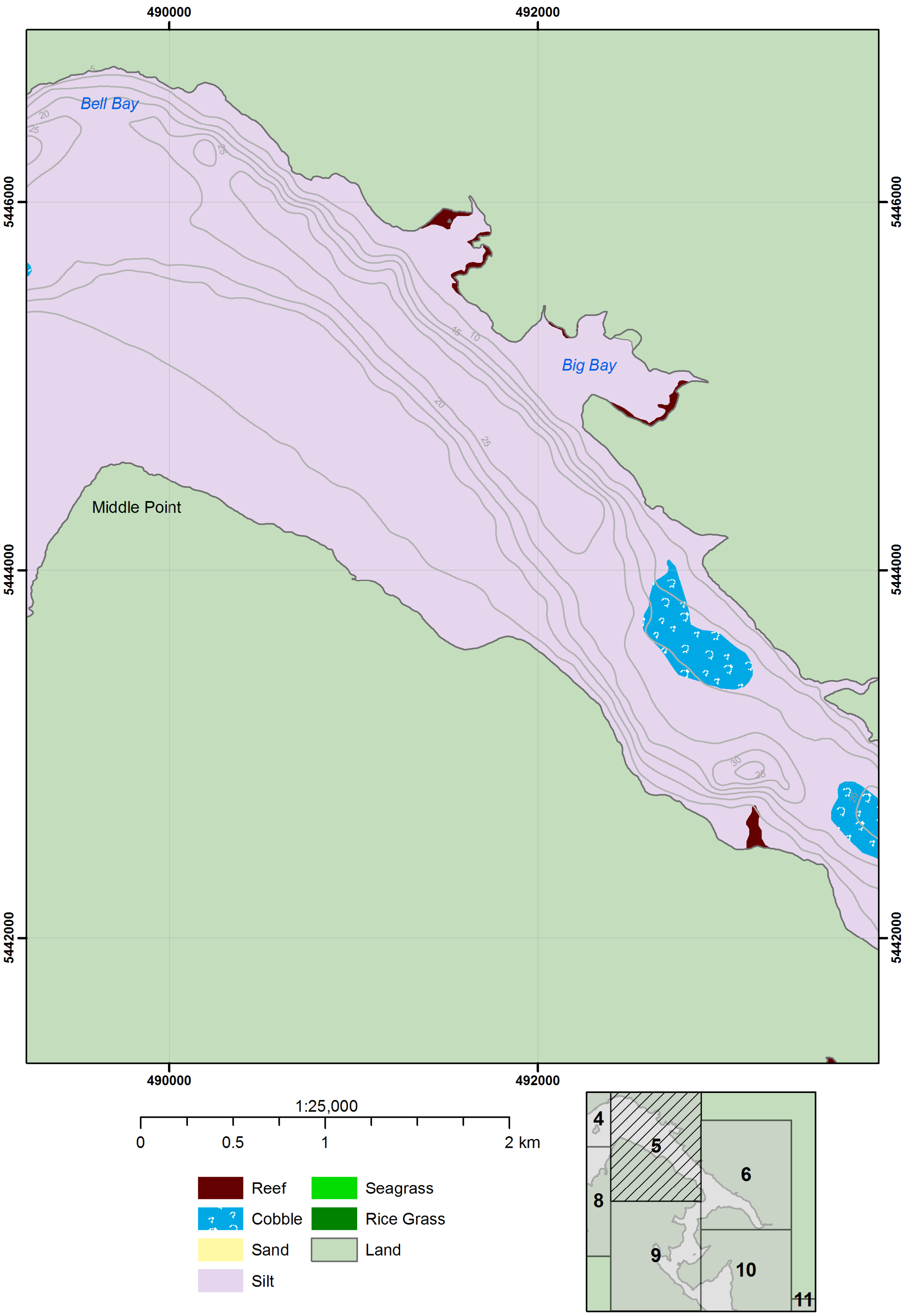

Figure 108. Tamar River map series map 5 showing bathymetry and habitats in Long Reach.

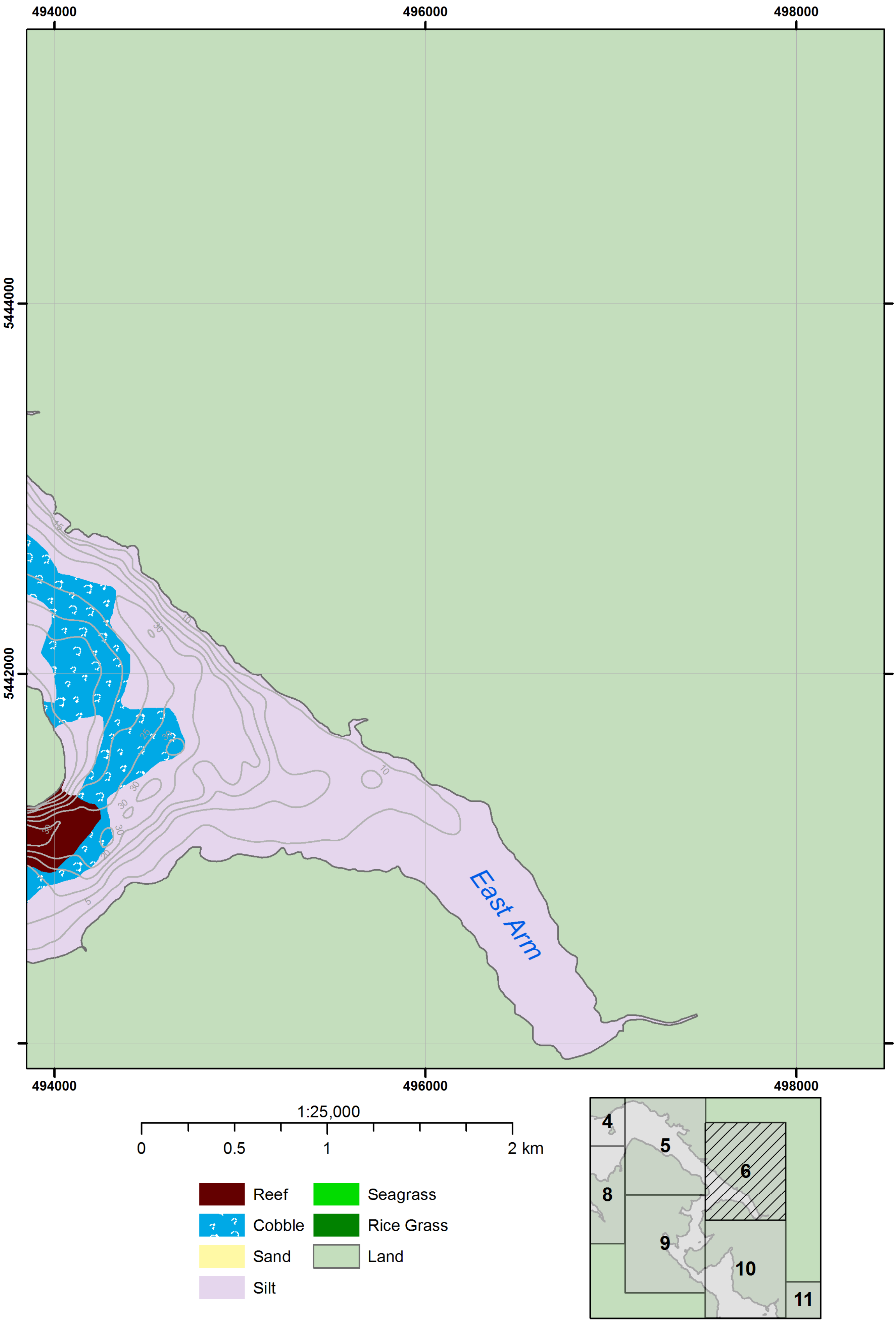

Figure 109. Tamar River map series map 6 showing bathymetry and habitats in East Arm.

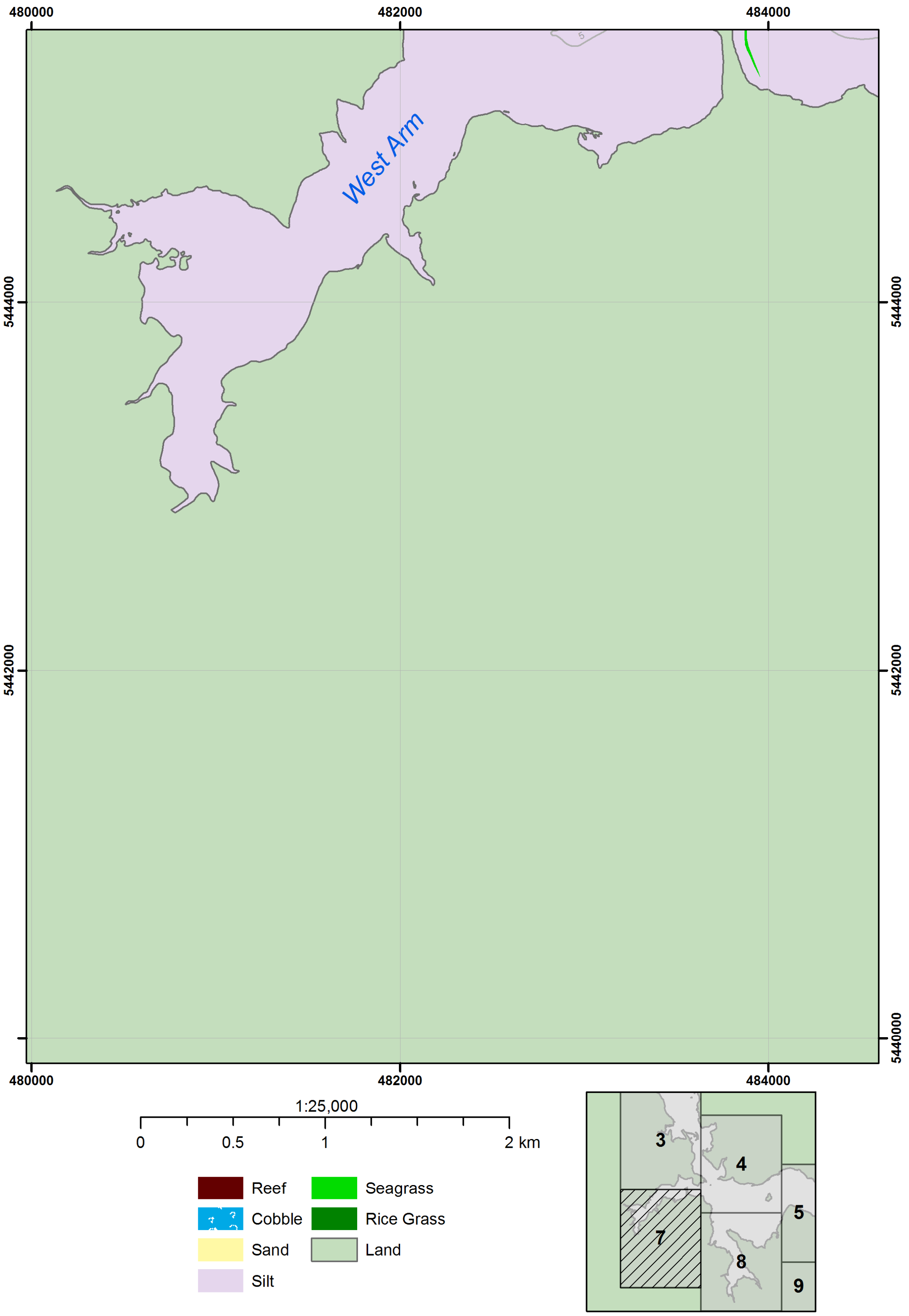

Figure 110. Tamar River map series map 7 showing bathymetry and habitats in West Arm.

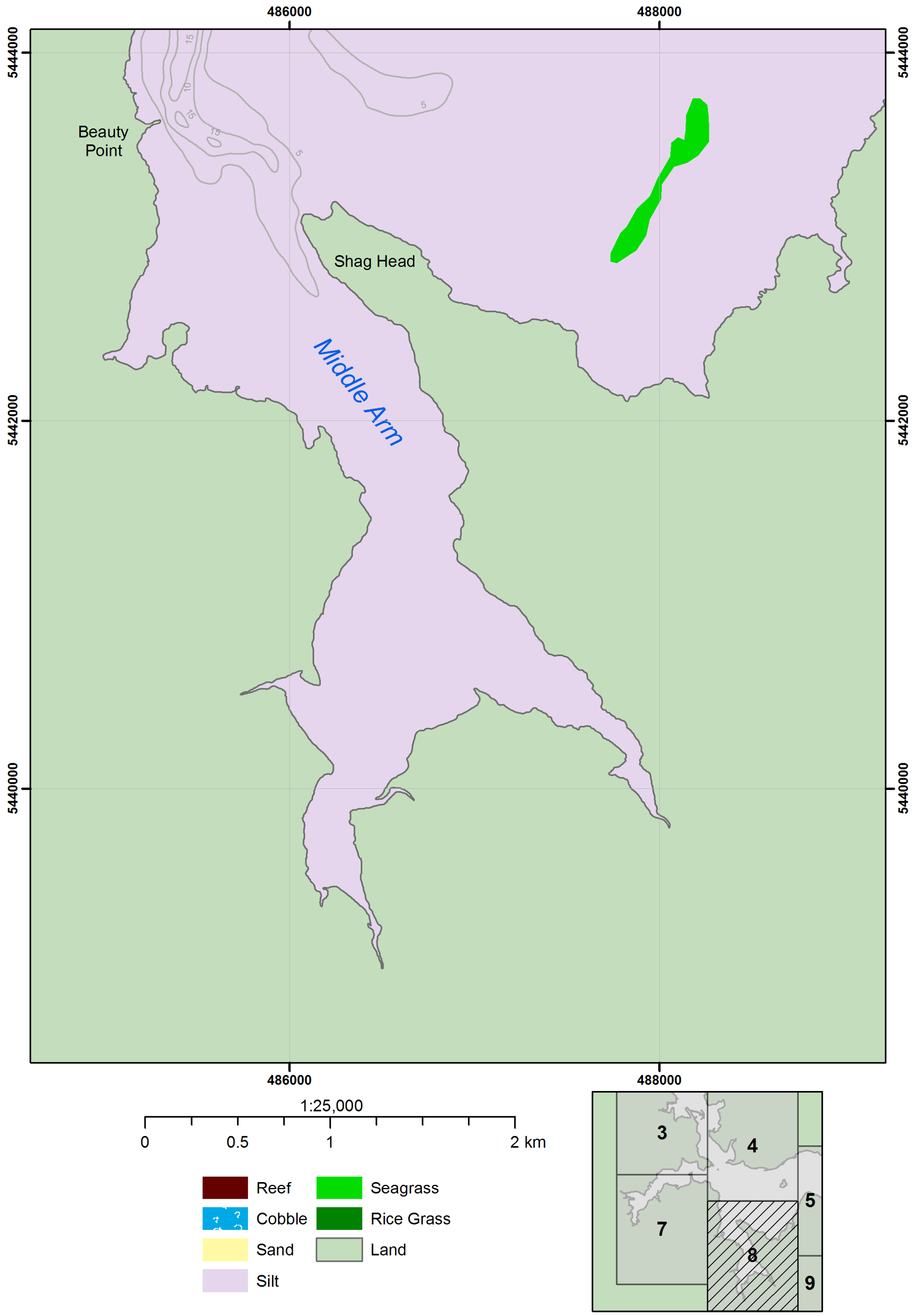

Figure 111. Tamar River map series map 8 showing bathymetry and habitats in Middle Arm and off Beauty Point.

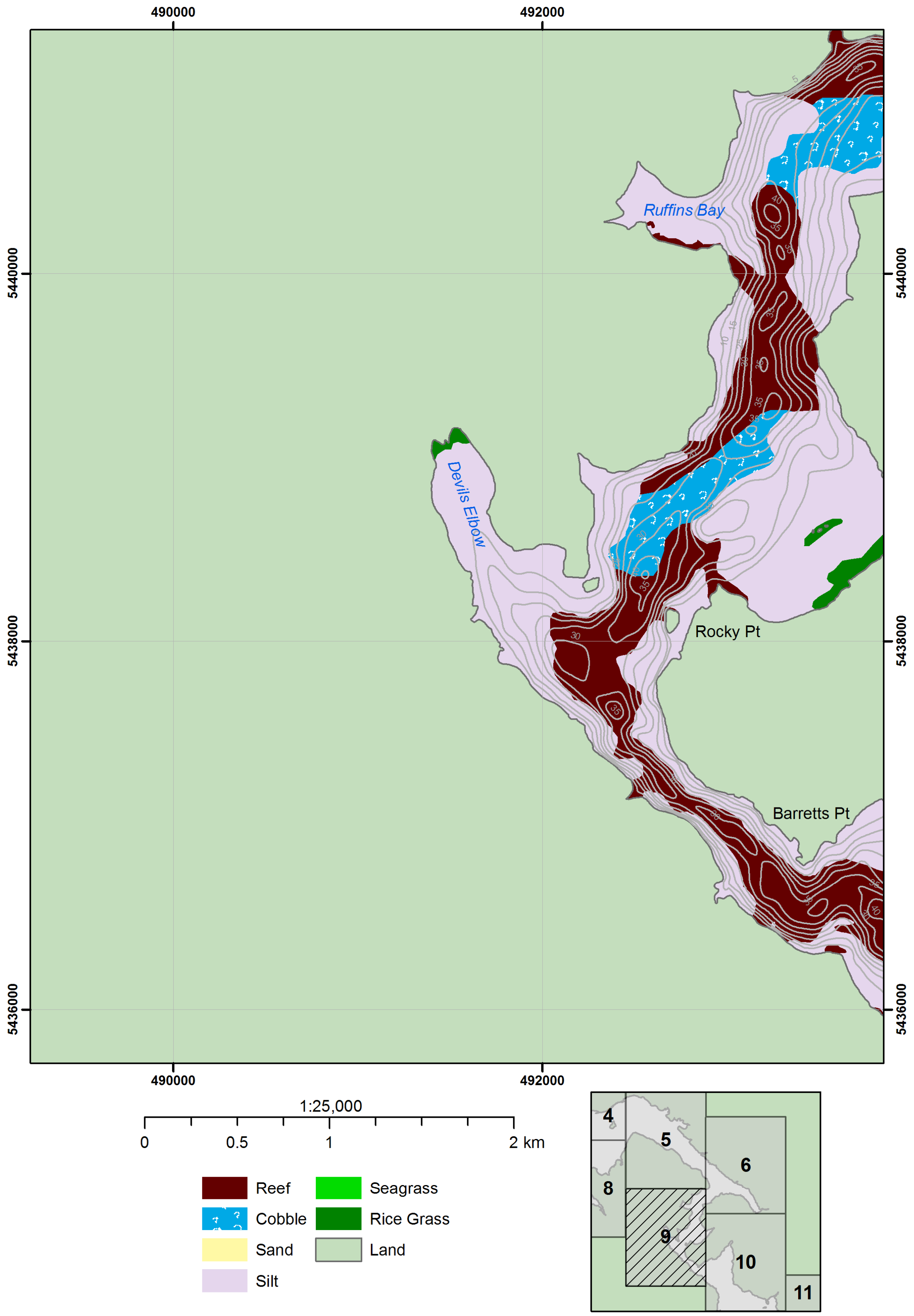

Figure 112. Tamar River map series map 9 showing bathymetry and habitats from Ruffins Bay to Barretts Point.

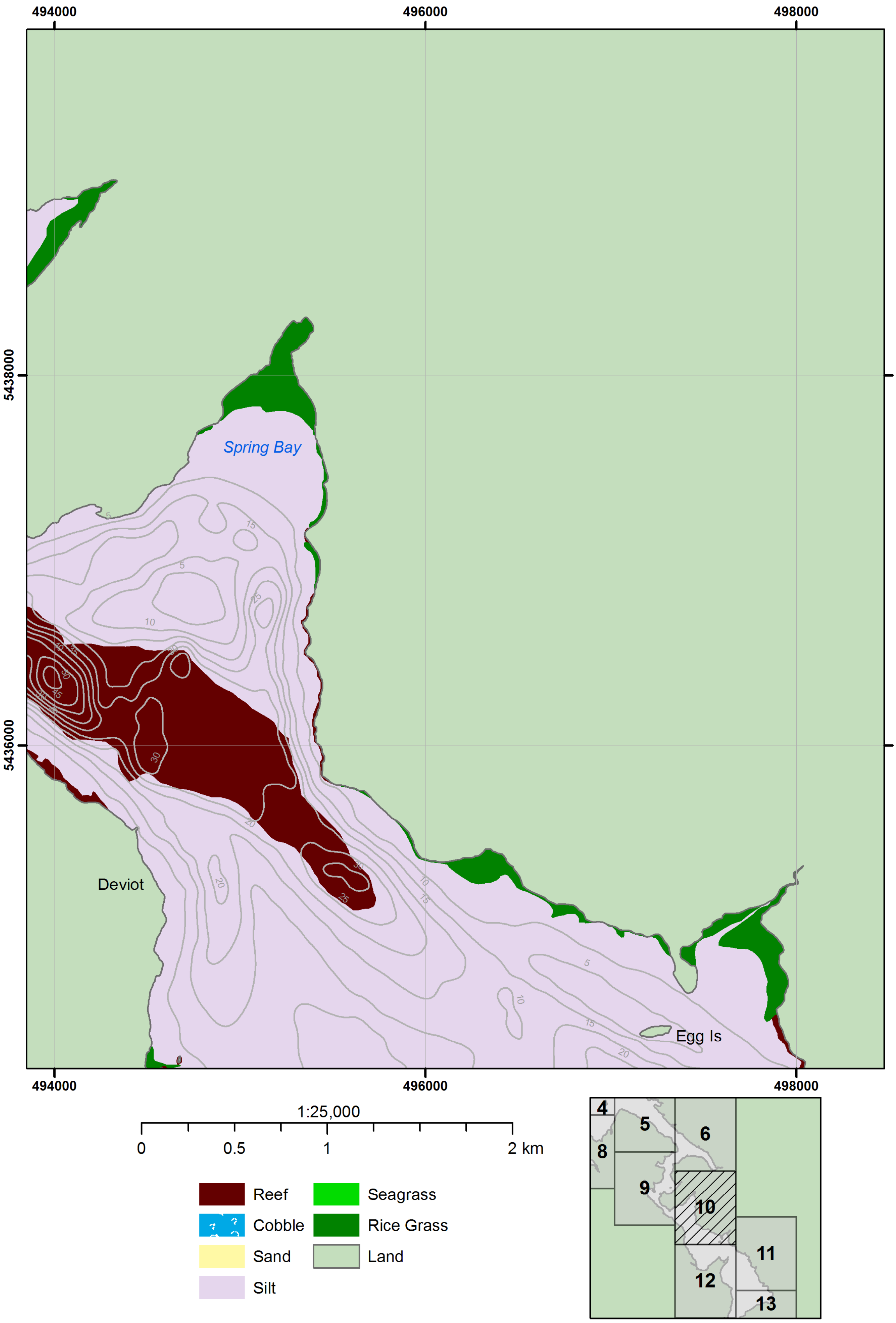

Figure 113. Tamar River map series map 10 showing bathymetry and habitats from Spring Bay to Egg Island.

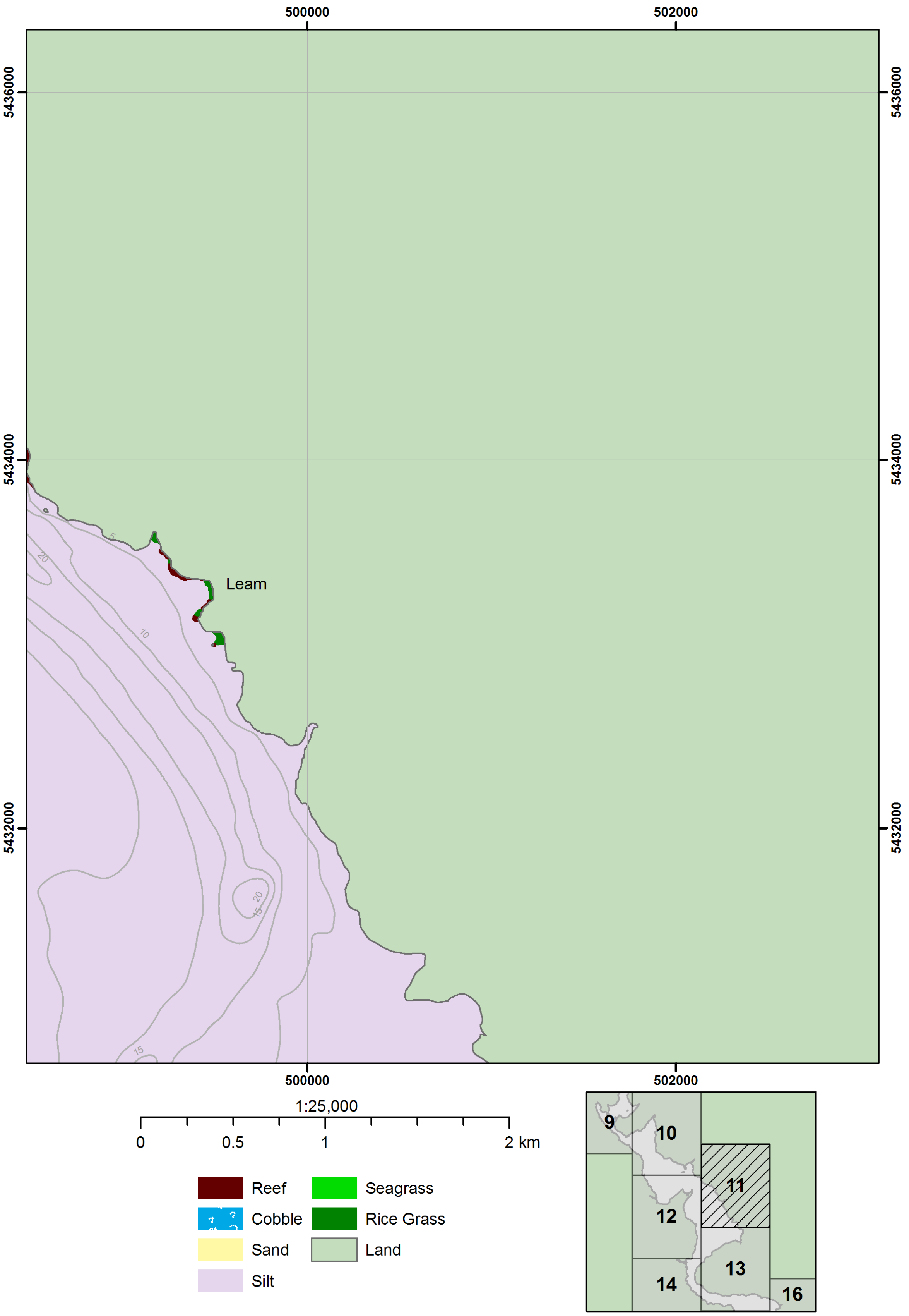

Figure 114. Tamar River map series map 11 showing bathymetry and habitats from Leam to Swan Bay.

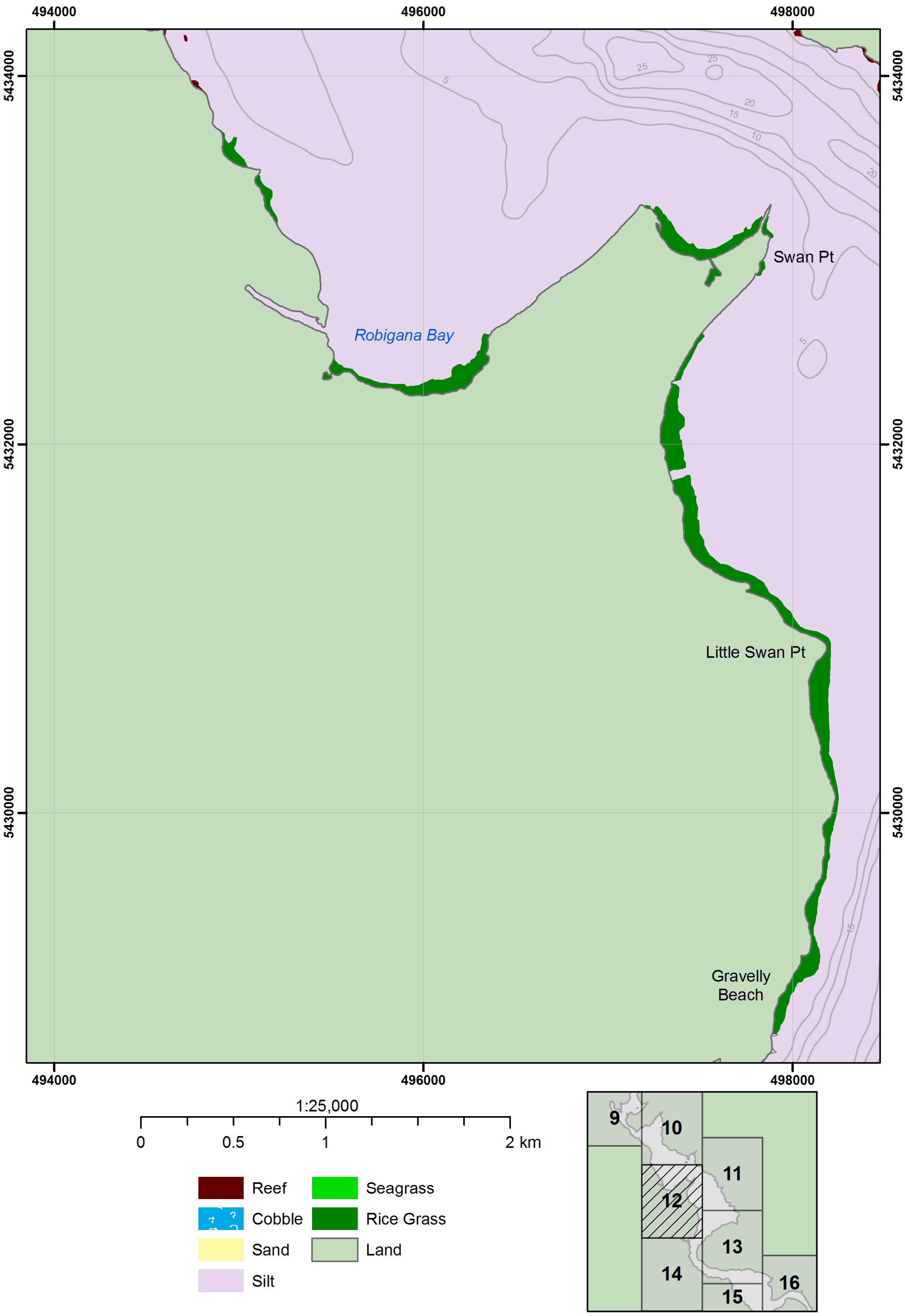

Figure 115. Tamar River map series map 12 showing bathymetry and habitats from Swan Point to Gravelly Beach.

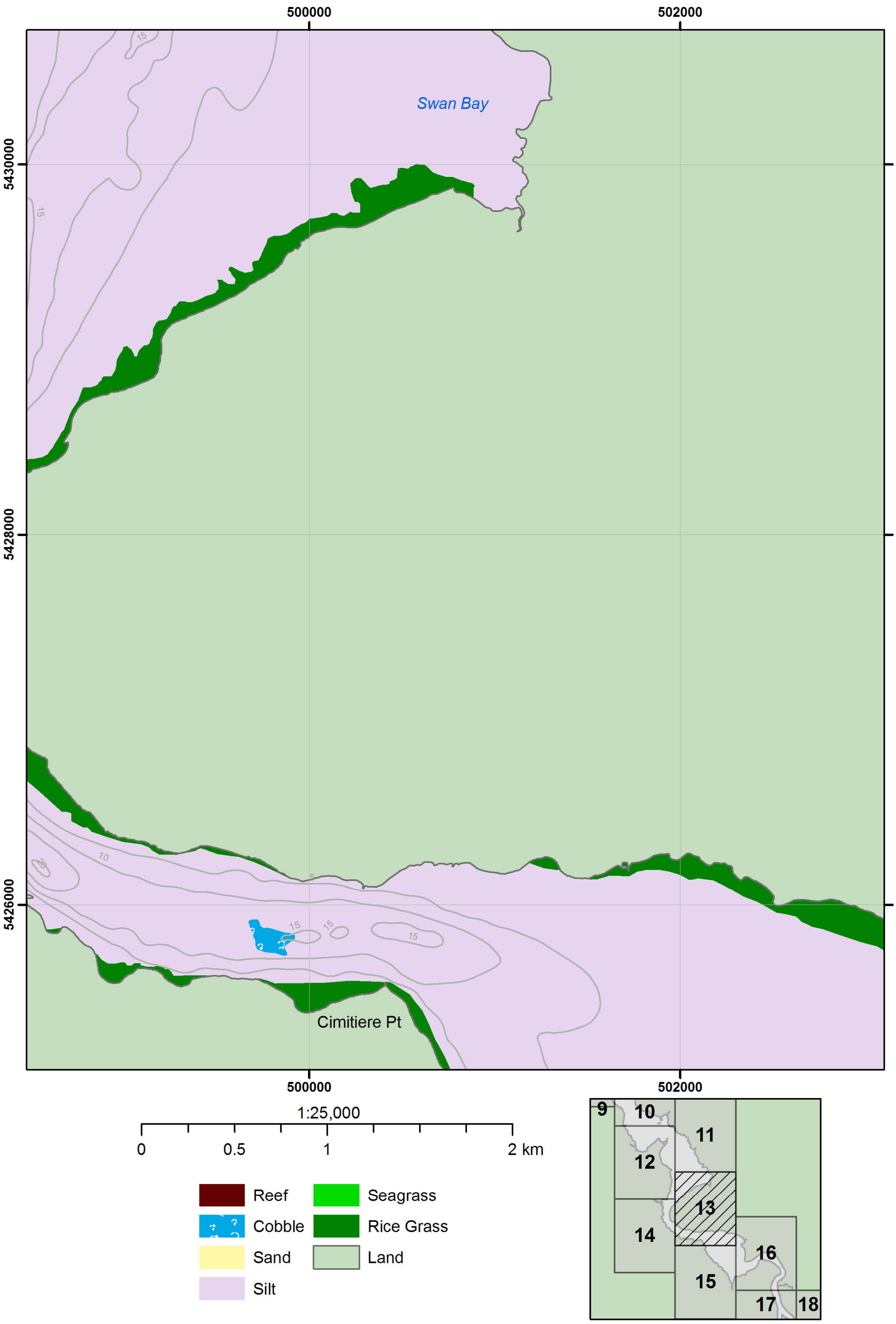

Figure 116. Tamar River map series map 13 showing bathymetry and habitats from Swan Bay to Cimitiere Point.

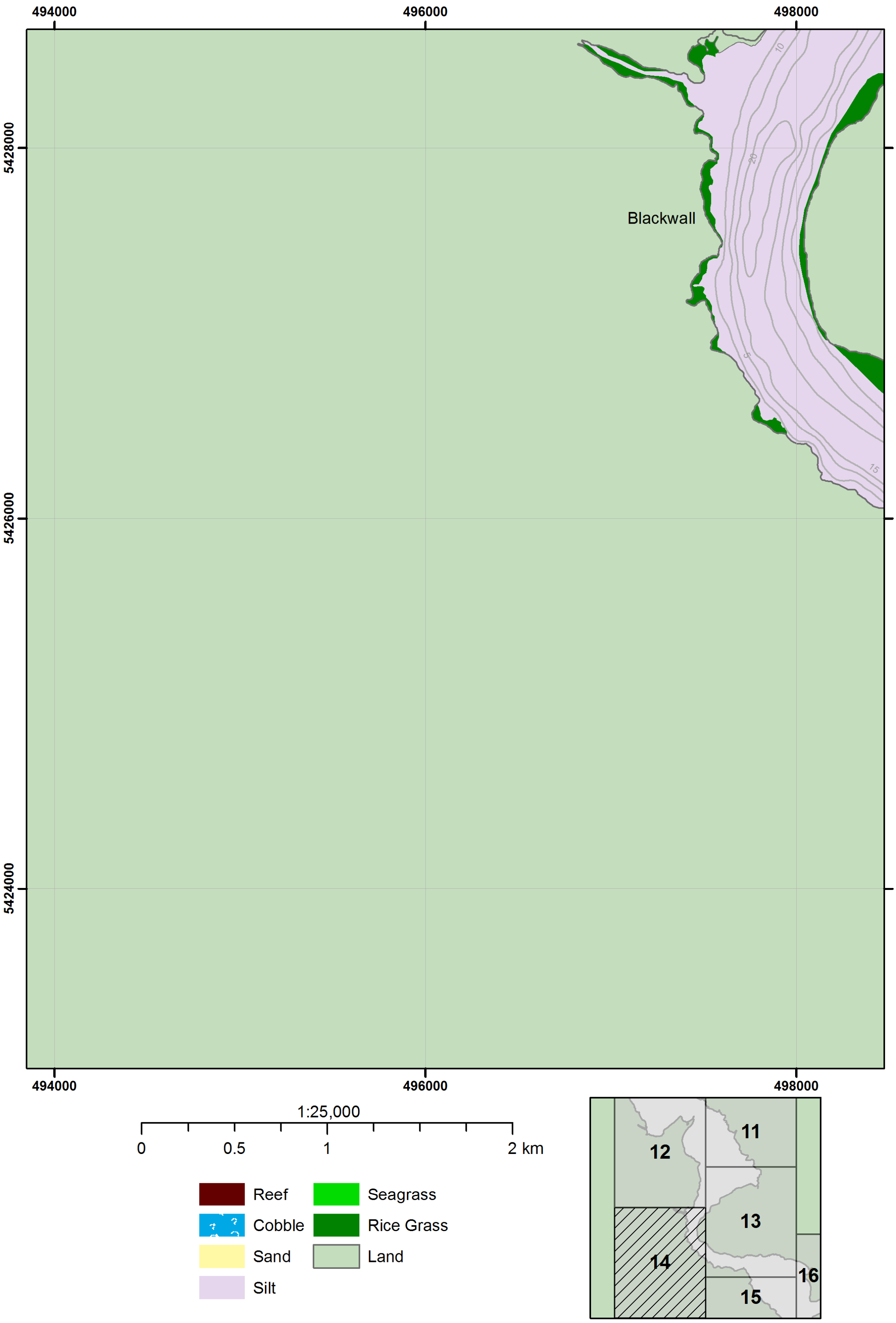

Figure 117. Tamar River map series map 14 showing bathymetry and habitats around Blackwall.

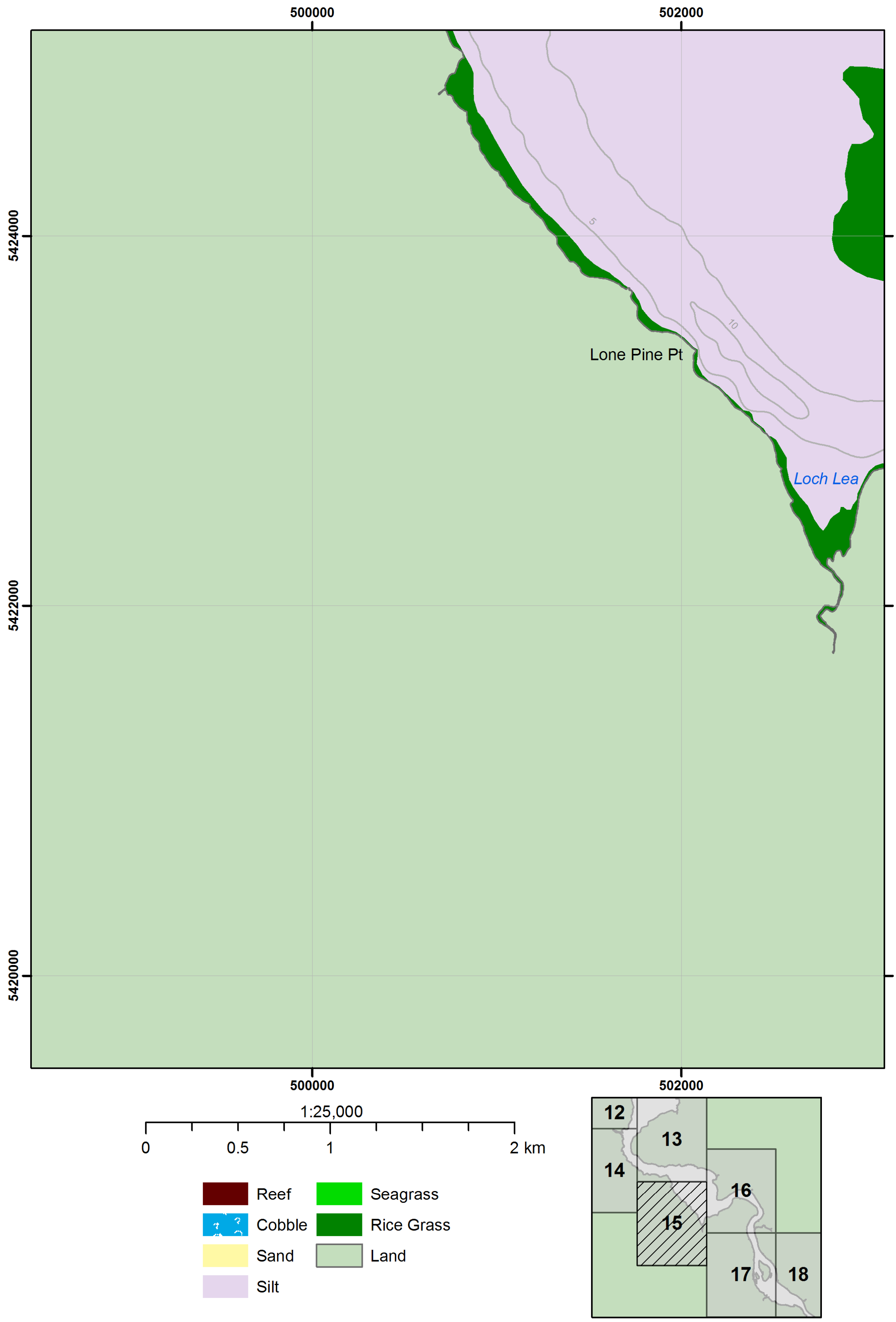

Figure 118. Tamar River map series map 15 showing bathymetry and habitats off Lone Pine Point.

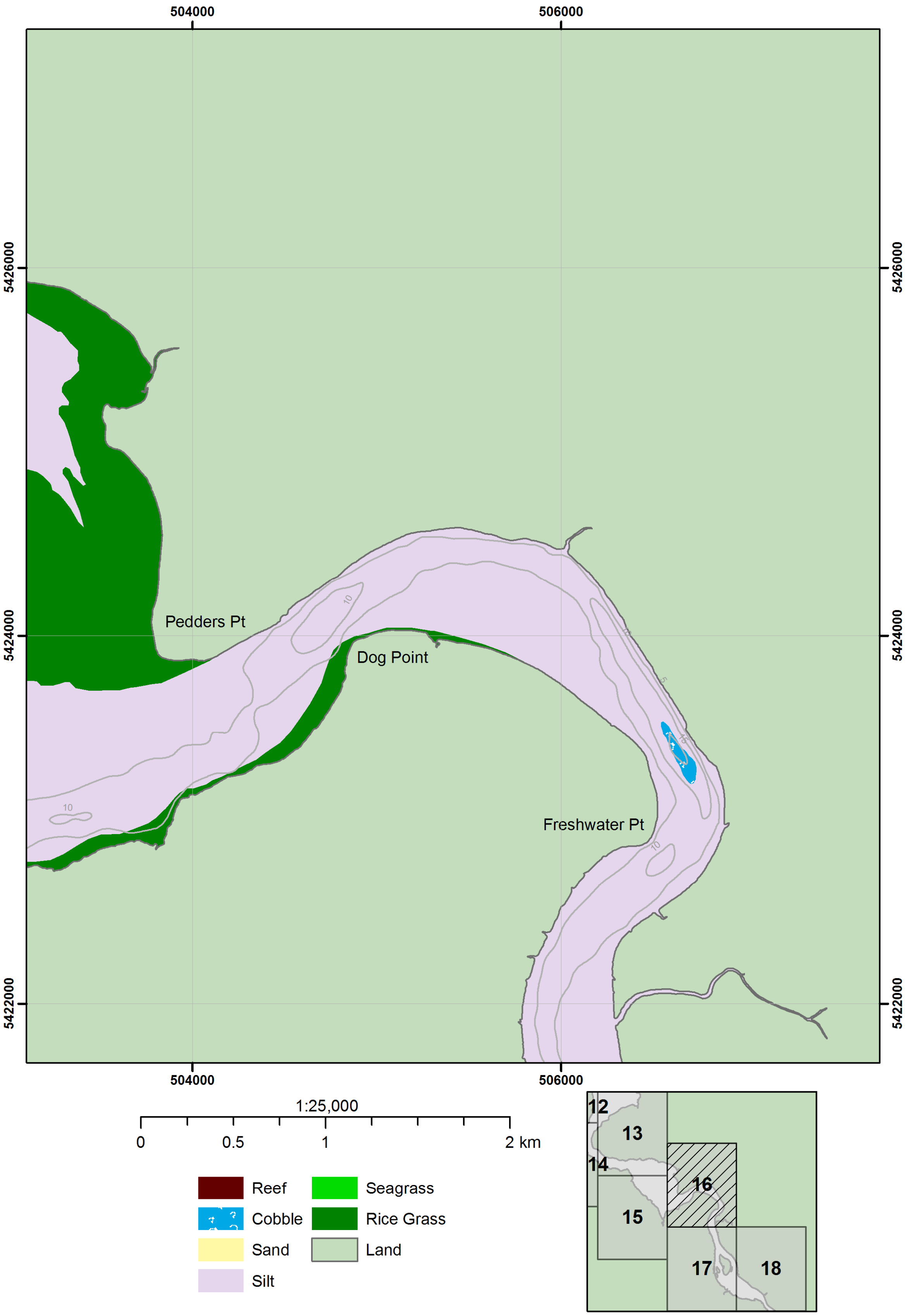

Figure 119. Tamar River map series map 16 showing bathymetry and habitats off Dog Point and Freshwater Point.

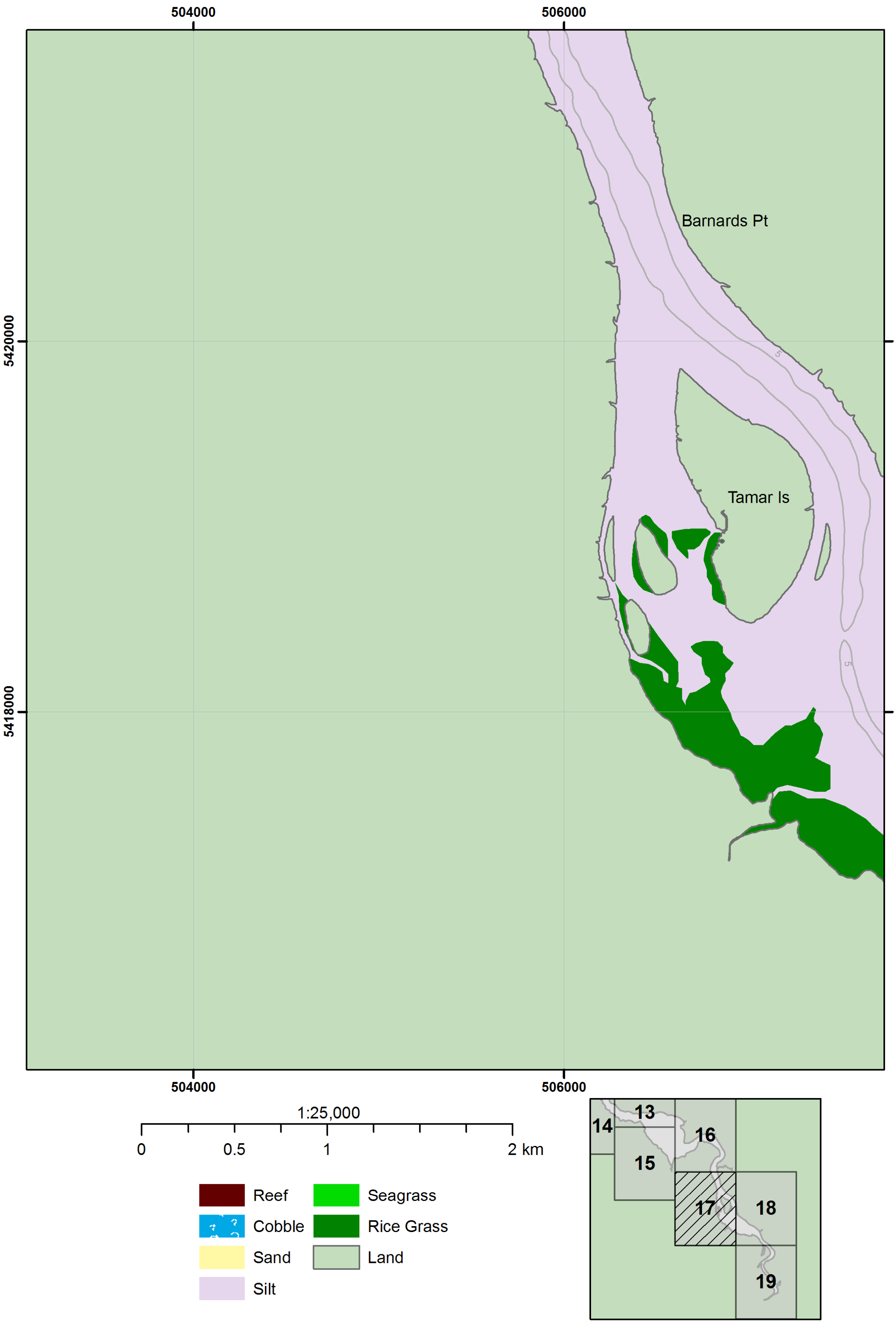

Figure 120. Tamar River map series map 17 showing bathymetry and habitats around Tamar Island.

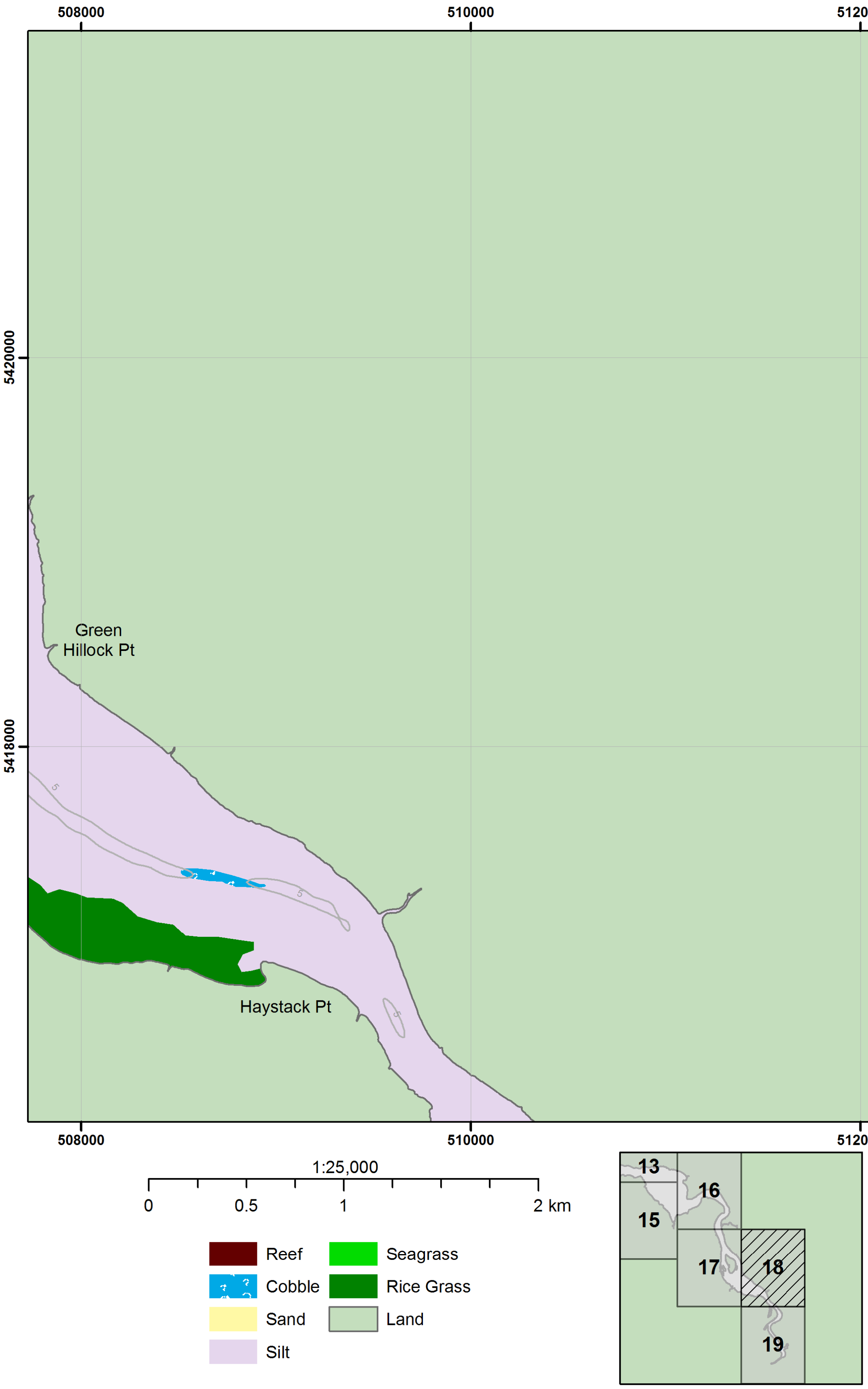

Figure 121. Tamar River map series map 18 showing bathymetry and habitats between Green Hillock Point and Haystack Point.

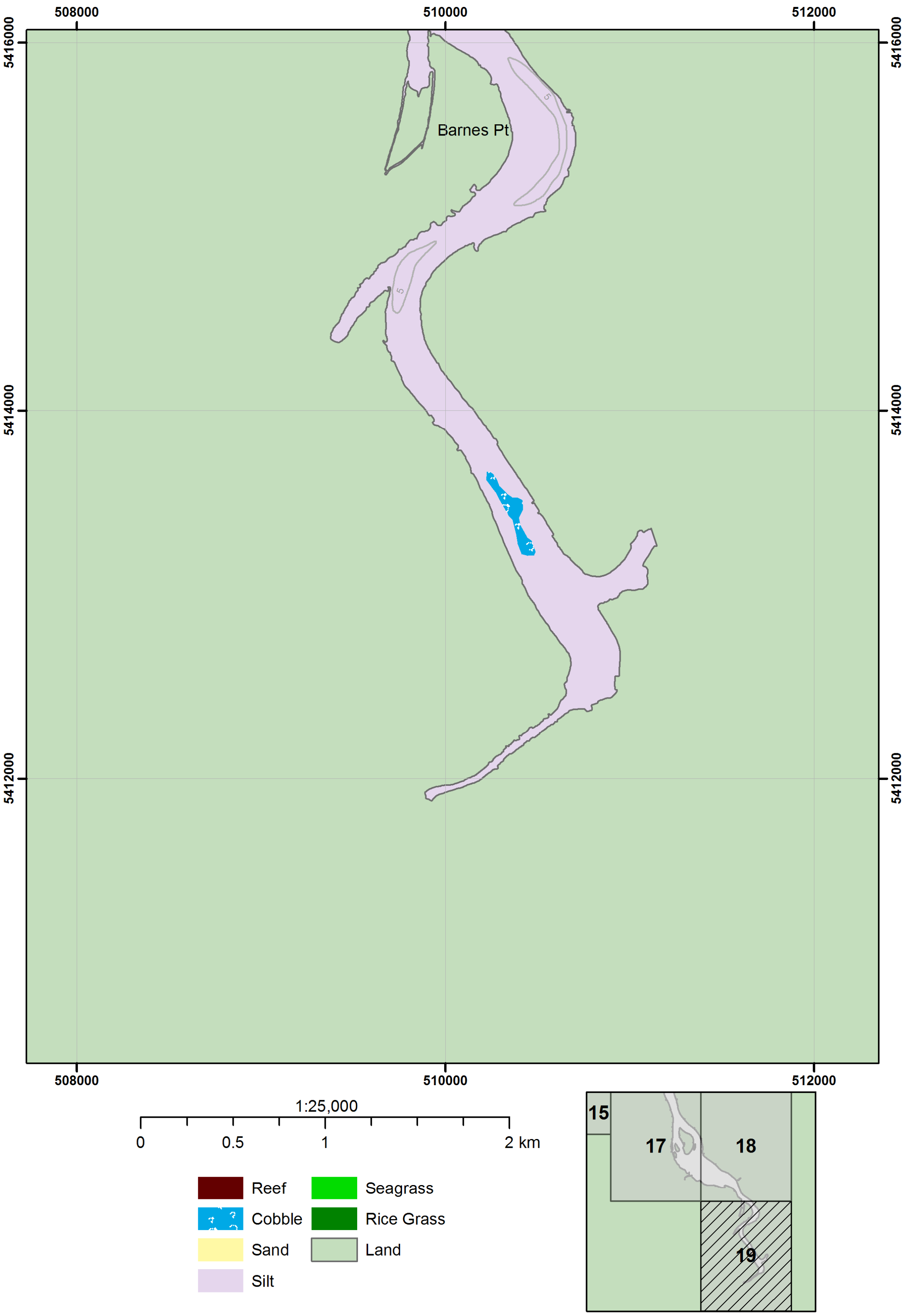

Figure 122. Tamar River map series map 19 showing bathymetry and habitats between Bames Point and Launceston.

3.3.2. Section A

3.3.2.1. Habitat Distribution

Section A covered a total area of 7250.23 ha of seabed within the estuary and ranged from West Head/ Low Head to the Batman Bridge. The majority of the habitat type within the survey zone was characterised by silt (46.5%) and reef (29.7%) with seagrass, cobble, sand and rice grass present (Table 30). The boundaries of the rice grass habitat were determined from aerial photography records scanned and digitised as per the methodology outline in Section 2.3 and 2.4. The accuracy of the habitat maps in this subsection had an overall result of 68.4% (Table 31). This was characterised by a low producer's accuracy of 29% for cobble habitat which was often misclassified with sand habitat. Due to the soft smooth nature of the acoustic response to silt habitat, sand habitat appears much harder on the echogram and can be confused if the habitat graduated into cobble from silt as opposed to graduating from silt to sand.

Table 30. Distribution of habitats by depth in Section A of the Tamar Estuary.

DEPTH	SUBSTRATE						TOTAL
	Cobble (ha)	Reef (ha)	Sand (ha)	Seagrass (ha)	Silt (ha)	Rice Grass (ha)	
0-5	2.60	488.68	501.42	294.52	1909.69	13.78	**3210.68**
5-10	22.06	344.01	125.81	0.71	563.34	0.00	**1055.93**
10-15	52.05	508.20	86.99	23.21	325.41	0.00	**995.86**
15-20	109.53	386.59	41.29	0.00	295.55	0.00	**832.96**
20-25	227.41	105.54	22.91	0.00	170.58	0.00	**526.43**
25-30	74.01	99.52	2.62	0.00	96.09	0.00	**272.24**
30+	120.67	223.94	1.47	0.00	10.03	0.00	**356.11**
TOTAL	**608.34**	**2156.48**	**782.50**	**318.44**	**3370.69**	**13.78**	**7250.23**
Percentage	*8.39%*	*29.74%*	*10.79%*	*4.39%*	*46.49%*	*0.19%*	

Table 31. Accuracy assessment of habitats in Section A of the Tamar Estuary.

Video Class	Map Class					User Total	User Accuracy
	Cobble	Reef	Sand	Seagrass	Silt		
Cobble	1420	1171	159	3	314	**3067**	46.30%
Reef	985	6170	72	0	243	**7470**	82.60%
Sand	235	693	805	64	0	**1797**	44.80%
Seagrass	0	360	337	478	142	**1317**	36.29%
Silt	206	76	0	0	2098	**2380**	88.15%
Producer Total	**2846**	**8470**	**1373**	**545**	**2797**	**16031**	
Producer Accuracy	49.89%	72.85%	58.63%	87.71%	75.01%		
Accuracy:	68.44%						
Kappa:	0.537						

3.3.2.2. Seagrass Distribution Section A

Section A contained a mix of four seagrass species (Figure 123). In 0 – 5 m depth *Heterozostera tasmanica* was the dominant species, comprising nearly 60 % of seagrass cover. This decreased to

28 % by 5 – 10 m depth and less than 5 % cover below 10 m depth. *Amphibolis antarctica* comprised around 20 % cover in 0 – 5 m depth, decreasing to 6 % cover in 5 – 10 m depth. *Posidonia australis* comprised 14 % cover in 0 – 5 m depth and increased to 28 % cover in 5 – 10 m depth. A small amount of *Halophila australis* (<1 %) occurred in 5 – 10 m depth.

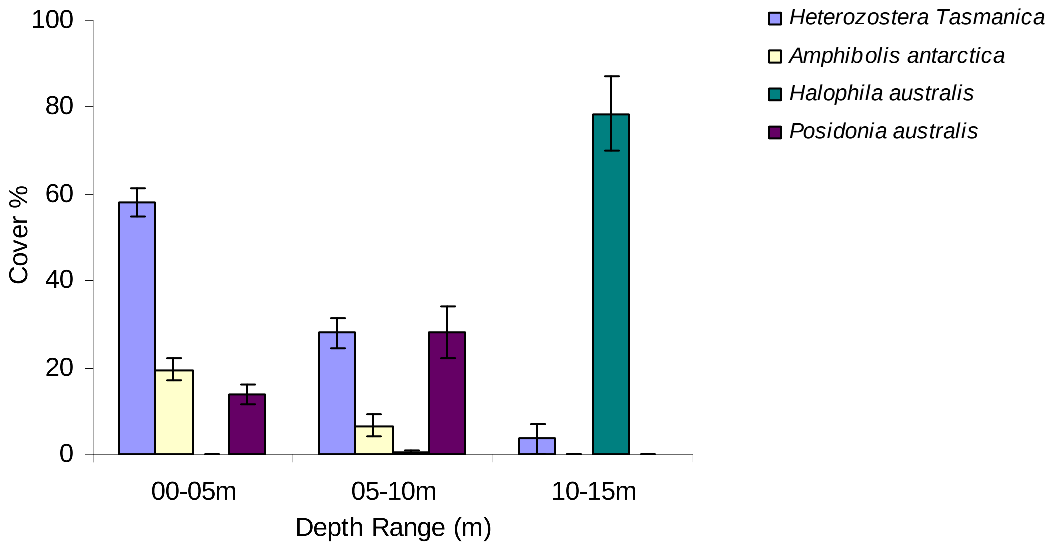

Figure 123. Mean seagrass cover (± s.e.) within seagrass beds by depth strata (5 m bin) for analysis section A.

3.3.2.3 Algal Distribution Section A

The total cover of algae in section A, From West Head/Low Head to the Batman Bridge, was greater than 95 % in the 0 – 10 m depth range and then rapidly reduced to less than 5 % cover below 25 m depth (Figure 124). The 0 – 5 m depth range was dominated by a mix of *Phyllospora*, *Ecklonia*, *Cystophora*, *Acrocarpia*, *Sargassum*, and red algae. Small amounts of *Caulocystis*, *Seirococcus*, *Perithalia*, red and brown turfing algae, and filamentous brown algae were also present in this depth range. The 5 – 10 m depth range was dominated by *Ecklonia*, *Acrocarpia*, *Sargassum* and red algae. A mix of minor species were also present including *Phyllospora*, *Cystophora*, *Caulocystis*, *Carpoglossum*, *Xiphophora*, *Seirococcus*, red and brown turfing algae, and filamentous brown algae. Below 10 m depth the algal community was dominated by red algae, with small amounts of a mix of algae including *Ecklonia*, *Cystophora*, *Caulocystis*, *Acrocarpia*, *Carpoglossum*, *Sargassum*, *Sporonchus* and filamentous brown algae. Below 25 m there was very little algae present on the reef, with only small amounts of red algae present to 35 m depth. Sponge was present from 5 – 10 m and encrusting invertebrates from 10 – 15 m depth. These became the dominant component of the biota below 15 m depth, with sponge comprising 55 % of the benthic cover below 20 m depth.

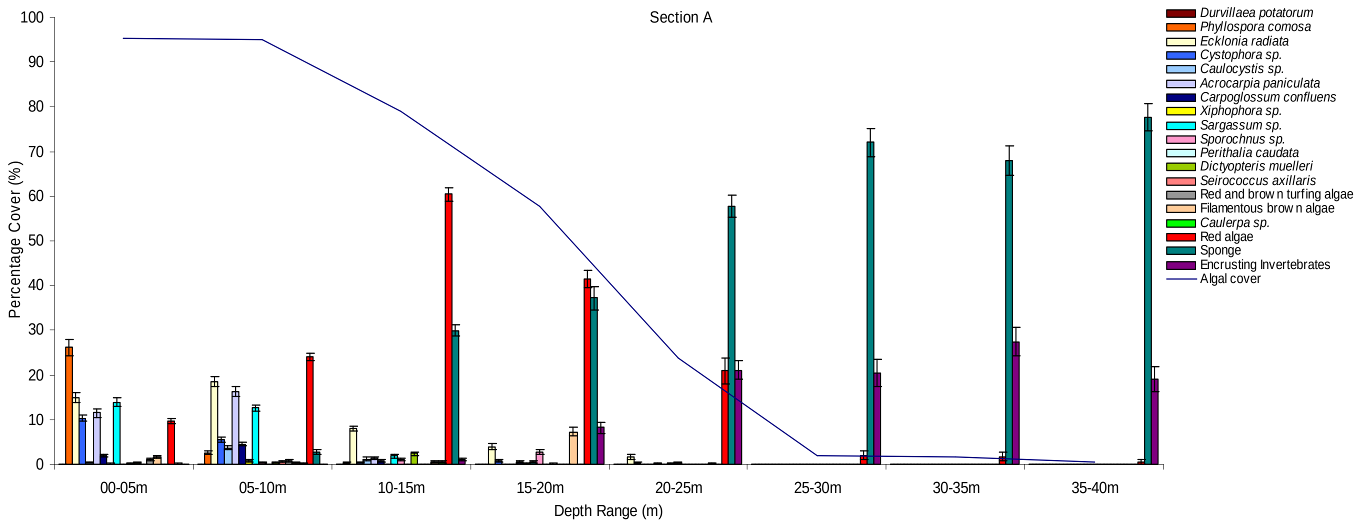

Figure 124. Mean Algal Cover (± s.e.) by depth strata (5 m bin) for analysis section A.

The algal analysis of the algae of section A of the Tamar River was further subdivided into three sections based on the distribution of dominant algal species. Section A1, which encompassed the exposed sections at the mouth of the Tamar River, from Lagoon Bay to West Head /Low Head,

Section A1. Low Head to Lagoon Bay

The algal cover in section A1 was close to 100 % in the 0 – 5 m depth range and gradually decreased to 70 % in the 20 – 25 % depth range (Figure 125). Below 25 m the algal cover rapidly decreased to below 6 % cover. In 0 – 5 m depth *Phyllospora* dominated the algal community, comprising around 50 % of the algal cover. *Cystophora* and *Acrocarpia* were also common in this depth range, with small amounts of *Ecklonia*, *Carpoglossum* , *Sargassum* and red algae. In 5 – 10 m depth a mix of *Ecklonia*, *Acraocarpia*, and red algae dominated the algal community, with smaller amounts of *Cystophora*, *Caulocystis*, *Carpoglossum*, *Sargassum* also present. In 10 – 15 m depth red algae was the dominant algal group, with Small amounts of *Ecklonia*, *Caulocystis*, *Acrocarpia*, *Carpoglossum*, *Sargassum*, *Sporonchus*, and *Dictyopteris*. From 15 – 25 m depth red algae comprised greater than 50 % of the algal cover, with small amounts of *Ecklonia*, *Cystophora*, *Carpoglossum*, *Sargassum*, *Sporonchus* and filamentous brown algae. Below 25 m small amounts of red algae were present to 40 m depth. Sponge became a common component of the benthic community from 10 – 15 m depth and was the dominant component form 25 – 50 m depth.

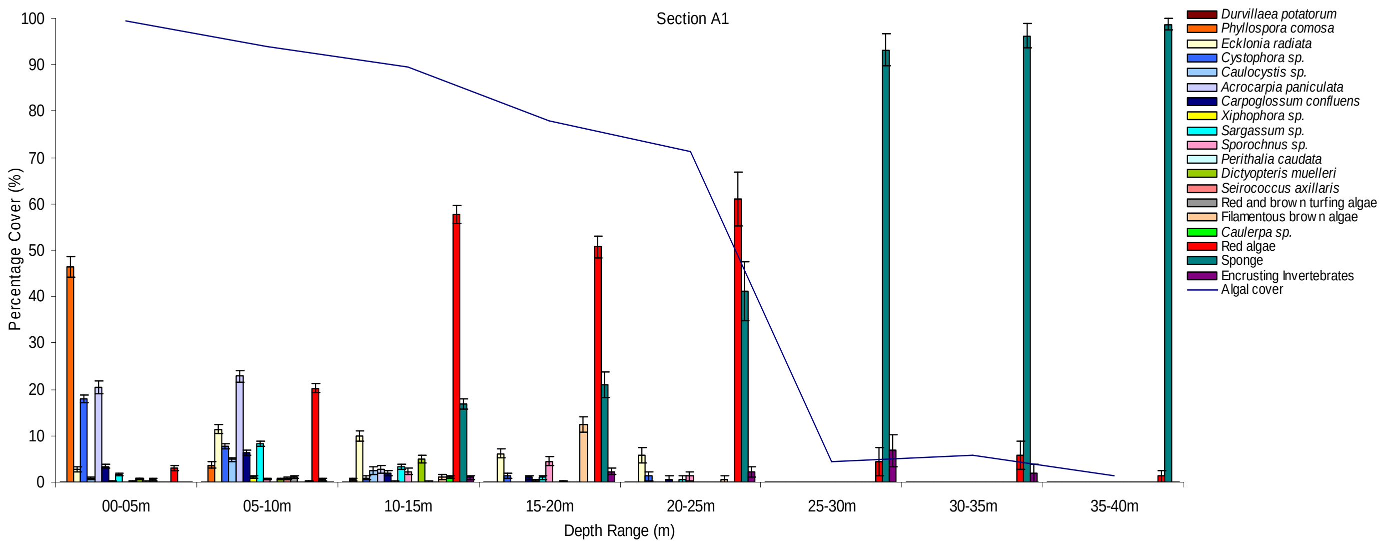

Figure 125. Mean Algal Cover (± s.e.) by depth strata (5 m bin) for analysis sub-section A1.

Section A2. Lagoon Bay to Beauty Point

The total algal cover in section A1, from Lagoon Bay to Beauty Point was greater than 95 % in the 0 – 10 m depth range then decreased to less than 2 % by 25 m depth (Figure 126). In 0 – 10 m the algal community was dominated by *Ecklonia*, *Sargassum* and Red algae, with small amounts of filamentous brown algae. Below 10 m red algae dominated the algal community to 25 m depth, with peak cover in the 10 – 15 m depth range at around 65 % cover. Sponge was present in small quantities from 5 – 10 mm depth and became the dominant benthic cover below 15 m depth. Encrusting invertebrates became common below 15 m depth, and comprised 25 – 40 % cover below 20 m depth.

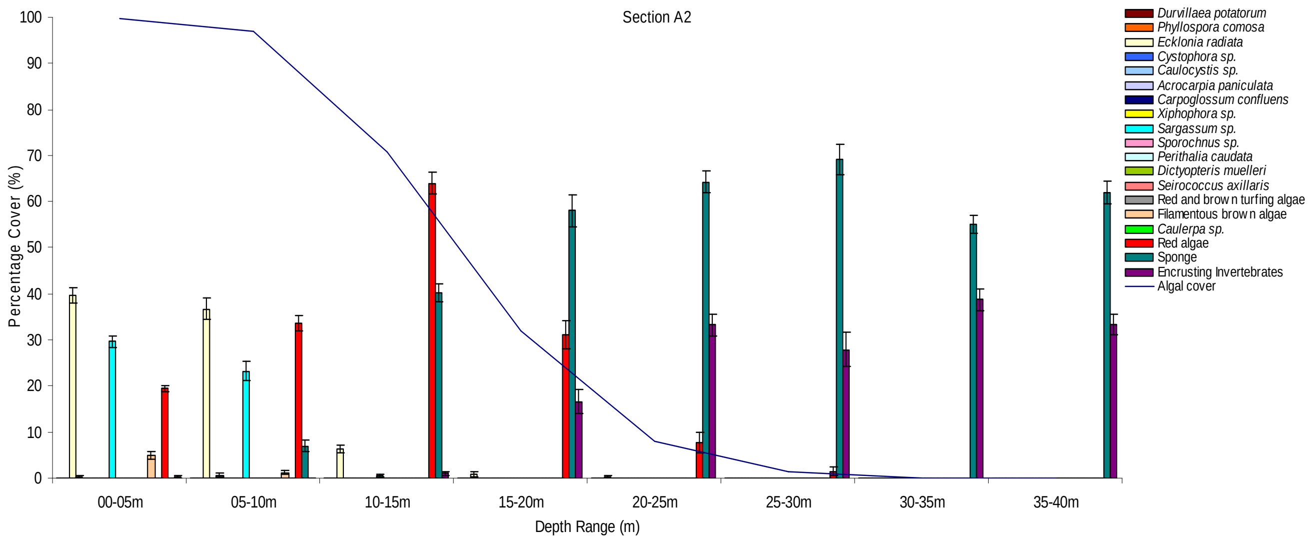

Figure 126. Mean Algal Cover (± s.e.) by depth strata (5 m bin) for analysis sub-section A2.

Section A3. Beauty Point to Batman Bridge.

Total algal cover in section A1, from Beauty Point to the Batman Bridge was low, at around 60 % in the 0 – 5 m depth range (Figure 127). Along the fringing reef in 0 – 5 m depth *Sargassum* was the most common algae, wit small amounts of red and brown turfing algae, and red algae. Below 5 m reef was generally dominated by invertebrate growth, including sponges, although there was little continuous reef from shore to this depth.

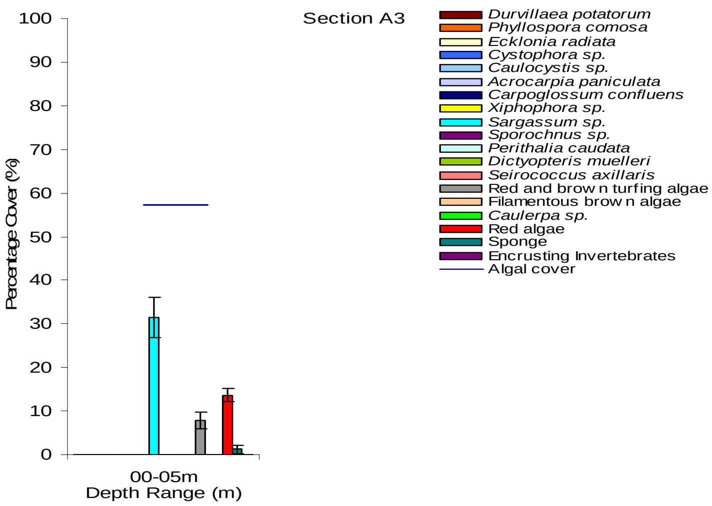

Figure 127. Mean Algal Cover (± s.e.) by depth strata (5 m bin) for analysis sub-section A3.

3.3.2.4 Invertebrate Communities

Extensive invertebrate communities exist on both reef and cobble substrate at the mouth of the Tamar River. Overall there were approximately 540 ha of invertebrate habitat within a region extending from the mouth of the Tamar River to approximately Beauty Point (Table 32). South of Beauty Point the density of invertebrates on reef and cobble substrate decreased significantly, and although dense patches were occasionally observed on the video, the invertebrate cover was generally low.

Table 32. Breakdown of area (ha) covered by invertebrate communities within the Tamar River by 5 m depth strata for both reef and cobble substrates, and combined total.

Depth	Cobble	Reef	Total
05-10m	-	1.37	1.37
10-15m	-	1.99	1.99
15-20m	11.51	44.48	55.99
20-25m	47.25	52.07	99.32
25-30m	32.87	65.93	98.80
30-35m	40.08	64.94	105.02
35-40m	28.30	49.15	77.45
40-45m	13.14	50.17	63.31
45-50m	11.54	19.63	31.17
50-55m	5.32	0.21	5.53
55-60m	0.03	-	0.03
Total	190.03	348.57	538.61

The invertebrate habitat consists of a mix of groups including but not limited to; sponges (Phylum Porifera), Bryozoans (Phylum Bryozoa), and several groups belonging to the Class Anthozoa (Phylum Cnidaria) which include Zoanthids (Order Zoanthidea), Octocorals (Order Alcyonacea), Hydroids (Order Hydroida) and Anemones (Order Actiniaria). Ascideans (Phylum Chordata, Class Ascidiacea) have also been included in the invertebrate analysis, due to their similar growth habit, although they are more closely related to vertebrates. Data was collated from the video transects for this region to examine the cover of these species by depth on both cobble and reef habitat. Reef habitat had a higher invertebrate cover than on the cobble habitat. In both cases invertebrate cover was very low in the 0 – 10 m depth range with less than 5 % cover. Below 10 m depth the invertebrate cover increased as a result of decreased algal cover. In both cases greater than 50 % invertebrate cover was reached at below 20 m depth. On both reef and cobble substrates sponges were the dominant component of the invertebrate community across all depth ranges.

The cover of invertebrates on reef was generally very high below 20 m depth, with between 68 %

and 100 % cover (Figure 128). The invertebrate community was dominated by sponges in all depths below 10 m depth. Sponges comprised over 50 % of reef cover between 25 and 45 m depth and again below 55 m depth. Octocorals were the next most common group, with 18 % to 26 % cover between 20 and 50 m depth. The octocorals observed were a mix of soft corals and gorgonians. Low amounts of anemones were present in depth between 15 and 55 m depth, ranging from 5 – 15 % cover. Ascidians were present in similar quantities in the deeper water between 40 and 50 m depth. Bryozoans were also present in low quantities between 20 and 35 m depth, with cover between 5 and 7 %. Hydroids were present in trace amounts between 15 and 40 m depth.

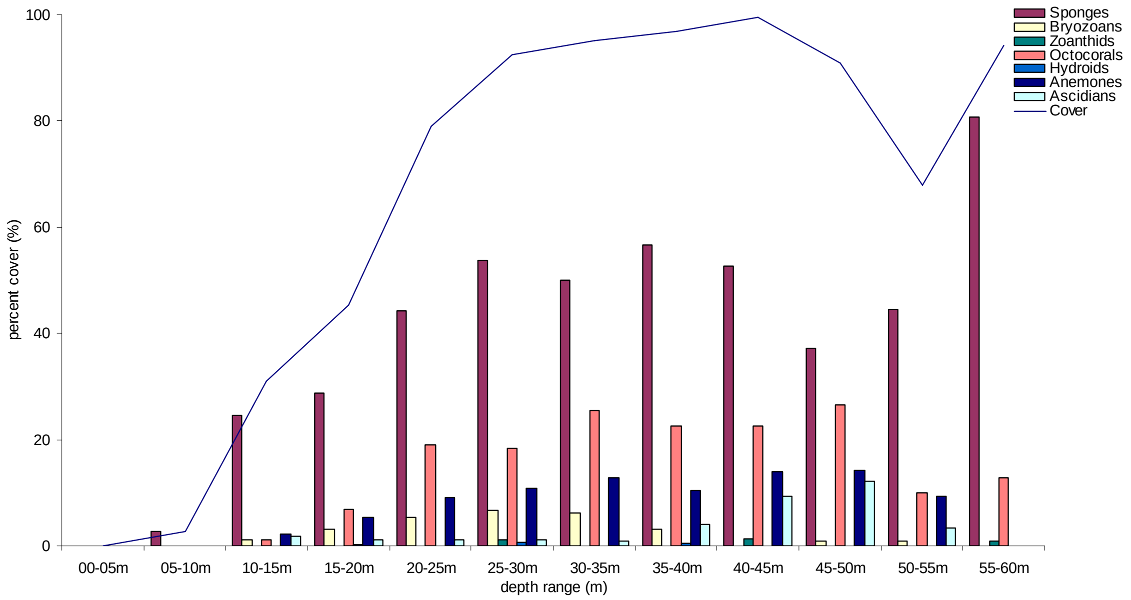

Figure 128. Average cover of dominant invertebrate groups on reef substrate divided by 5 m depth bins for the Tamar River.

The cover of invertebrates was lower on cobble habitat than for reef habitat, possibly due to the less stable nature of cobble habitat. Total invertebrate cover varied between 30 % and 53 % between 15 and 60 m depth, in all these depth ranges there was little algal growth, and as such the invertebrate community was dominant. As for the reef substrate, the invertebrate community on the cobble substrate was dominated by sponges across all depth ranges, with sponge cover from 20 to 36 % between 20 and 60 m depth (Figure 129). Octocorals were the next most dominant group with between 5 % and 18 % cover between 15 and 60 m depth. On the cobble habitat the octocorals were dominated by soft corals. Small amounts of bryozoan cover (4 % – 8 %) were observed between 15 and 25 m depth and again in 35 – 40 m depth. Small amounts of ascidians were present between 20 and 35 m depth. Hydroids were present in trace amounts in 15 to 30 m depth.

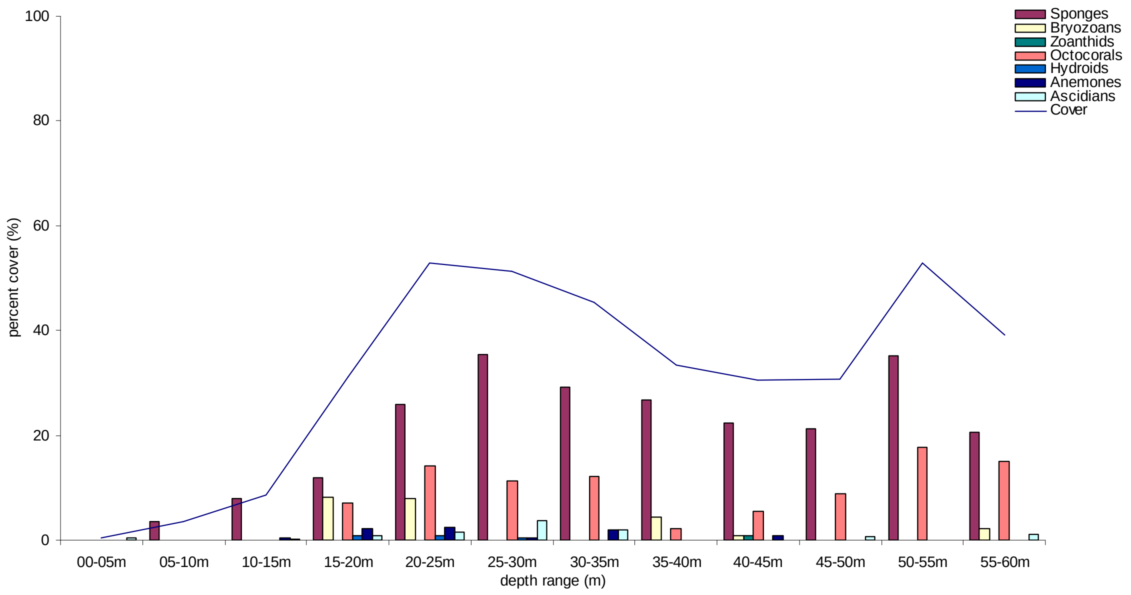

Figure 129. Average cover of dominant invertebrate groups on reef substrate divided by 5 m depth bins for the Tamar River.

3.3.3. Section B

3.3.3.1. Habitat Distribution

Section B of the Tamar Estuary subregion analysis extended from the Batman Bridge to Launceston. The survey area covered a region of 4,479.27ha (4.4 km2) (Table 33). The dominant habitat type was silt habitat (87.15%) with very small areas of reef and rice grass into the intertidal zone. Section B of the estuary did not support any sand or seagrass habitat. The accuracy assessment for Section B was 97.3% (Table 34) with some uncertainty in the boundary identification between cobble and silt habitat. This insignificant result could be explained due to the miscalculation of boundaries in interpolating the acoustic points into continuous polygons.

Table 33. Distribution of habitats by depth in Section B of the Tamar Estuary.

DEPTH	SUBSTRATE						TOTAL
	Cobble (ha)	Reef (ha)	Sand (ha)	Seagrass (ha)	Silt (ha)	Rice Grass (ha)	
0-5	4.53	6.90	0.00	0.00	2257.29	422.78	**2691.51**
5-10	0.36	0.32	0.00	0.00	913.01	1.21	**914.89**
10-15	3.93	1.25	0.00	0.00	420.96	0.00	**426.14**
15-20	0.88	8.23	0.00	0.00	226.67	0.00	**235.77**
20-25	0.00	23.70	0.00	0.00	68.01	0.00	**91.71**
25-30	0.00	63.98	0.00	0.00	17.71	0.00	**81.69**
30+	0.00	37.54	0.00	0.00	0.00	0.00	**37.54**
TOTAL	**9.70**	**141.93**	**0.00**	**0.00**	**3903.64**	**423.99**	**4479.26**
Percentage	*0.22%*	*3.17%*	*0.00%*	*0.00%*	*87.15%*	*9.47%*	

Table 34. Accuracy assessment of habitat in Section B of the Tamar Estuary.

Video Class	Map Class					User Total	User Accuracy
	Cobble	Reef	Sand	Seagrass	Silt		
Cobble	0	0	0	0	10	**10**	0.00%
Reef	0	0	0	0	81	**81**	0.00%
Sand	0	0	0	0	0	**0**	0.00%
Seagrass	0	0	0	0	0	**0**	0.00%
Silt	0	0	0	0	626	**626**	100.00%
Producer Total	**0**	**0**	**0**	**0**	**717**	**717**	
Producer Accuracy	0.00%	0.00%	0.00%	0.00%	87.31%		
Accuracy:	87.31%						
Kappa:	0.000						

3.3.3.2 Seagrass Distribution Section B

Section B, from the Batman Bridge to Launceston, did not contain any sub-tidal seagrass beds.

3.3.3.3 Algal Distribution Section B

The reef in section B, from the Batman Bridge to Launceston, did not support any significant (mappable) beds of sub tidal algae.

3.3.4. Tamar Estuary Region Summary

Of the 11,729 ha (117 km2) of seabed in the Tamar Estuary surveyed 62% of the habitat was silt, 19% reef and the remaining habitat cobble, sand, seagrass and ricegrass (Table 35). Seagrass habitat was detected to 15 m water depths and rice grass out to 10 m. Of the total area of habitat surveyed 5902 ha of the 11,729 ha was sampled in the 0-5 mm depth contour. Tables 35 – 37 describe the distribution of habitats by subsection for the entire estuary.

Table 35. Distribution of habitats by depth for the Tamar Estuary.

DEPTH	SUBSTRATE						TOTAL
	Cobble (ha)	Reef (ha)	Sand (ha)	Seagrass (ha)	Silt (ha)	Rice Grass (ha)	
0-5	7.12	495.58	482.06	313.88	4166.98	436.57	**5902.19**
5-10	22.42	344.32	120.10	0.71	1476.35	1.21	**1965.11**
10-15	55.99	509.45	86.99	28.92	746.36	0.00	**1427.71**
15-20	110.41	394.82	41.29	0.00	522.22	0.00	**1068.74**
20-25	227.41	129.24	22.91	0.00	238.58	0.00	**618.15**
25-30	74.01	163.50	2.62	0.00	113.80	0.00	**353.93**
30+	120.67	261.49	1.47	0.00	10.03	0.00	**393.66**
TOTAL	**618.04**	**2298.40**	**757.43**	**343.51**	**7274.33**	**437.78**	**11729.49**
Percentage	*5.27%*	*19.60%*	*6.46%*	*2.93%*	*62.02%*	*3.73%*	

Table 36. Distribution of habitats by reporting subsection for the Tamar Estuary.

HABITAT	SECTION		TOTAL
	A	B	
Cobble	608.34	9.70	618.04
Reef	2,156.48	141.93	2,298.40
Sand	757.43	0.00	757.43
Seagrass	343.51	0.00	343.51
Silt	3,370.69	3,903.64	7,274.33
Rice Grass	13.78	423.99	437.78
TOTAL	7,250.23	4,479.26	11,729.49

Table 37. Percentage of habitat area total by reporting section in the Tamar Estuary.

HABITAT	SECTION		TOTAL
	A	B	
Cobble	5.2%	0.1%	5.3%
Reef	18.4%	1.2%	19.6%
Sand	6.7%	0.0%	6.7%
Seagrass	2.7%	0.0%	2.7%
Silt	28.7%	33.3%	62.0%
Rice Grass	0.1%	3.6%	3.7%
TOTAL	61.8%	38.2%	100.0%

The uncertainty analysis of the Tamar Estuary (Table 38) shows an overall accuracy result of 69.24%. The lowest producer’s accuracy was generated for cobble habitat. This could be explained by the difficulty in determining the boundaries of the cobble habitat with reef, sand and even silt where the boundaries are gradual transitions and not crisp boundaries. Sand and silt habitats were also at times confused in the cartography which may be explained by the sampling design of the across depth transects where the transition zones from sand to silt were so gradual it was impossible to identify from the acoustics the exact location of the boundary and even more difficult to determine from the video analysis if the sediment was indeed sand or silt.

Table 38. Error analysis for all habitat types within the Tamar Estuary.

Video Class	Map Class					User Total	User Accuracy
	Cobble	Reef	Sand	Seagrass	Silt		
Cobble	1420	1171	159	3	324	**3077**	46.15%
Reef	985	6170	72	0	324	**7551**	81.71%
Sand	235	693	805	64	0	**1797**	44.80%
Seagrass	0	360	337	478	142	**1317**	36.29%
Silt	206	76	0	0	2724	**3006**	90.62%
Producer Total	**2846**	**8470**	**1373**	**545**	**3514**	**16748**	
Producer Accuracy	49.89%	72.85%	58.63%	87.71%	77.52%		
Accuracy:	69.24%						
Kappa:	0.555						

3.3.5. Reef and Cobble Profile

The Tamar River was dominated by low profile reef, with between 72 and 81 % of all reef classified as low profile (Figure 130). Medium profile reef accounted for between 18 and 28 % of the reef, with high profile less than 1 %. There was a slightly higher proportion of low profile reef and a slightly lower proportion of medium in section A compared to section B. Section B however had significantly less reef overall, with the majority of that occurring in the immediate vicinity south of the Batman Bridge. Here the steep sides of the river channel account for the slightly higher proportion of medium profile reef.

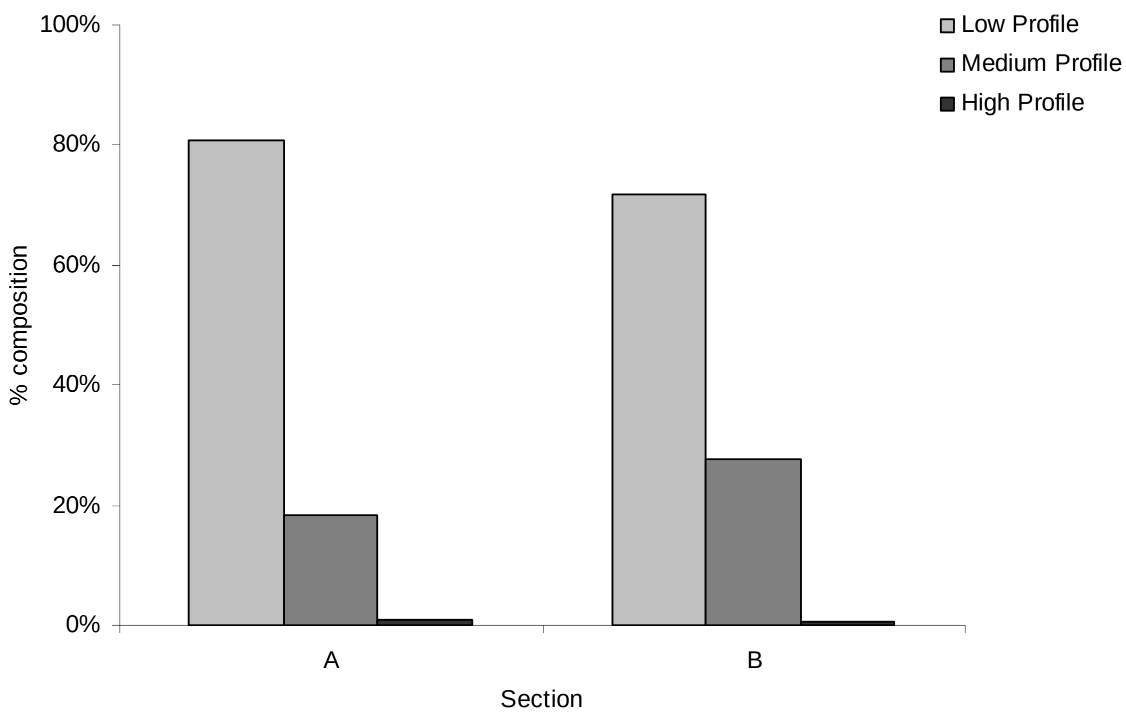

Figure 130. Percentage composition of low profile reef (< 1 m rise and fall), medium profile reef (1 – 4 m rise and fall) and high profile reef (> 4 m rise and fall) for reef substrate by section in the Tamar River.

The profile of cobble in the Tamar River was dominated by low profile cobble. Low profile cobble accounted for between 93 % and 95 % of all cobble within the Tamar River (Figure 131). Medium profile cobble accounted for a further 5 to 6 % of all cobble. This relatively high proportion of medium profile cobble may be a reflection of the steep sides of the main river channel. A small amount of high profile cobble was also observed in section A.

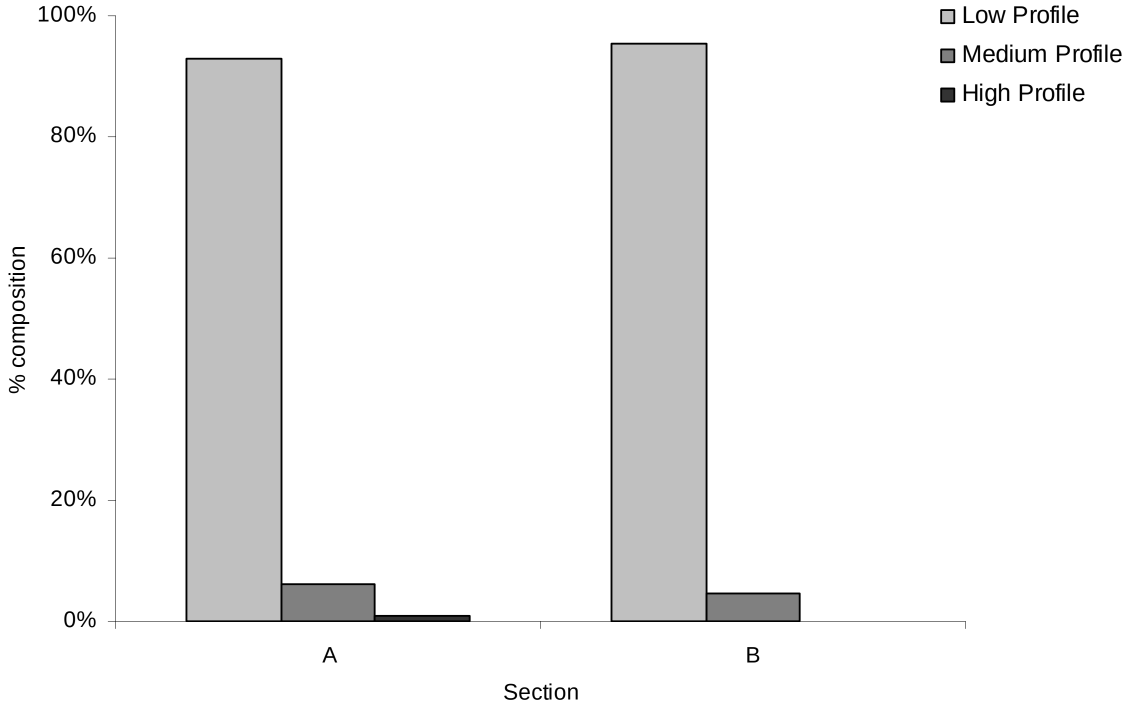

Figure 131. Percentage composition of low profile cobble (< 1 m rise and fall), medium profile cobble (1 – 4 m rise and fall) and high profile cobble (> 4 m rise and fall) for cobble substrate by section in the Tamar River.

3.3.6. Particle Size Analysis

The particle size of sediment cores taken throughout the Tamar River showed a high degree of variation along the length of the river. In the upper end of the Tamar River, south of Blackwall, the sediments were dominated by silt, with some fine sand around Nelsons Shoal (Figure 132 -Figure 139). Between Blackwall and Beauty point the sediments were predominantly very fine to fine sand, with occasional medium sand (Figure 140 -Figure 157). From Beauty Point to the Mouth of the Tamar the sediments were dominated by medium to coarse sands, and very fine to fine gravel, with silt in the sheltered backwater behind Green Island (Figure 154 -Figure 165).

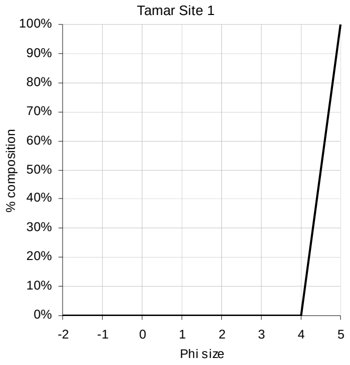

Figure 132. Tamar Site 1, Phi 50% > 4.5, Wentworth classification = silt.

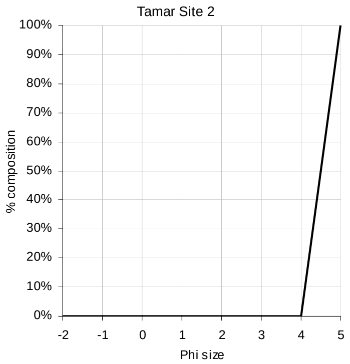

Figure 133. Tamar Site 2, Phi 50% > 4.5, Wentworth classification = silt.

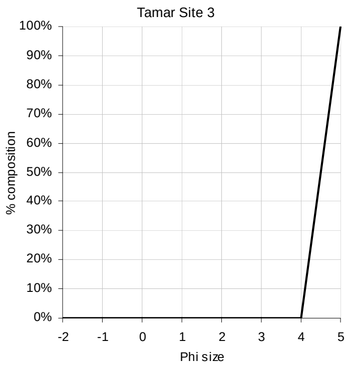

Figure 134. Tamar Site 3, Phi 50% > 4.5, Wentworth classification = silt.

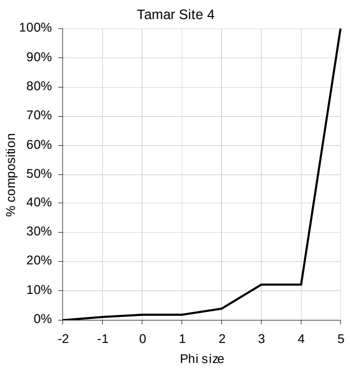

Figure 135. Tamar Site 4, Phi 50% > 4.5, Wentworth classification = silt.

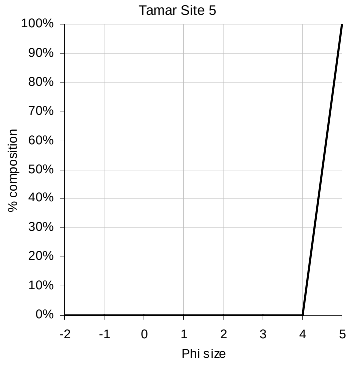

Figure 136. Tamar Site 5, Phi 50% > 4.5, Wentworth classification = silt.

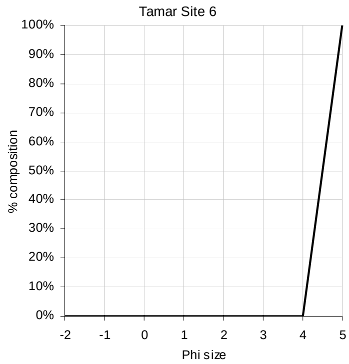

Figure 137. Tamar Site 6, Phi 50% > 4.5, Wentworth classification = silt.

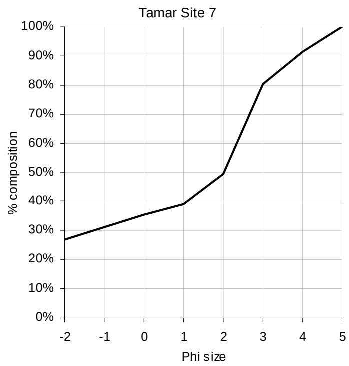

Figure 138. Tamar Site 7, Phi 50% = 2.0, Wentworth classification = fine sand.

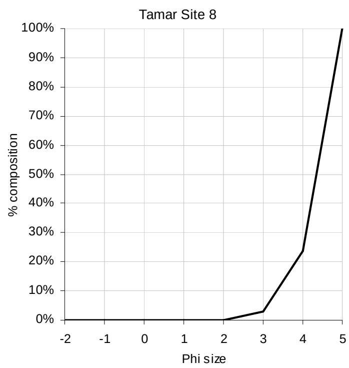

Figure 139. Tamar Site 8, Phi 50% = 4.3, Wentworth classification = silt.

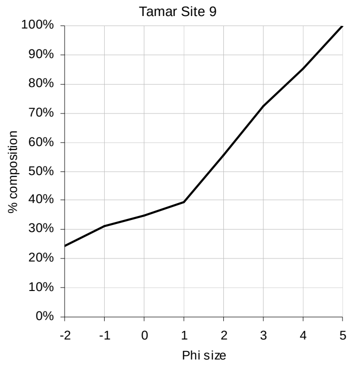

Figure 140. Tamar Site 9, Phi 50% = 1.7, Wentworth classification = medium sand.

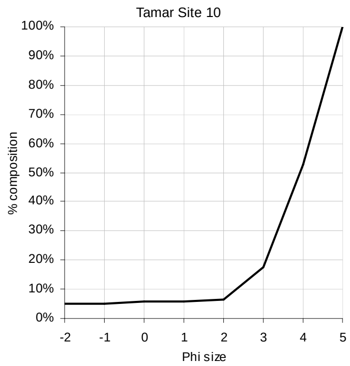

Figure 141. Tamar Site 10, Phi 50% = 3.9, Wentworth classification = very fine sand.

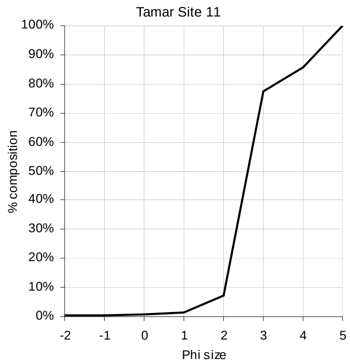

Figure 142. Tamar Site 11, Phi 50% = 2.6, Wentworth classification = fine sand.

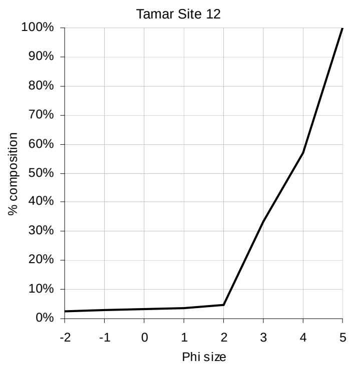

Figure 143. Tamar Site 12, Phi 50% = 3.7, Wentworth classification = very fine sand.

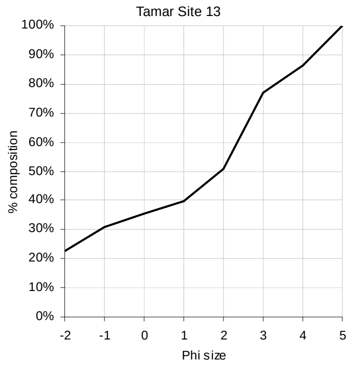

Figure 144. Tamar Site 13, Phi 50% = 1.9, Wentworth classification = medium sand.

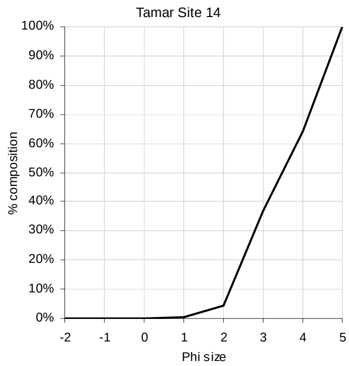

Figure 145. Tamar Site 14, Phi 50% = 3.5, Wentworth classification = very fine sand.

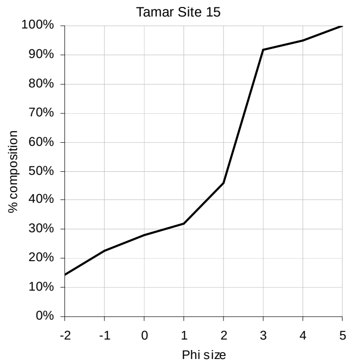

Figure 146. Tamar Site 15, Phi 50% = 2.1, Wentworth classification = fine sand.

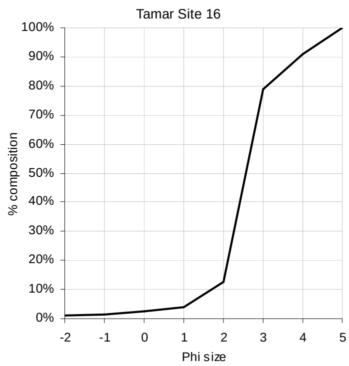

Figure 147. Tamar Site 16, Phi 50% = 2.6, Wentworth classification = fine sand.

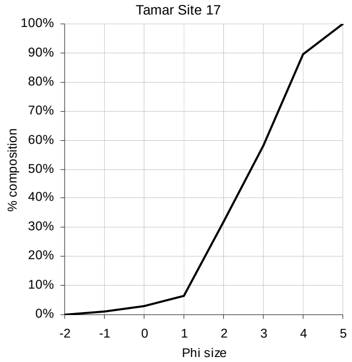

Figure 148. Tamar Site 17, Phi 50% = 2.7, Wentworth classification = fine sand.

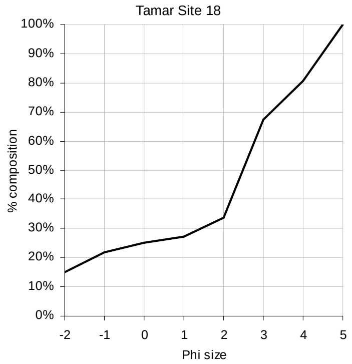

Figure 149. Tamar Site 18, Phi 50% = 2.5, Wentworth classification = fine sand.

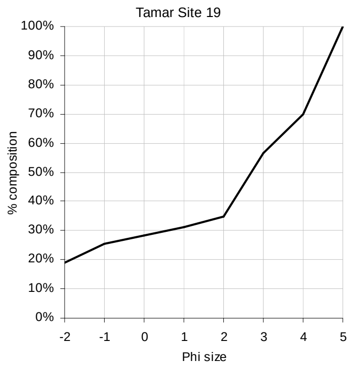

Figure 150. Tamar Site 19, Phi 50% = 2.7, Wentworth classification = fine sand.

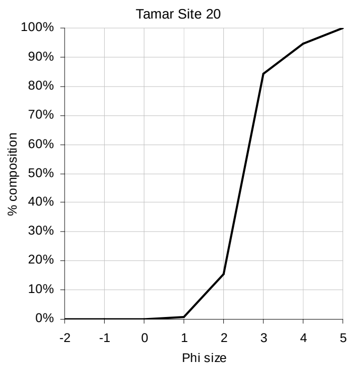

Figure 151. Tamar Site 20, Phi 50% = 2.5, Wentworth classification = fine sand.

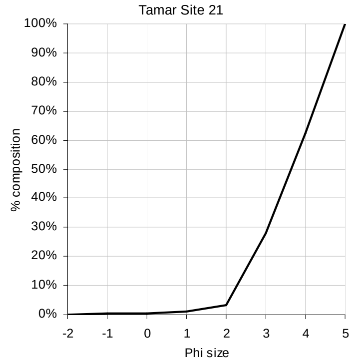

Figure 152. Tamar Site 21, Phi 50% = 3.6, Wentworth classification = very fine sand.

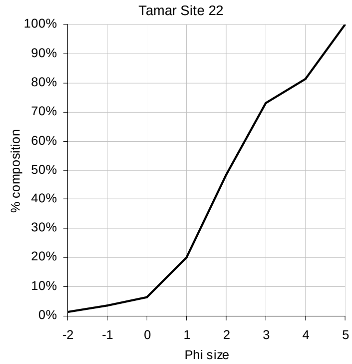

Figure 153. Tamar Site 22, Phi 50% = 2.1, Wentworth classification = fine sand.

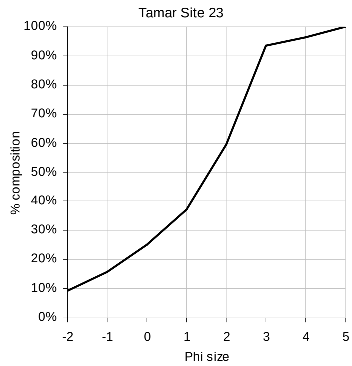

Figure 154. Tamar Site 23, Phi 50% = 1.6, Wentworth classification = medium sand.

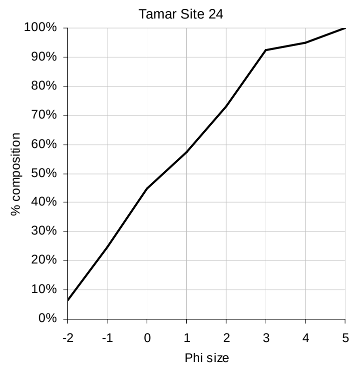

Figure 155. Tamar Site 24, Phi 50% = 0.4, Wentworth classification = coarse sand.

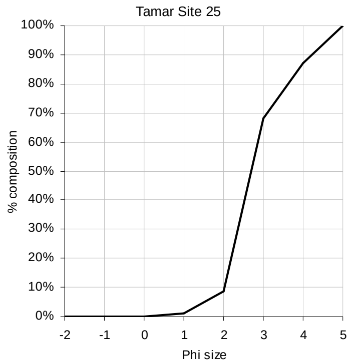

Figure 156. Tamar Site 25, Phi 50% = 2.7, Wentworth classification = fine sand.

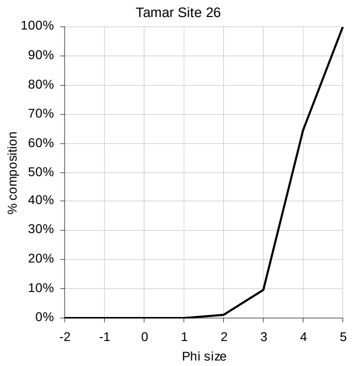

Figure 157. Tamar Site 26, Phi 50% = 3.7, Wentworth classification = very fine sand.

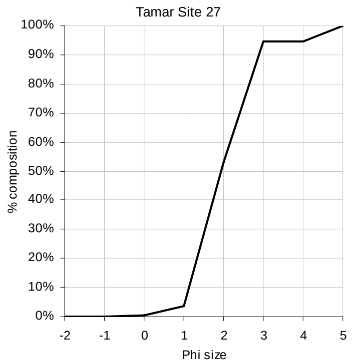

Figure 158. Tamar Site 27, Phi 50% = 1.9, Wentworth classification = medium sand.

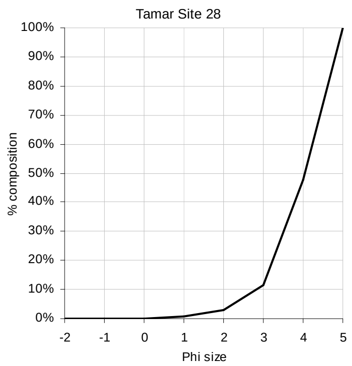

Figure 159. Tamar Site 28, Phi 50% = 4.0, Wentworth classification = silt.

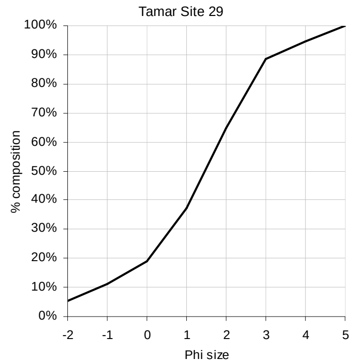

Figure 160. Tamar Site 29, Phi 50% = 1.5, Wentworth classification = medium sand.

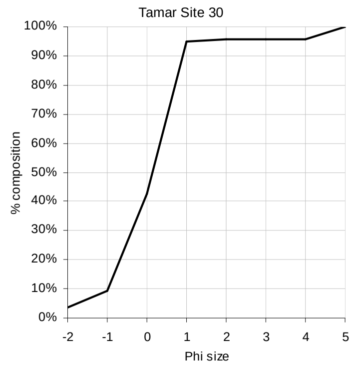

Figure 161. Tamar Site 30, Phi 50% = 0.1, Wentworth classification = coarse sand.

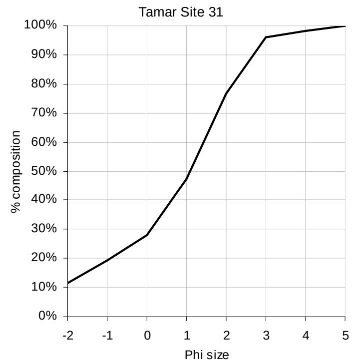

Figure 162. Tamar Site 31, Phi 50% = 1.1, Wentworth classification = medium sand.

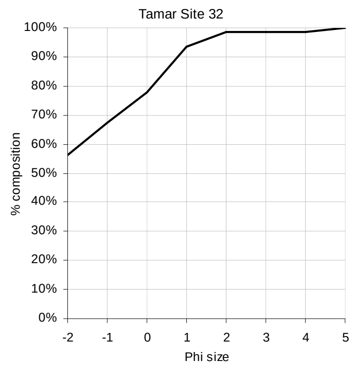

Figure 163. Tamar Site 32, Phi 50% = -2.5, Wentworth classification = fine gravel.

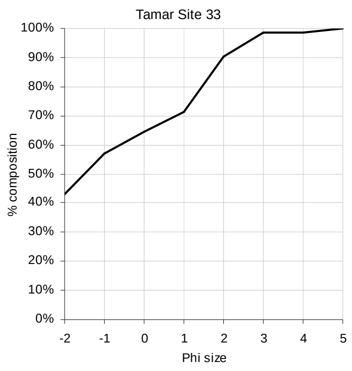

Figure 164. Tamar Site 33, Phi 50% = -1.5, Wentworth classification = very fine gravel.

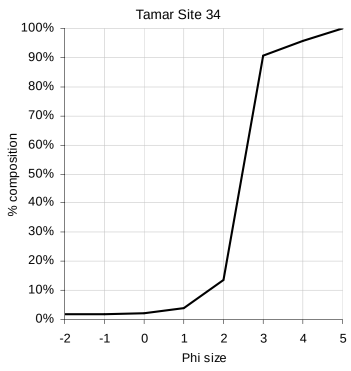

Figure 165. Tamar Site 34, Phi 50% = 2.5, Wentworth classification = fine sand

3.4. Orielton Lagoon

Orielton Lagoon is situation in the NRM South region and has been overlooked in the past few years of seabed mapping within the region. Never the less it is a very important RAMSAR listed site for breeding shorebirds. The area surveyed within Orielton Lagoon covered an area of 255.66 ha (2.5 km^2) (Figure 166). The maximum depth of Orielton Lagoon was 1.4 m (Figure 167) and five habitat types were identified; reef, cobble, sand, silt and seagrass.

Figure 166. Location map showing area mapped in Orielton Lagoon.

3.4.1. Bathymetry of Orielton Lagoon

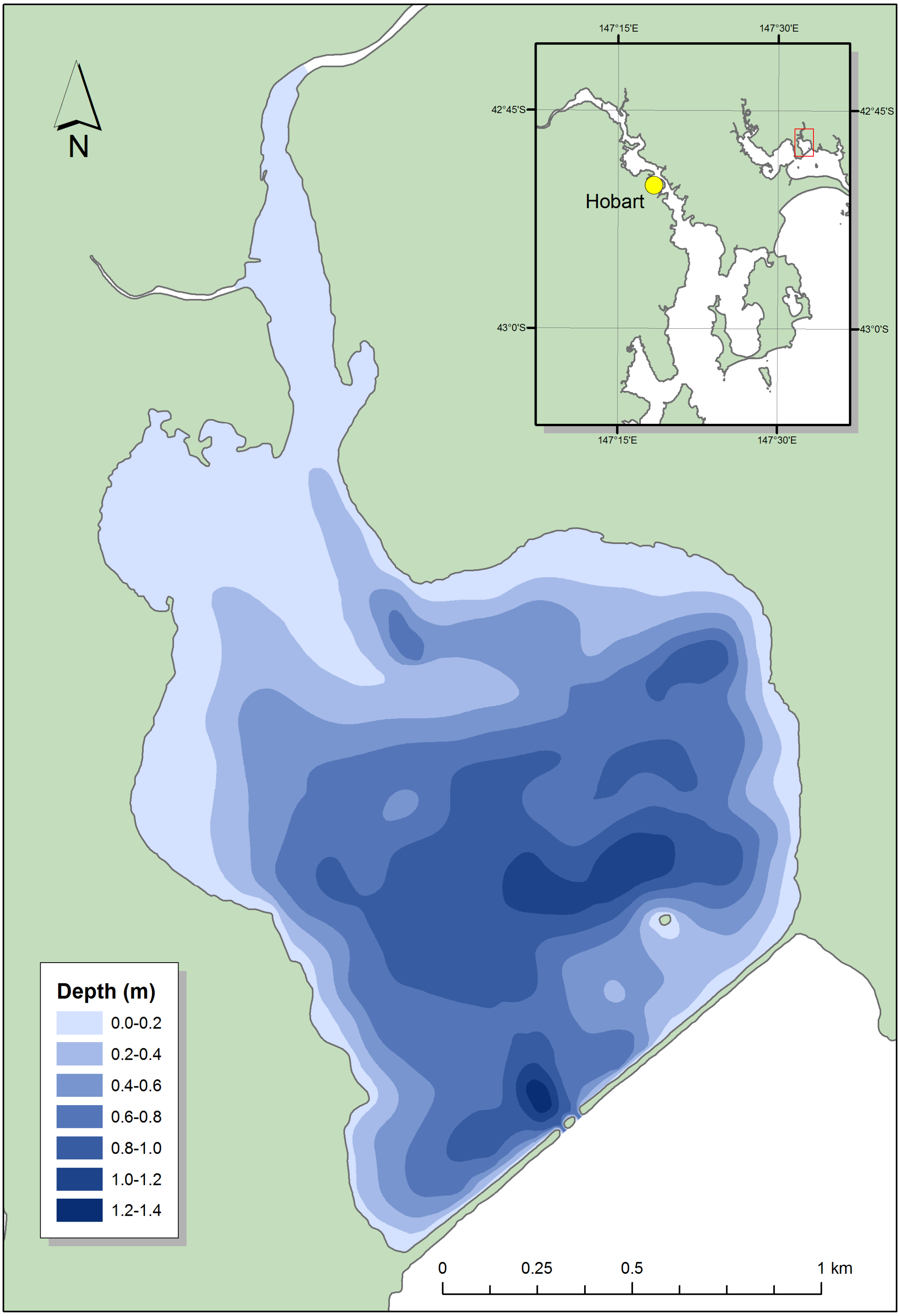

Figure 167. Map of bathymetry interpolated from acoustic data.

3.4.2. Orielton Lagoon

3.4.2.1. Habitat Distribution

A total of 255.66 ha or (2.5 km^2) of seabed was mapped within Orielton Lagoon (Table 39). The dominant habitat type was silt with sand habitat occurring on the western side of the Lagoon. A small area of rocky reef (3.41%) and cobble habitat (0.25%) were present on the eastern shoreline. There was a small amount of seagrass in the tidal exchange culvert on the southern side of the lagoon, however this was not a significant amount.

The accuracy assessment of Orielton Lagoon showed some uncertainty in detecting the boundaries of the rocky reef habitat (Table 40). Due to the shallow water of Orielton Lagoon parts of the inshore habitat mapping regime required sampling to be completed with a sea kayak, a Non Differential GPS and visual mapping techniques using Seabed Mapper. The interpolation of this data has led to some confusion in identifying the very shallow boundaries.

Table 39. Percentage of habitat area of total for Orielton Lagoon.

	Area (ha)	%
Cobble	0.63	0.25%
Reef	8.71	3.41%
Sand	51.15	20.01%
Silt	195.18	76.34%
TOTAL	**255.66**	

Table 40. Error analysis for all habitat types within Orielton Lagoon.

Video Class	Map Class					User Total	User Accuracy
	Cobble	Reef	Sand	Seagrass	Silt		
Cobble	0	0	0	0	0	**0**	0.00%
Reef	0	297	0	0	0	**297**	100.00%
Sand	0	0	0	0	0	**0**	0.00%
Seagrass	0	0	0	0	0	**0**	0.00%
Silt	0	104	0	0	142	**246**	57.72%
Producer Total	**0**	**401**	**0**	**0**	**142**	**543**	
Producer Accuracy	0.00%	74.06%	0.00%	0.00%	100.00%		
Accuracy:	80.85%						
Kappa:	0.599						

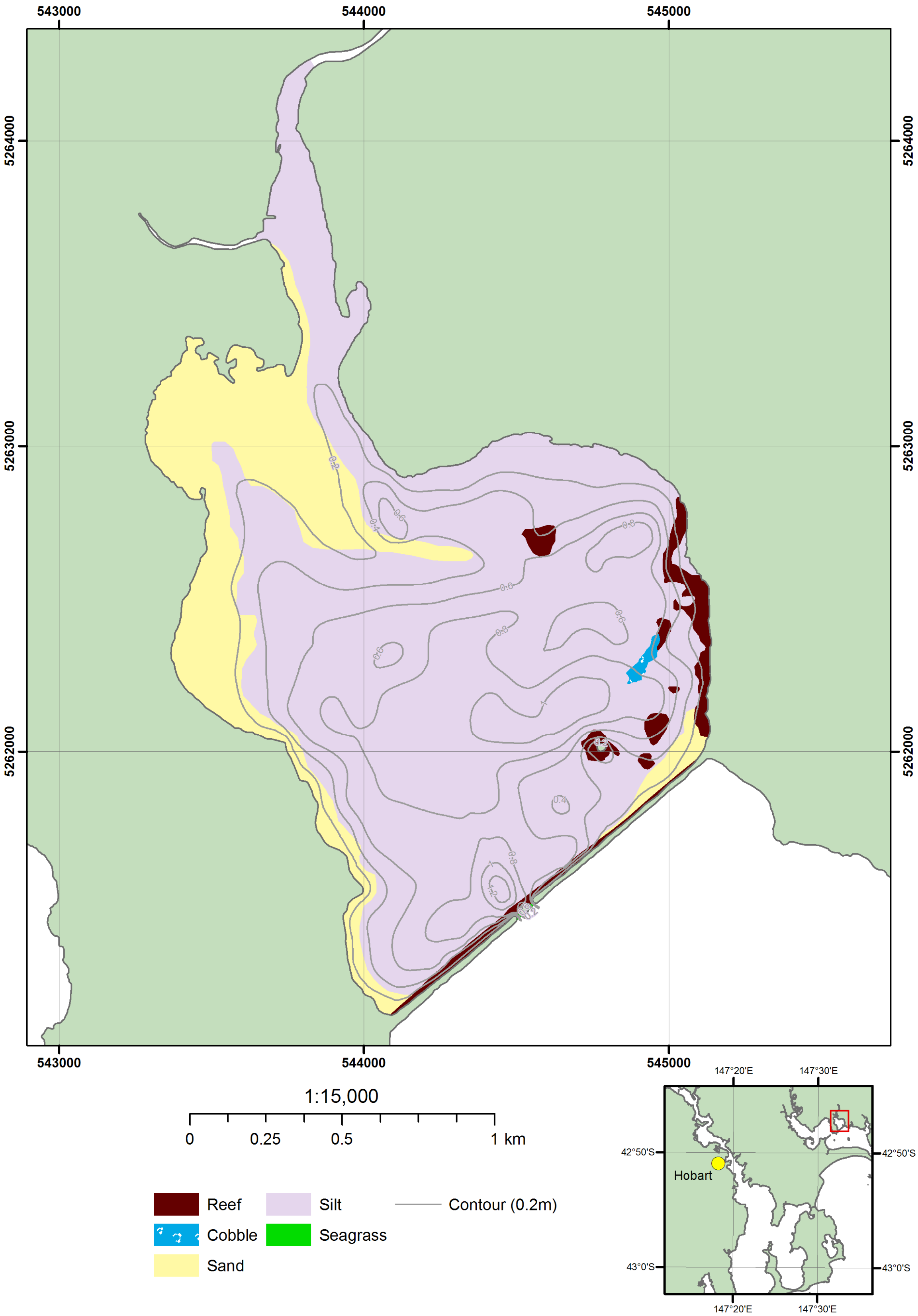

Figure 168. Map of habitats and bathymetry for Orielton Lagoon.

3.4.2.2 Seagrass Distribution Section A

A very small bed of seagrass was observed at the opening of the causeway into Pittwater.

3.4.2.3 Algal Distribution Section A

Due to the shallow depths of Orielton Lagoon (< 2 m deep) and the small amount of rocky substrate, the algal analysis in Orielton Lagoon is presented as a single depth region. Algal cover was generally high at around 88 % cover. The algal cover was dominated by two groups, Red algae (60 %) and *Codium fragile* (28 %). The red algae consisted of a mix of species including large amounts of *Polysiphonia* sp.

3.4.2.4 Particle Size Analysis

The particle size in Orielton Lagoon was dominated by fine sand, with a median particle size of between 2.5 and 2.8 on the Phi scale (Figure 169 -Figure 171 and Figure 173). In the slightly deeper basin of Orielton Lagoon the sediment was dominated by silt, with a median particle size of 4.1 on the Phi scale (Figure 172).

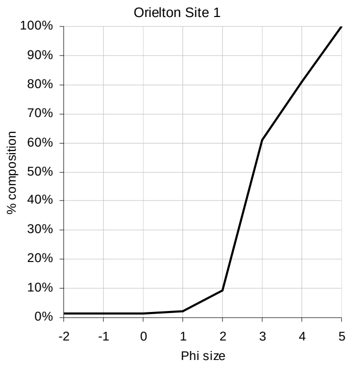

Figure 169. Orielton Site 1, Phi 50% = 2.8, Wentworth classification = fine sand.

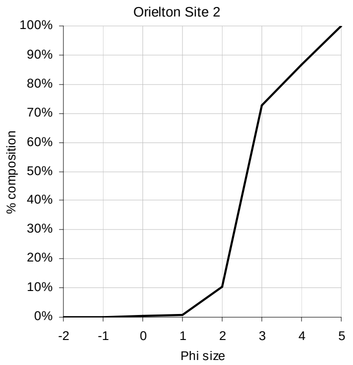

Figure 170. Orielton Site 2, Phi 50% = 2.6, Wentworth classification = fine sand.

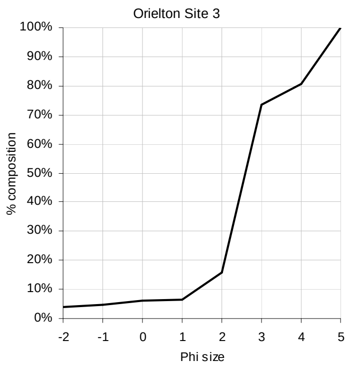

Figure 171. Orielton Site 3, Phi 50% = 2.6, Wentworth classification = fine sand.

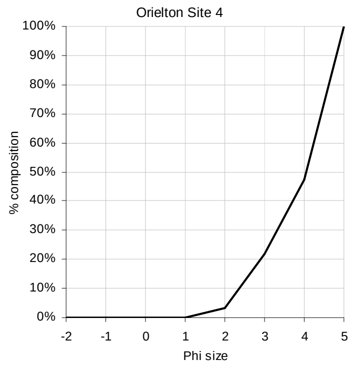

Figure 172. Orielton Site 4, Phi 50% = 4.1, Wentworth classification = silt.

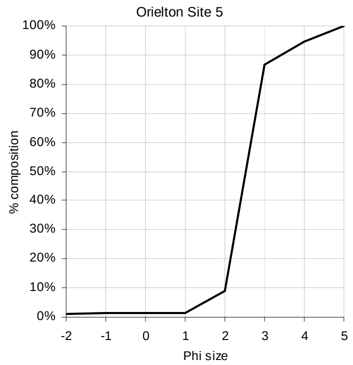

Figure 173. Orielton Site 5, Phi 50% = 2.5, Wentworth classification = fine sand.

3.5. Moulting Lagoon

Moulting Lagoon on the East Coast of Tasmania within the NRM South region was identified as a significant gap requiring mapping in the 'Mapping the Gaps' research project. The Great Swanport region below the entrance channel to Moulting Lagoon was mapped in 2005 as part of a Southern NRM mapping initiative (Mount et al, 2005) and this data builds onto that existing dataset. The total area of seabed within Moulting Lagoon mapped was 2880.56ha (28.8 km^2) (Figure 174). Four habitat classes were identified including Aquatic macrophytes, *Ruppia*, seagrass and silt (Figures 175-178). The maximum depth identified in Moulting Lagoon was 5 m occurring in the entrance channel with the majority of the Lagoon being under 2 m water depth (Figure 179).

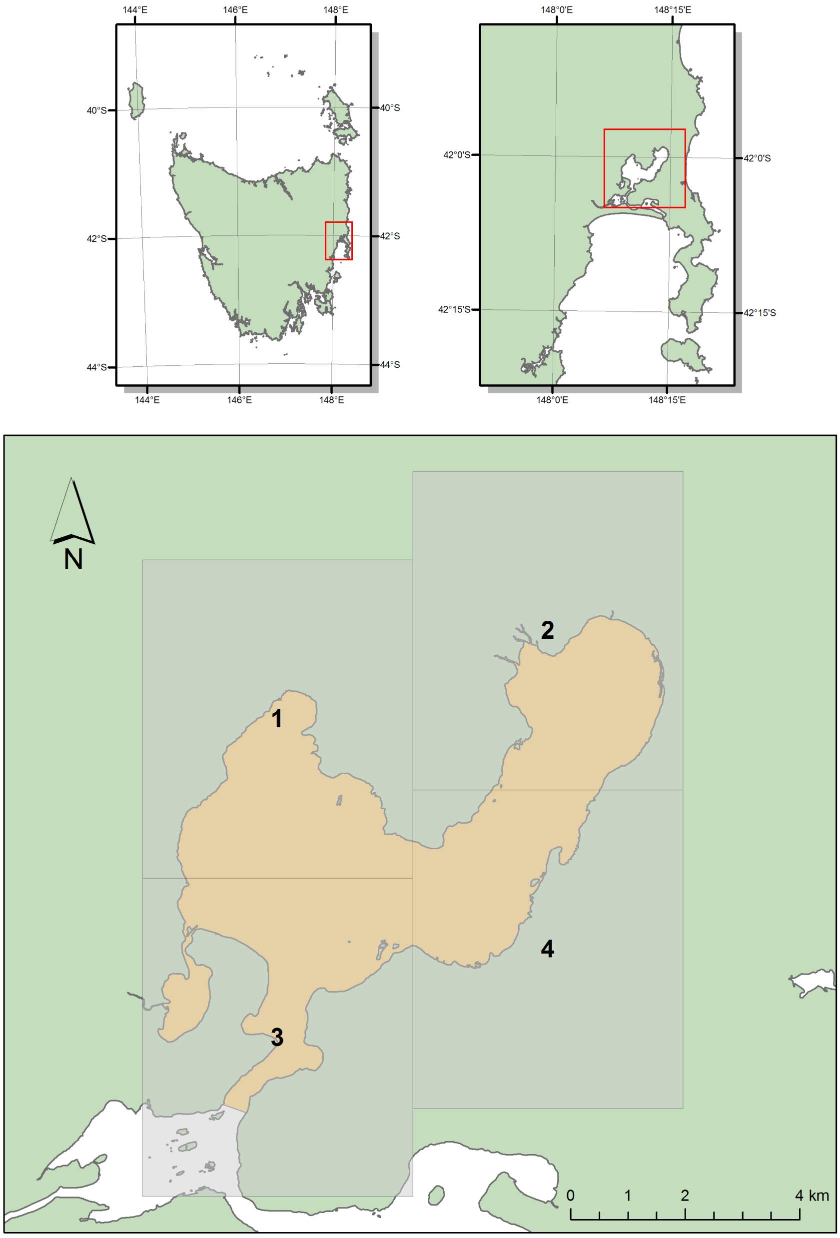

Figure 174. Location map and index map of 1:25 000 habitat maps for Moulting Lagoon map series.

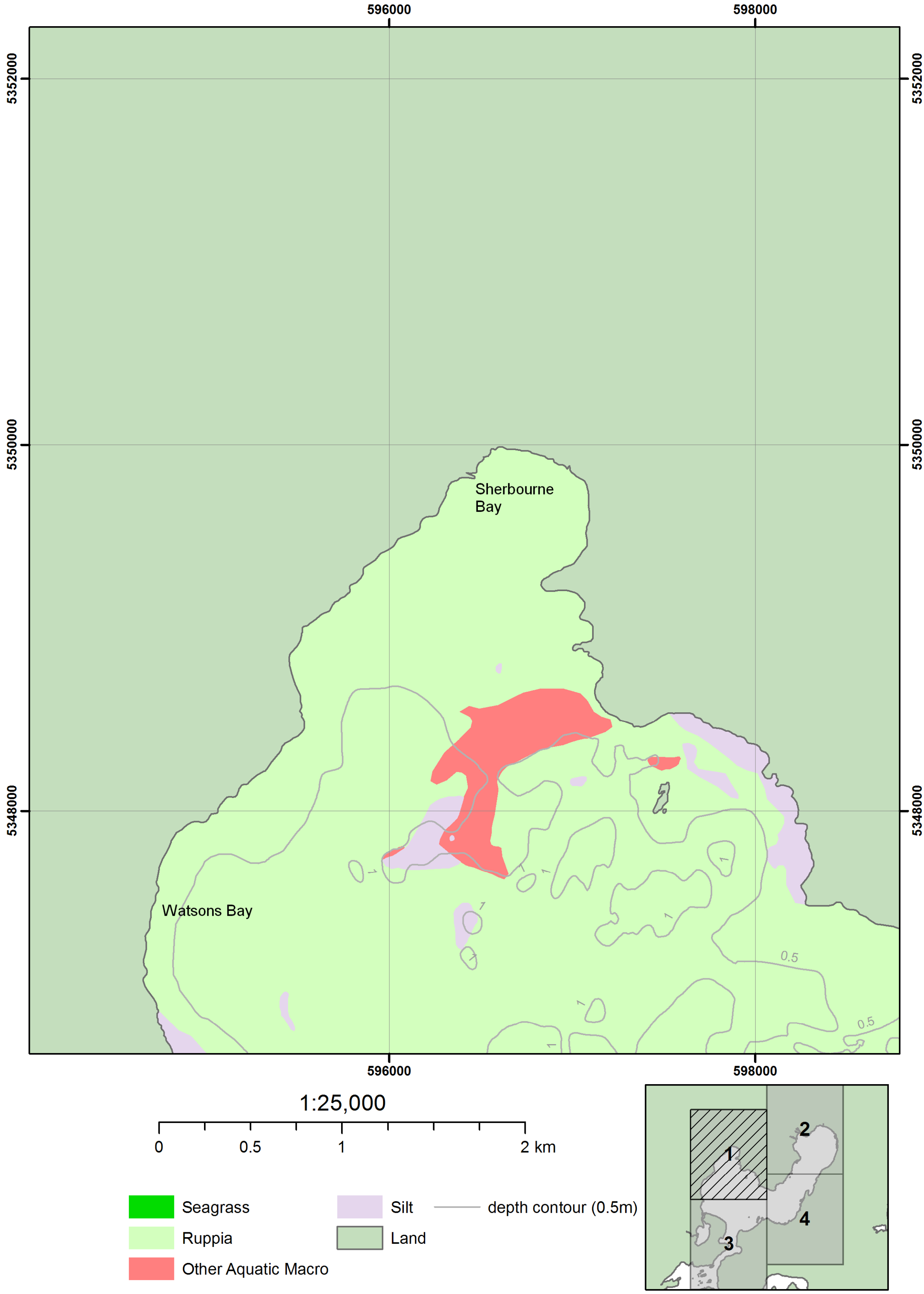

Figure 175. Moulting Lagoon map series map 1 showing bathymetry and habitats in Watsons Bay and Sherbourne Bay.

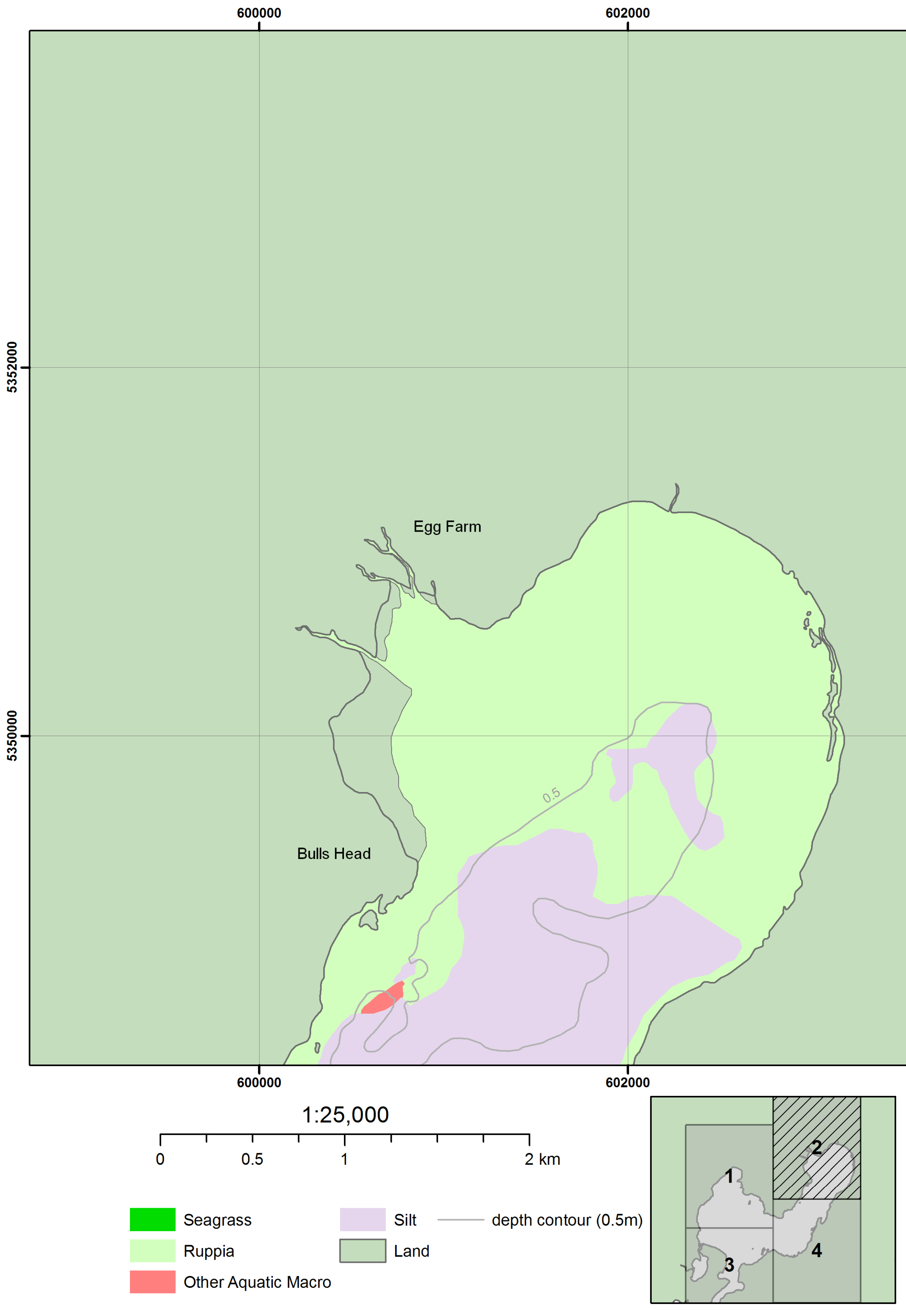

Figure 176. Moulting Lagoon map series map 2 showing bathymetry and habitats at Egg Farm and Bulls Head.

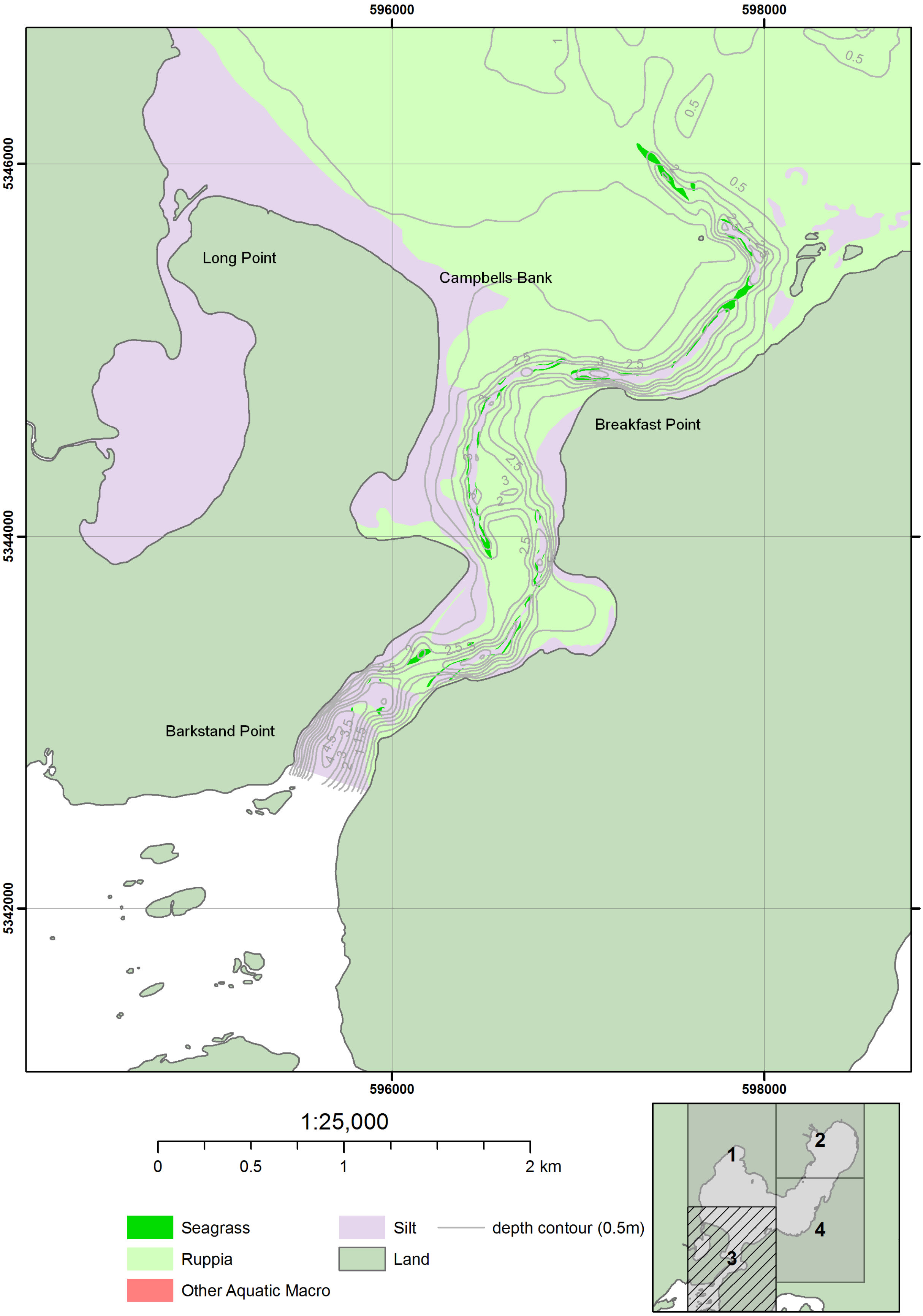

Figure 177. Moulting Lagoon map series map 3 showing bathymetry and habitats between Campbells Bank and Barkstand Point.

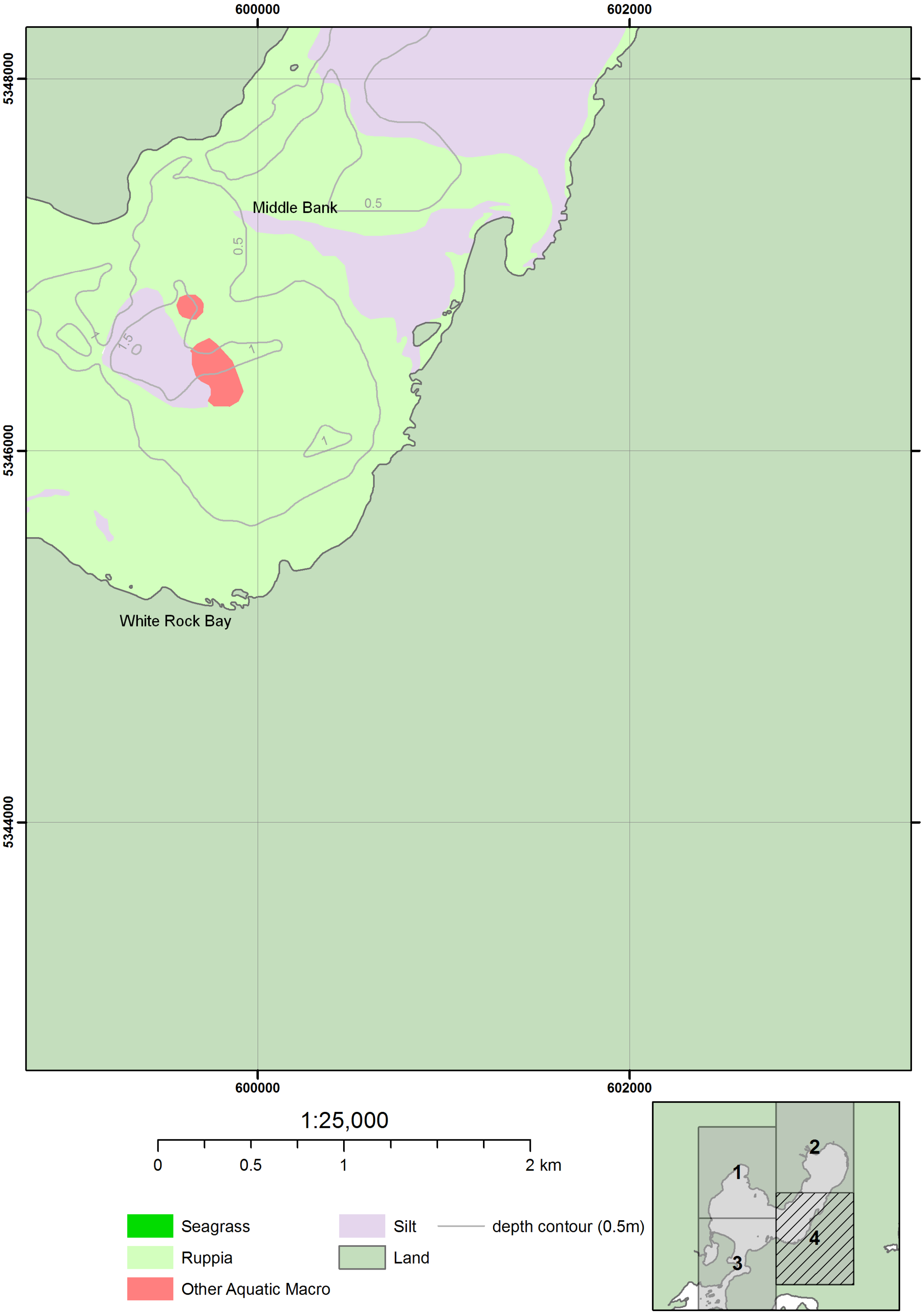

Figure 178. Moulting Lagoon map series map 4 showing bathymetry and habitats in White Rock Bay and Middle Bank.

3.5.1. Bathymetry of Moulting Lagoon

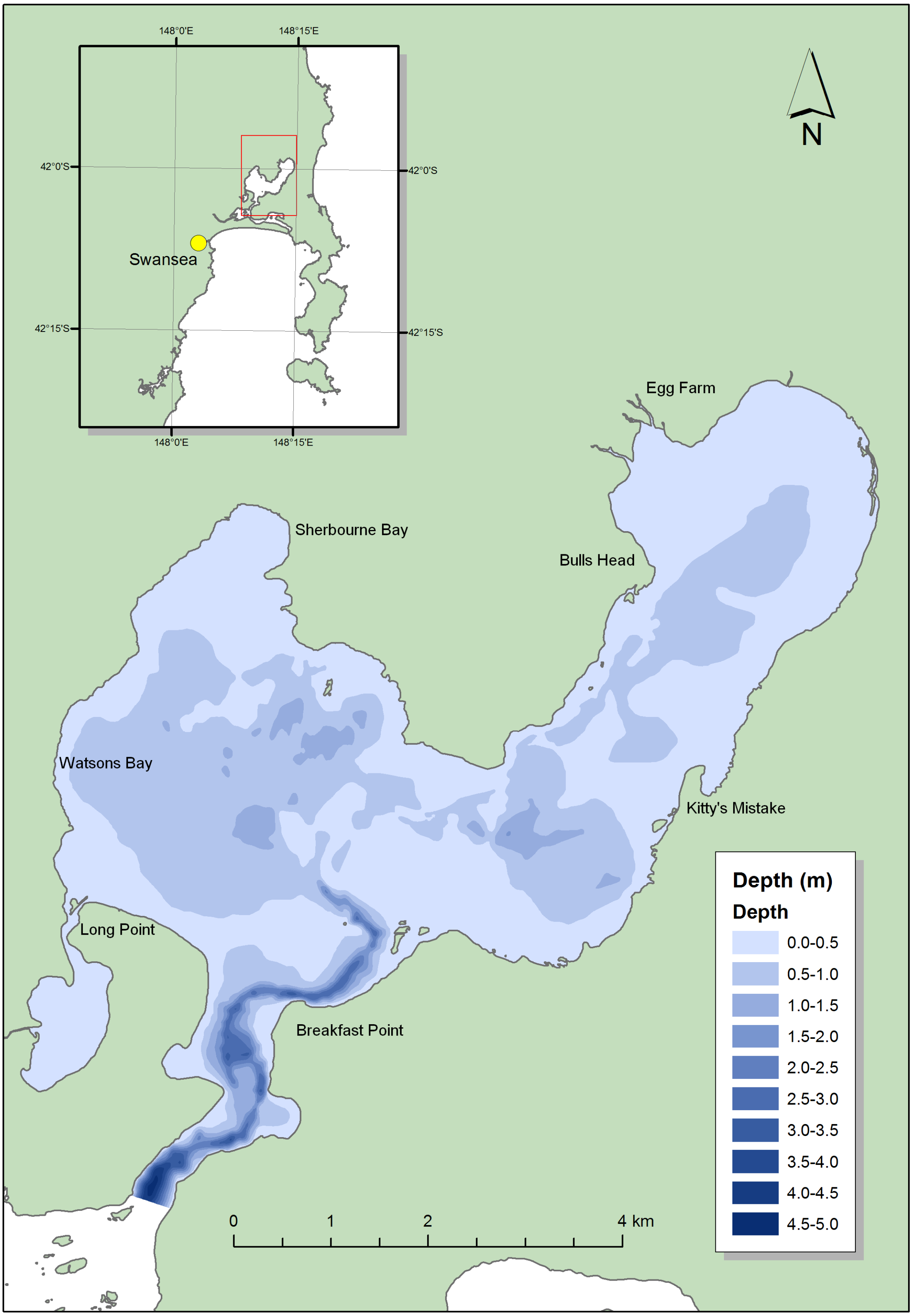

Figure 179. Map showing bathymetry of Moulting Lagoon interpolated from acoustic data.

3.5.2. Moulting Lagoon

3.5.2.1. Habitat Distribution

Of the 2880.56 ha mapped 76% consisted of *Ruppia* habitat on unconsolidated sediment. A further 21 % of the seabed was unvegetated silt with 0.21% seagrass and 1.72% aquatic macrophyte (Table 41).

The uncertainty analysis for Moulting Lagoon (Table 42) gives a very low uncertainty result. This is due to the nature of validating intermixed classes of aquatic vegetation from the video analysis combined with attempting to map mixed vegetation using acoustics. Seagrass had the highest producer's accuracies most likely attributed to the homogeneity and discrete nature of the seagrass occurring in the entrance channel (Figure 177).

Table 41. Percentage of habitat area of total for Moulting Lagoon.

	Area (ha)	%
Aquatic Macro	49.64	1.72%
Ruppia	2,205.66	76.57%
Seagrass	6.19	0.21%
Silt	619.07	21.49%
TOTAL	**2,880.56**	

Table 42. Error analysis for all habitat types within Moulting Lagoon.

Video Class	Map Class					User Total	User Accuracy
	Aquatic Macro	Ruppia	Sand	Silt	Seagrass		
Aquatic Macro	5	93		1		**99**	5.05%
Ruppia	7	287		1	11	**306**	93.79%
Sand						**0**	0.00%
Silt	31	136		53	1	**221**	23.98%
Seagrass		28		186	101	**315**	32.06%
Producer Total	**43**	**544**	**0**	**241**	**113**	**941**	
Producer Accuracy	11.63%	52.76%	0.00%	21.99%	89.38%		
Accuracy:	47.40%						
Kappa:	0.256						

3.5.2.2. Seagrass Distribution

Moulting Lagoon contained a large amount of seagrass and aquatic macrophyte growth. *Heterozostera tasmanica* was mainly limited to the entrance channel and the large shallow banks in the southern part of the lagoon. The remainder of the lagoon contained extensive beds of *Ruppia* sp. hornwort and filamentous algae. Within areas identified as *Heteozostera* beds from the video, *Heterozostera tasmanica* cover averaged 61 %, with 22 % filamentous algae and small amounts of both *Ruppia* sp. and hornwort (<5 % total), with the remainder bare substrate. Within areas identified as *Ruppia* beds from the video, *Ruppia* sp. cover averaged 65 %, with 30 % filamentous algae and 10 % hornwort, with the remainder bare substrate.

3.5.2.3. Algal Distribution

Reef habitat was not identified in Moulting Lagoon.

3.5.2.4. Particle Size Analysis

The majority of Moulting Lagoon was dominated by vegetation; however bare sediment was present on Middle Bank and Top Bank. The sediment from these shallow banks was found to be fine sand on the Wentworth classification, with a median particle size of 2.6 – 2.7 on the Phi scale (Figure 180 and Figure 181).

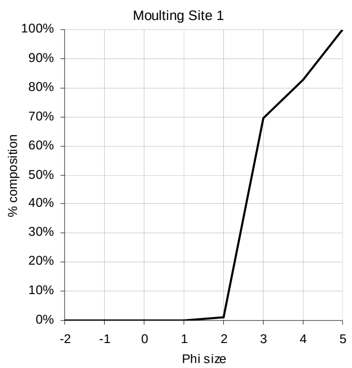

Figure 180. Moulting Site 1, Phi 50% = 2.7, Wentworth classification = fine sand.

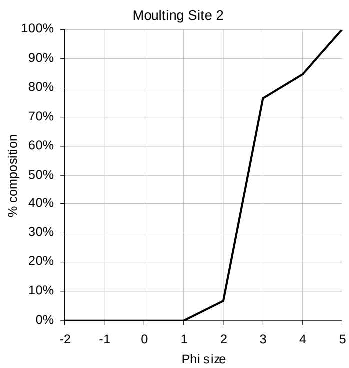

Figure 181. Moulting Site 2, Phi 50% = 2.6, Wentworth classification = fine sand

3.6. Macquarie Harbour

Macquarie Harbour lies within the NRM Cradlecoast jurisdiction on the west coast of Tasmania (Figure 182). The analysis of the 29,174ha area has been divided into three subregions A, B C and extend from Hells Gate at the entrance to the Harbour to the mouth of the Gordon River in the south east. A large proportion of the harbour is in depths <15 m, with 55 m being the deepest zone recorded (Figure 183). The distribution of habitats in the harbour are presented in Figures 184-205.

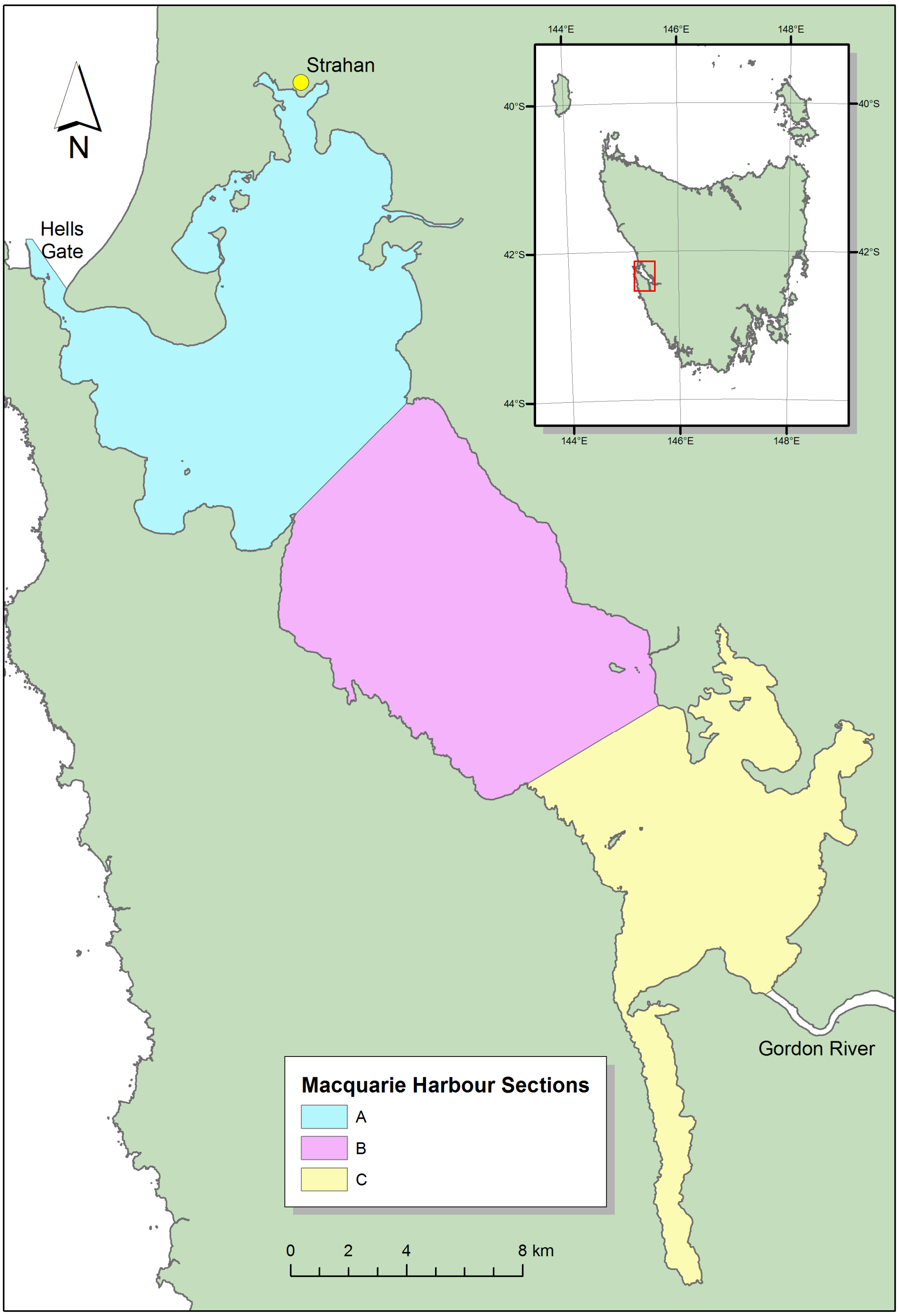

Figure 182. Location map showing analysis and reporting sections for Macquarie Harbour.

3.6.1. Bathymetry and habitat maps of Macquarie Harbour

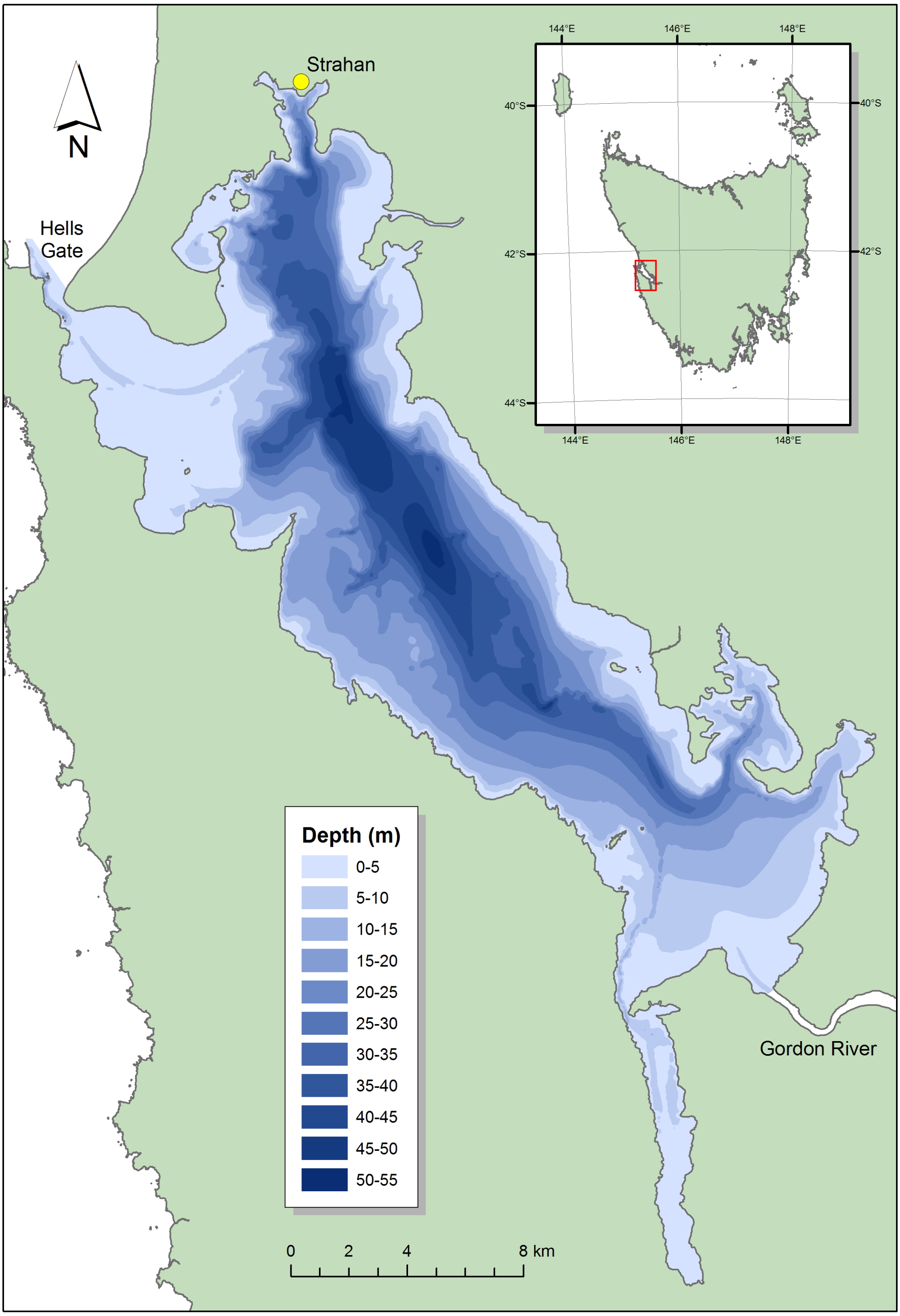

Figure 183. Map showing bathymetry for Macquarie Harbour interpolated from acoustic data.

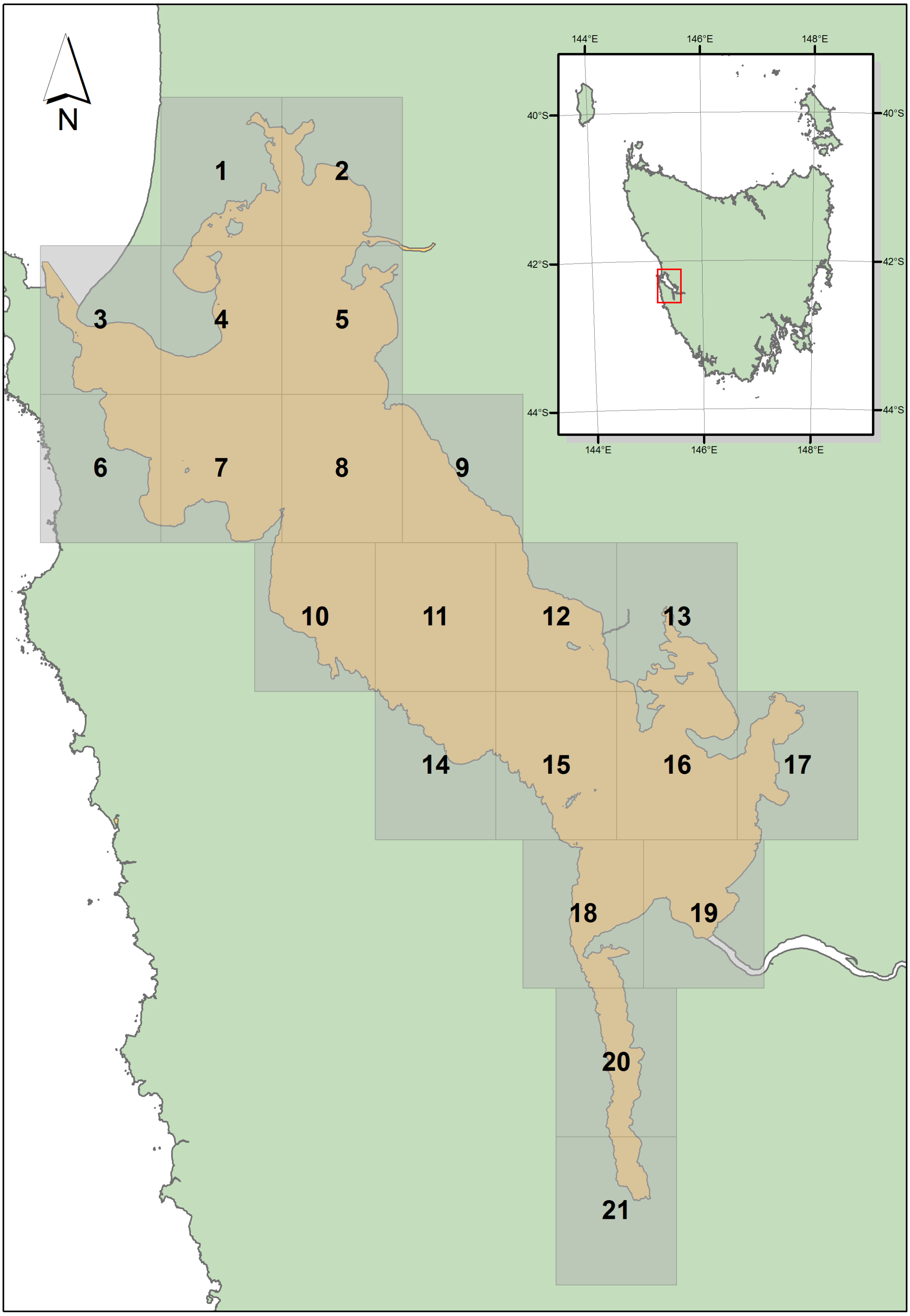

Figure 184. Index map of 1:25 000 habitat maps for Macquarie Harbour map series.

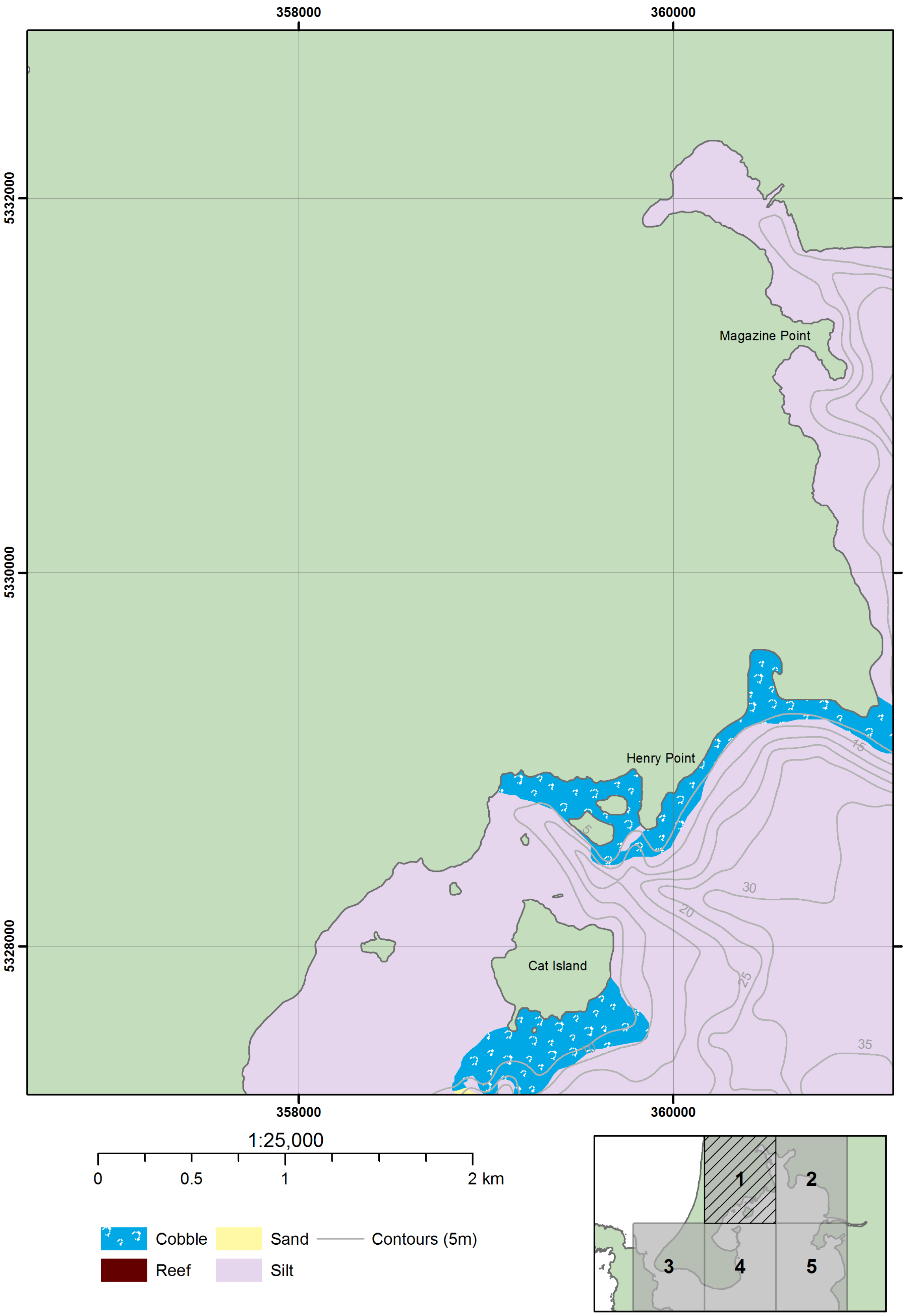

Figure 185. Macquarie Harbour map series map 1 showing bathymetry and habitats between Magazine Point and Cat Island.

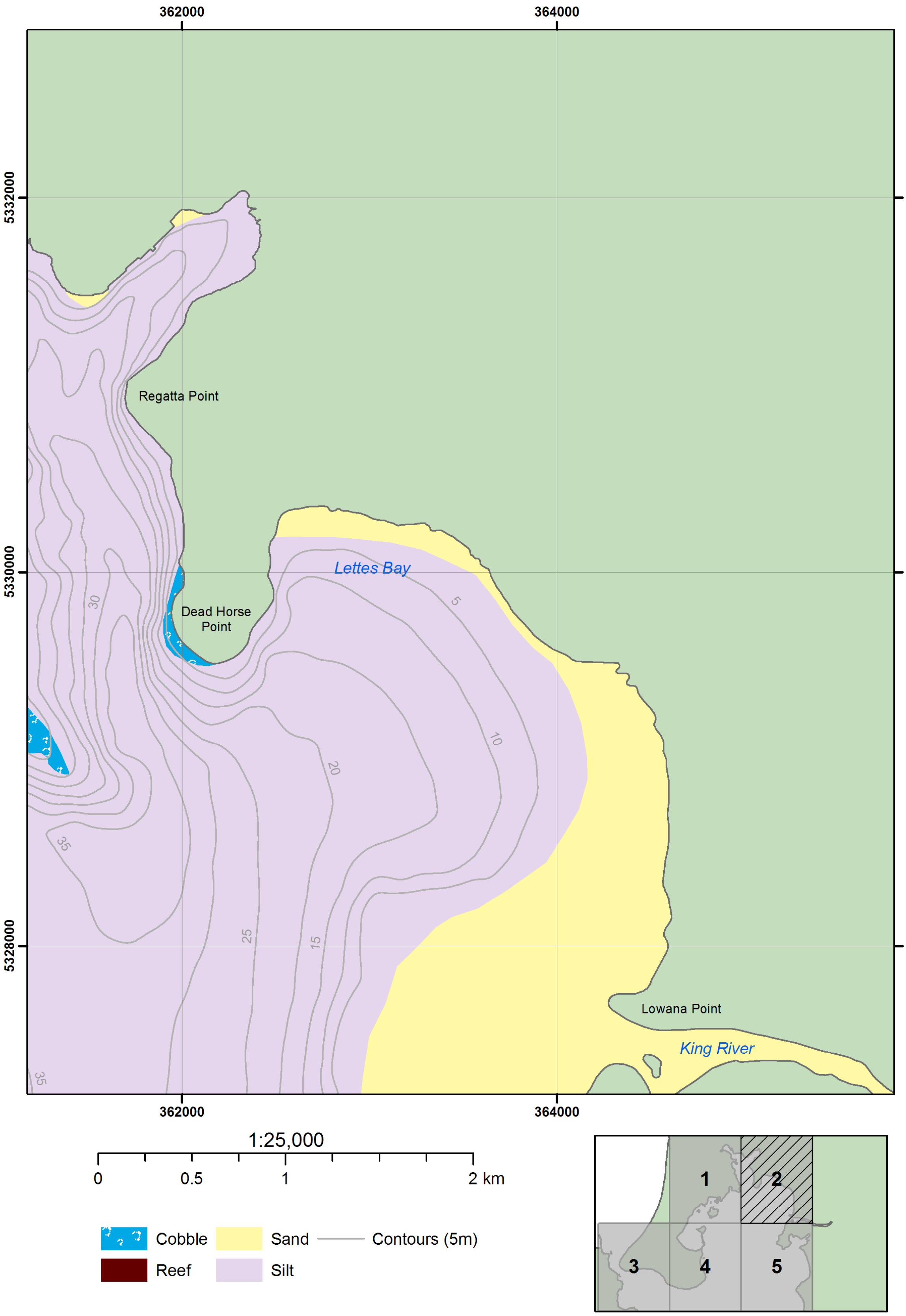

Figure 186. Macquarie Harbour map series map 2 showing bathymetry and habitats between Regatta Point and the King River.

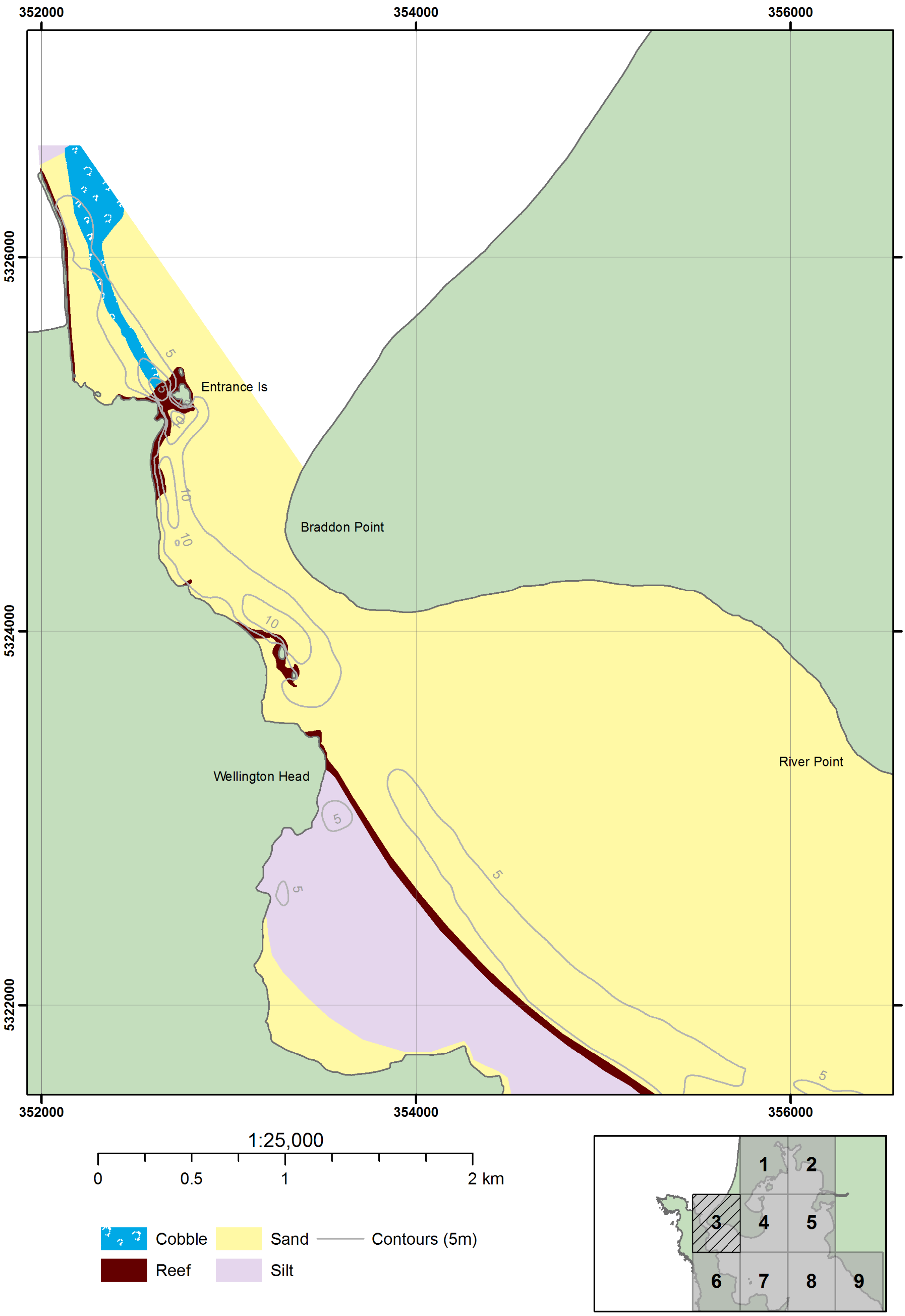

Figure 187. Macquarie Harbour map series map 3 showing bathymetry and habitats at the entrance to Macquarie Harbour.

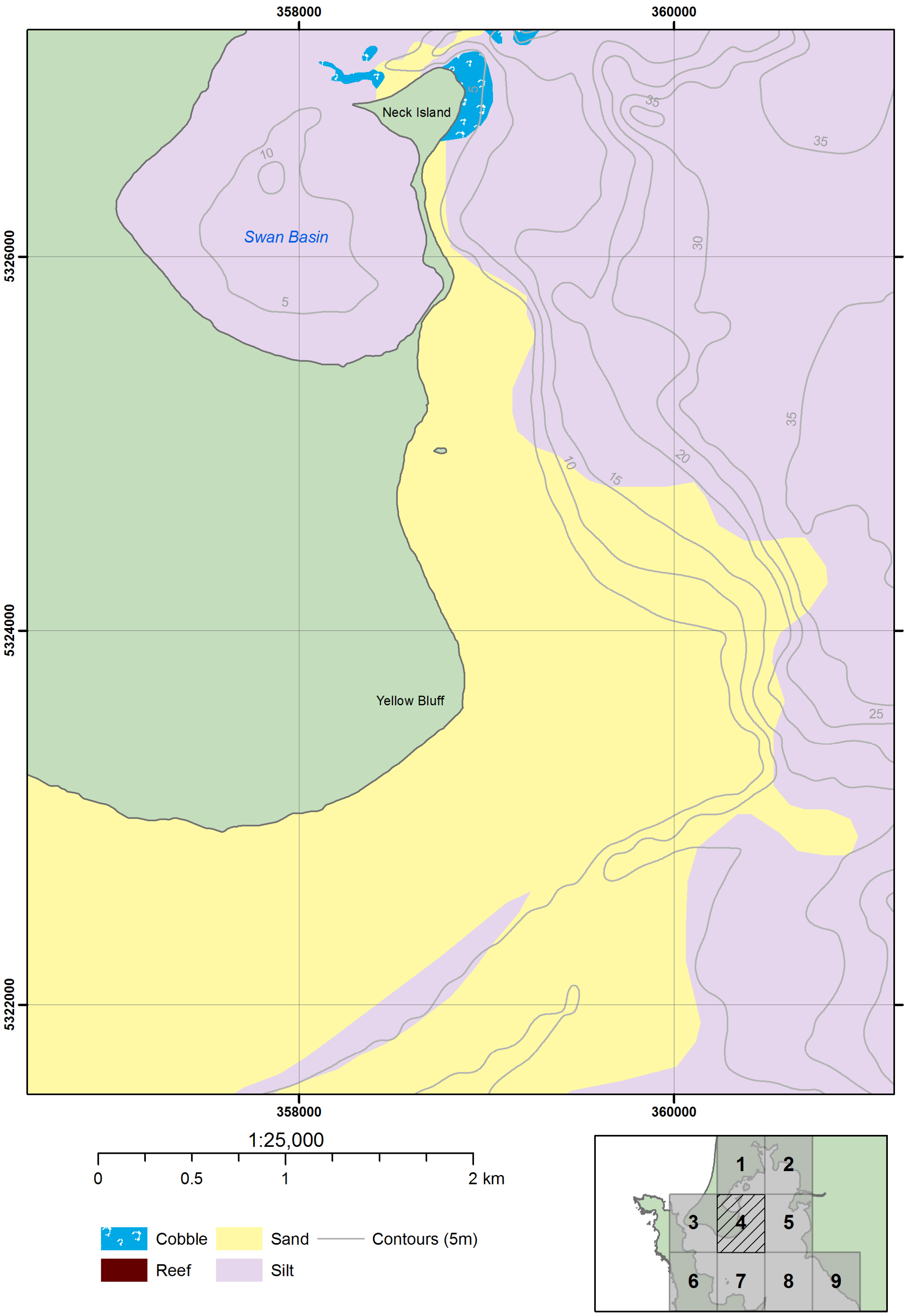

Figure 188. Macquarie Harbour map series map 4 showing bathymetry and habitats from Swan Basin to Fraser Flats.

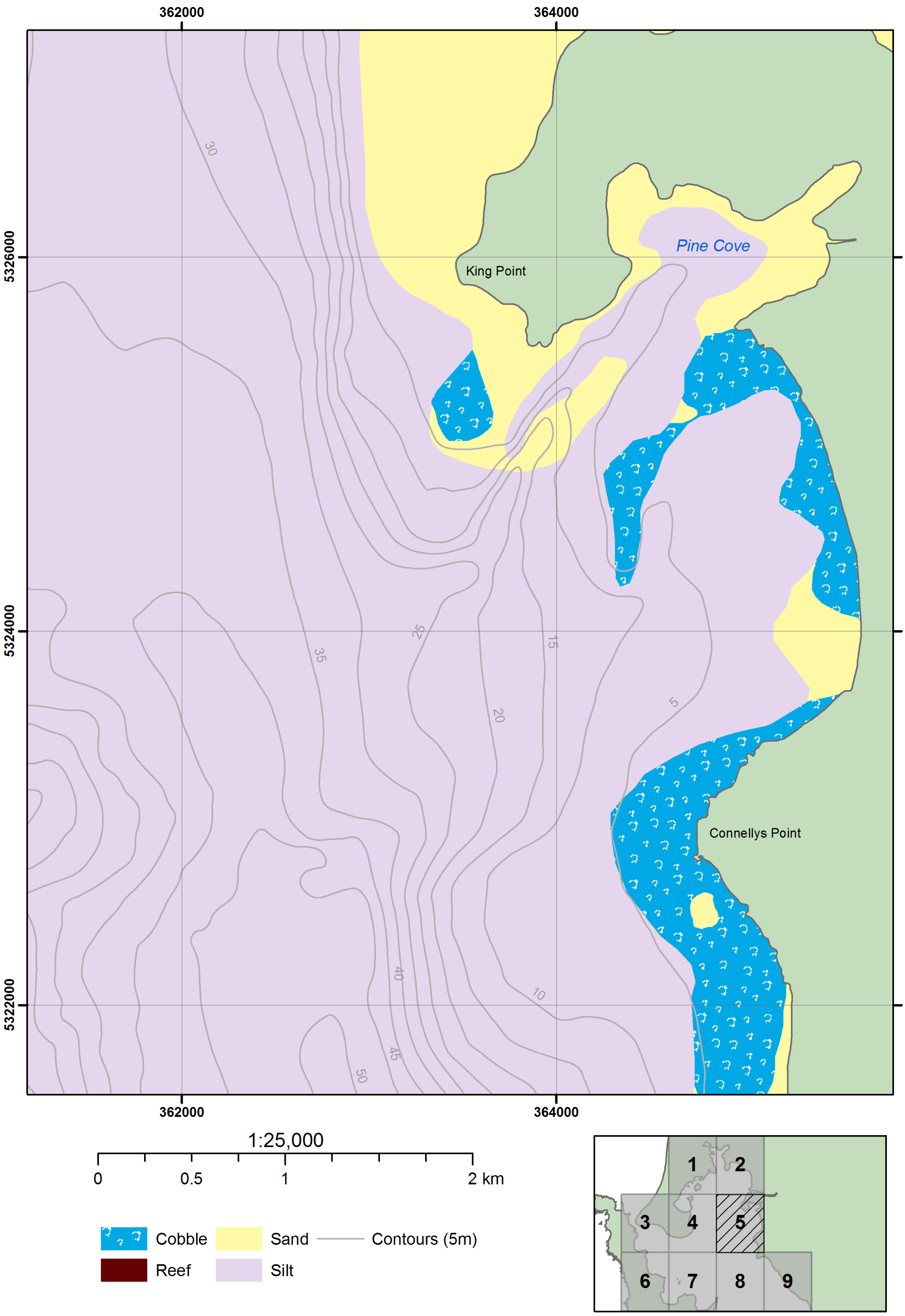

Figure 189. Macquarie Harbour map series map 5 showing bathymetry and habitats from King Point to Connellys Point.

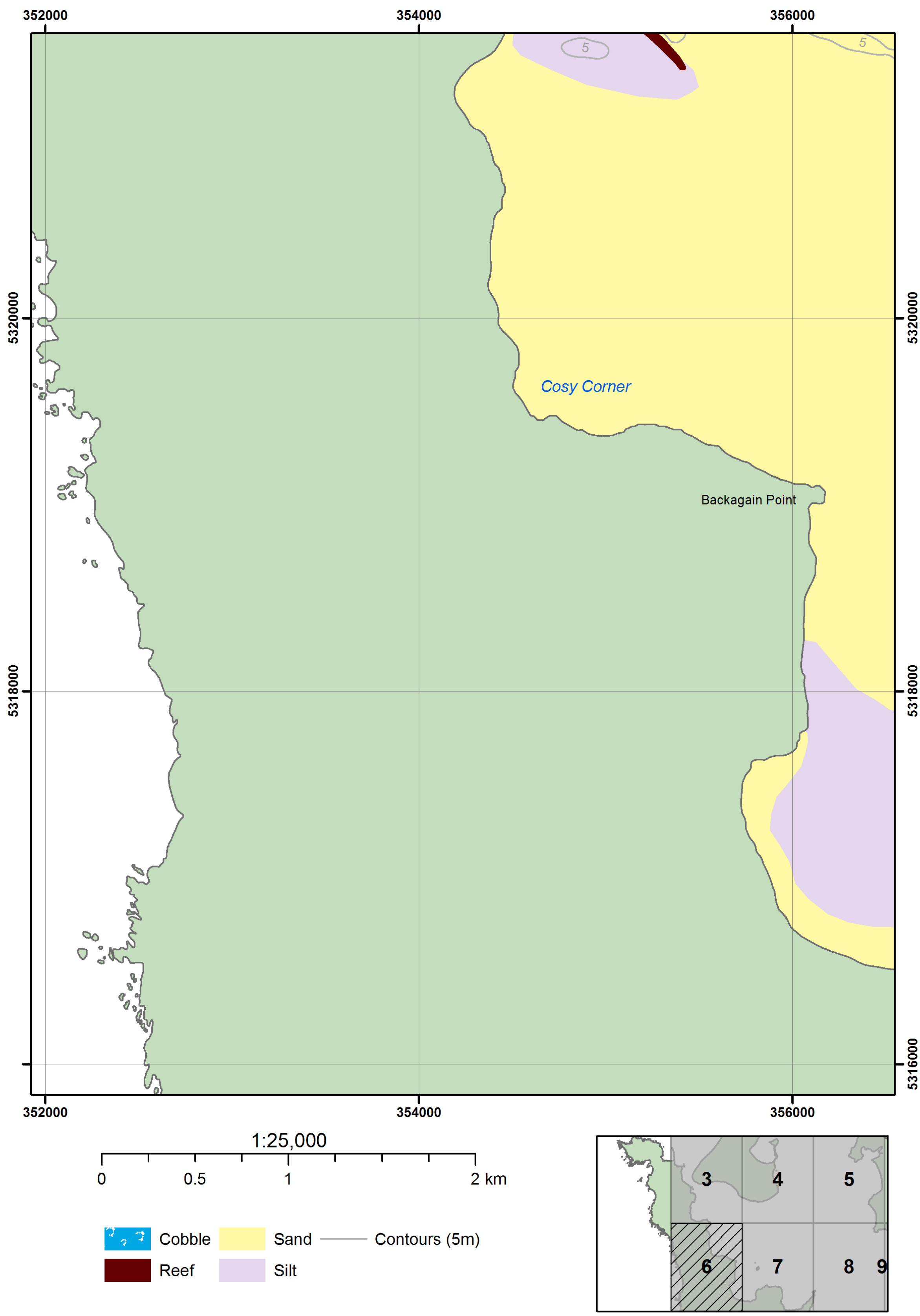

Figure 190. Macquarie Harbour map series map 6 showing bathymetry and habitats from Cosy Corner to Backagain Point.

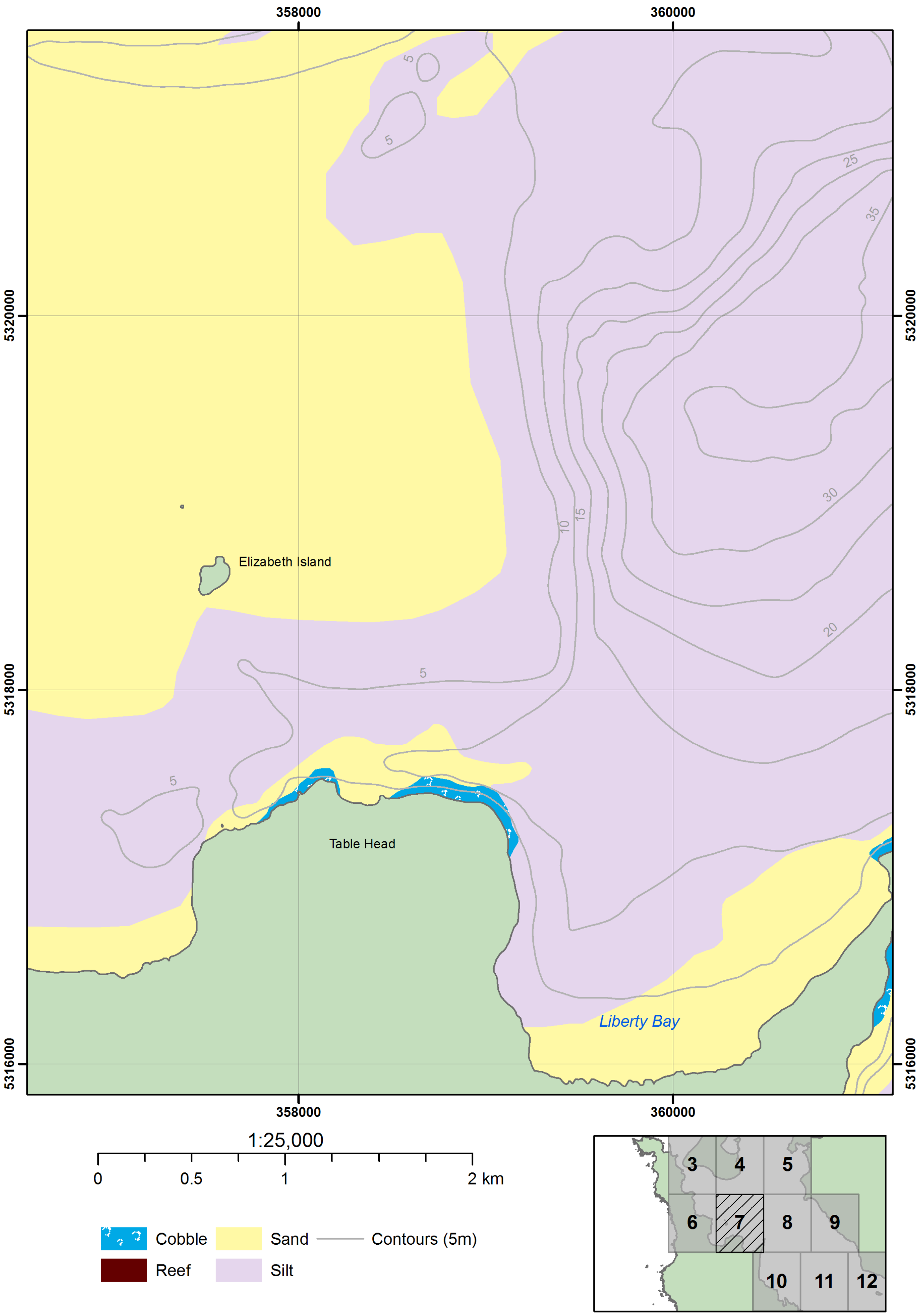

Figure 191. Macquarie Harbour map series map 7 showing bathymetry and habitats between Elizabeth Island and Liberty Bay.

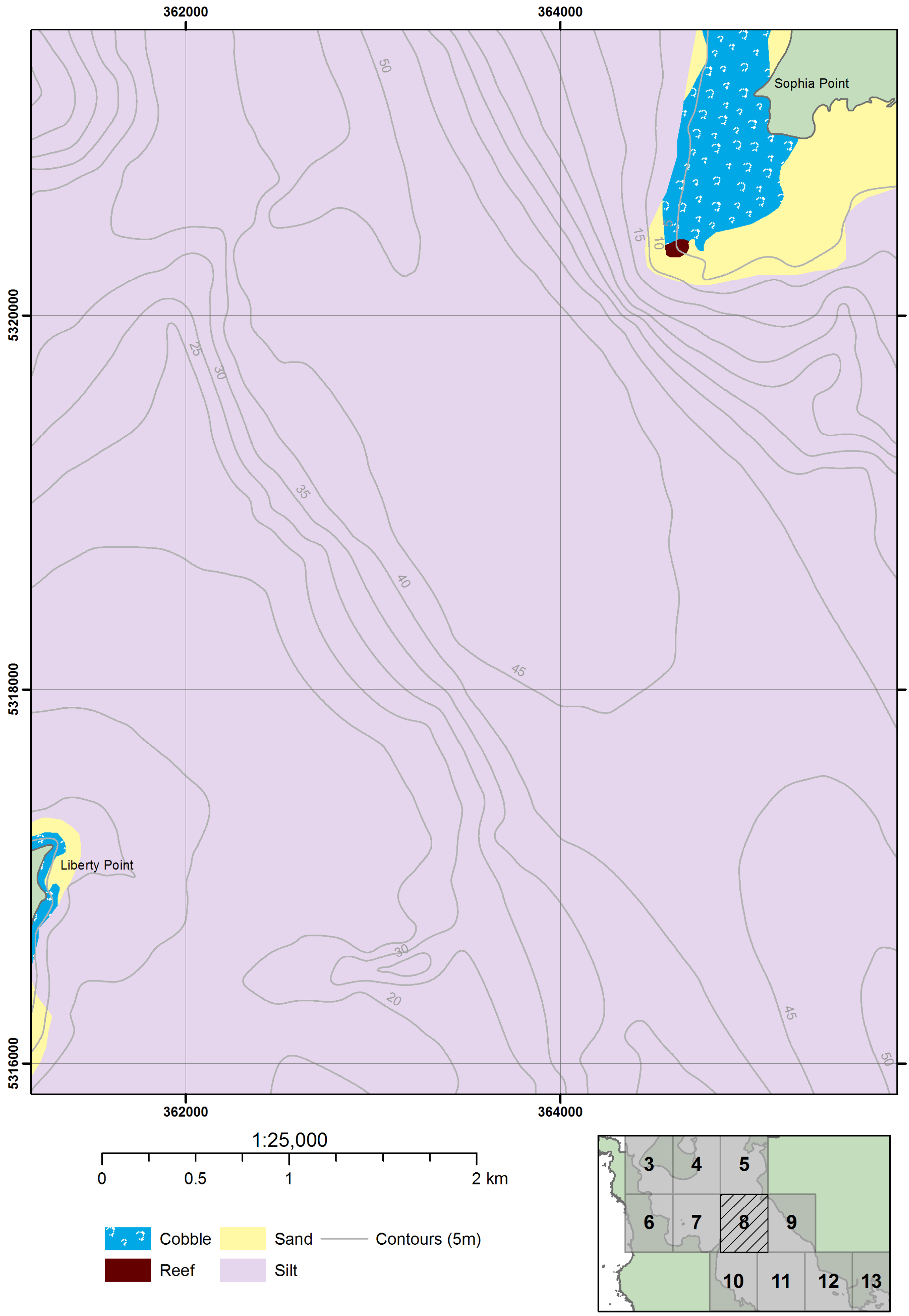

Figure 192. Macquarie Harbour map series map 8 showing bathymetry and habitats between Sophia Point and Liberty Point.

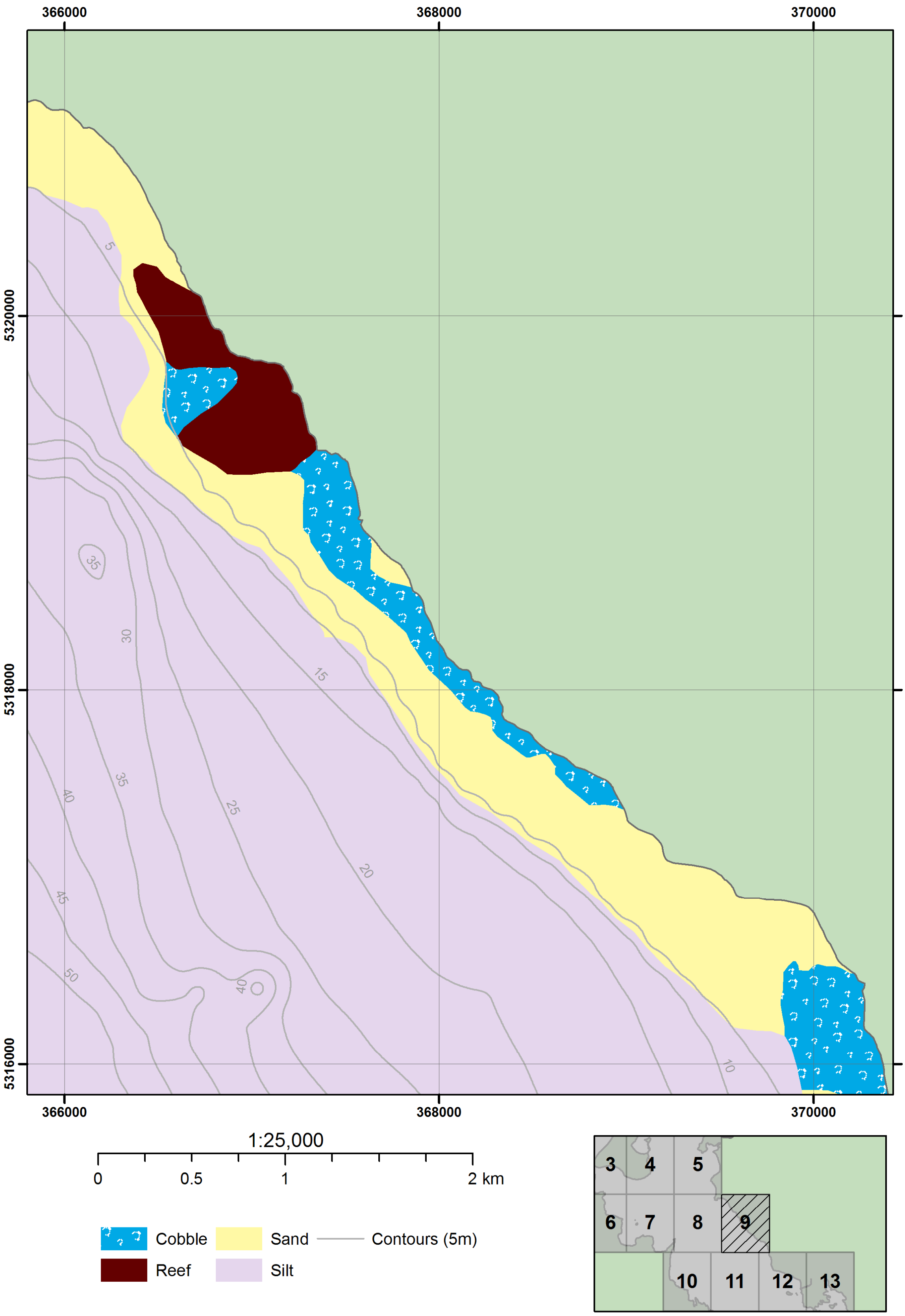

Figure 193. Macquarie Harbour map series map 9 showing bathymetry and habitats between Sophia Point and Coal Head.

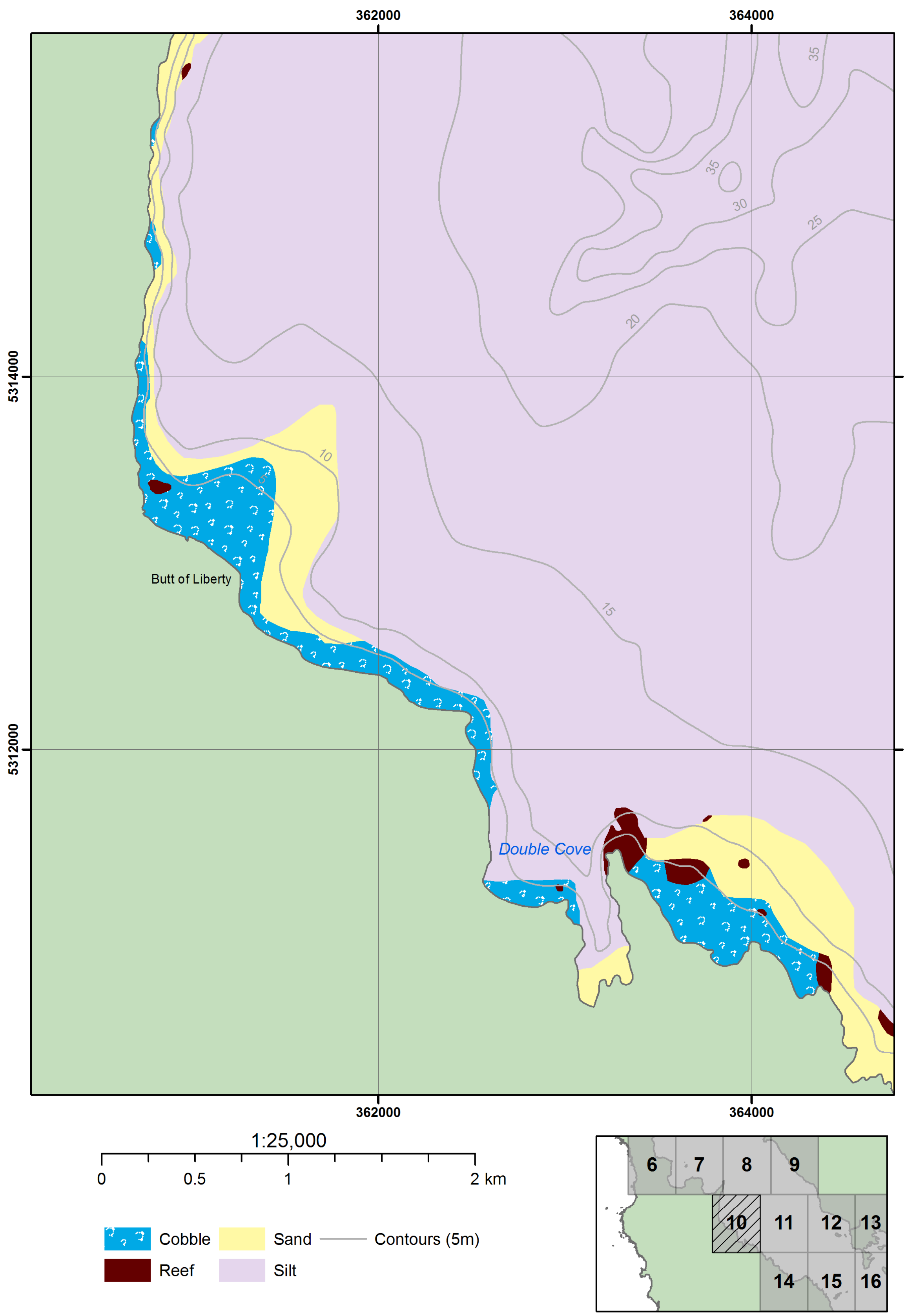

Figure 194. Macquarie Harbour map series map 10 showing bathymetry and habitats from Butt of Liberty to Double Cove.

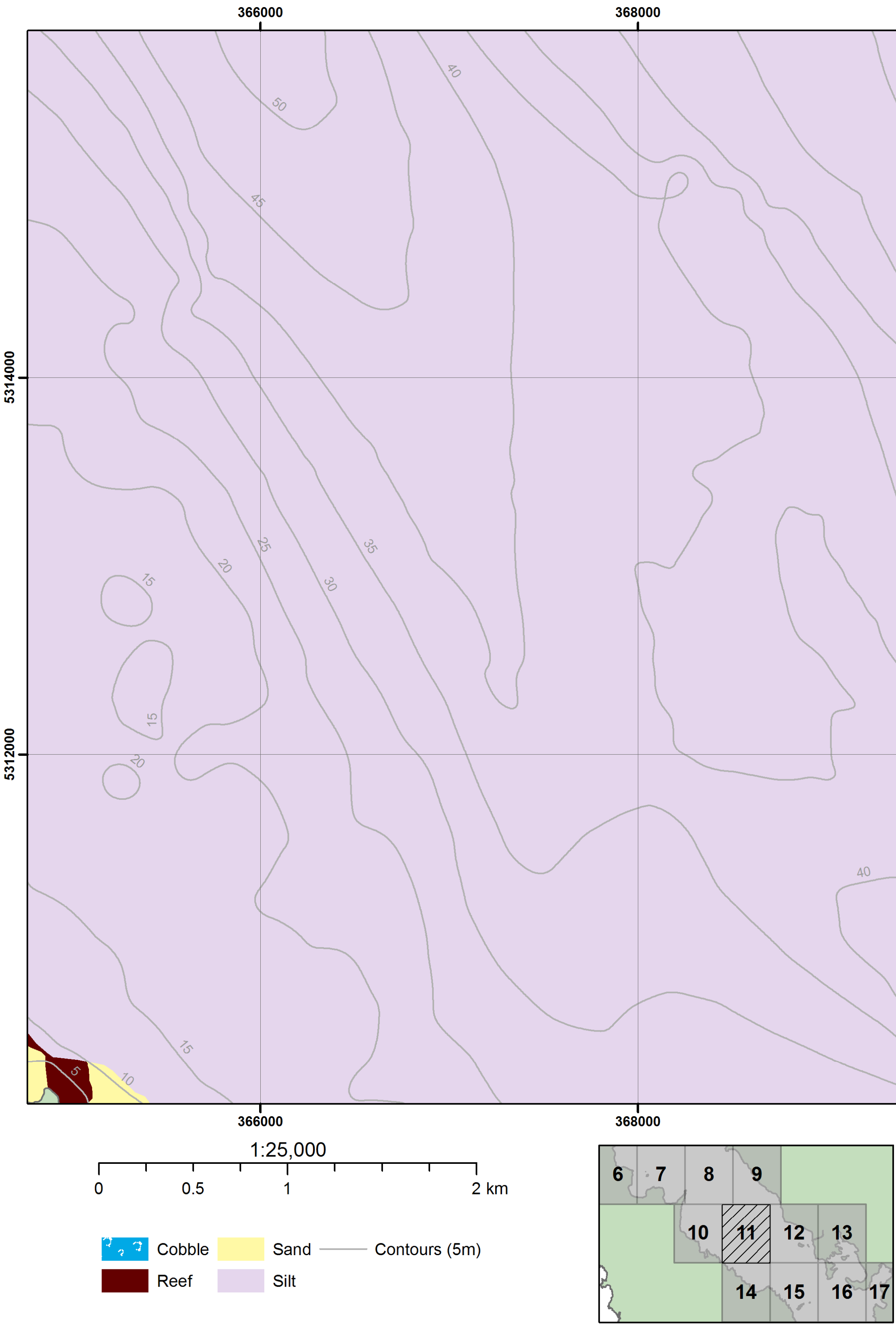

Figure 195. Macquarie Harbour map series map 11 showing bathymetry and habitats in central Macquarie Harbour.

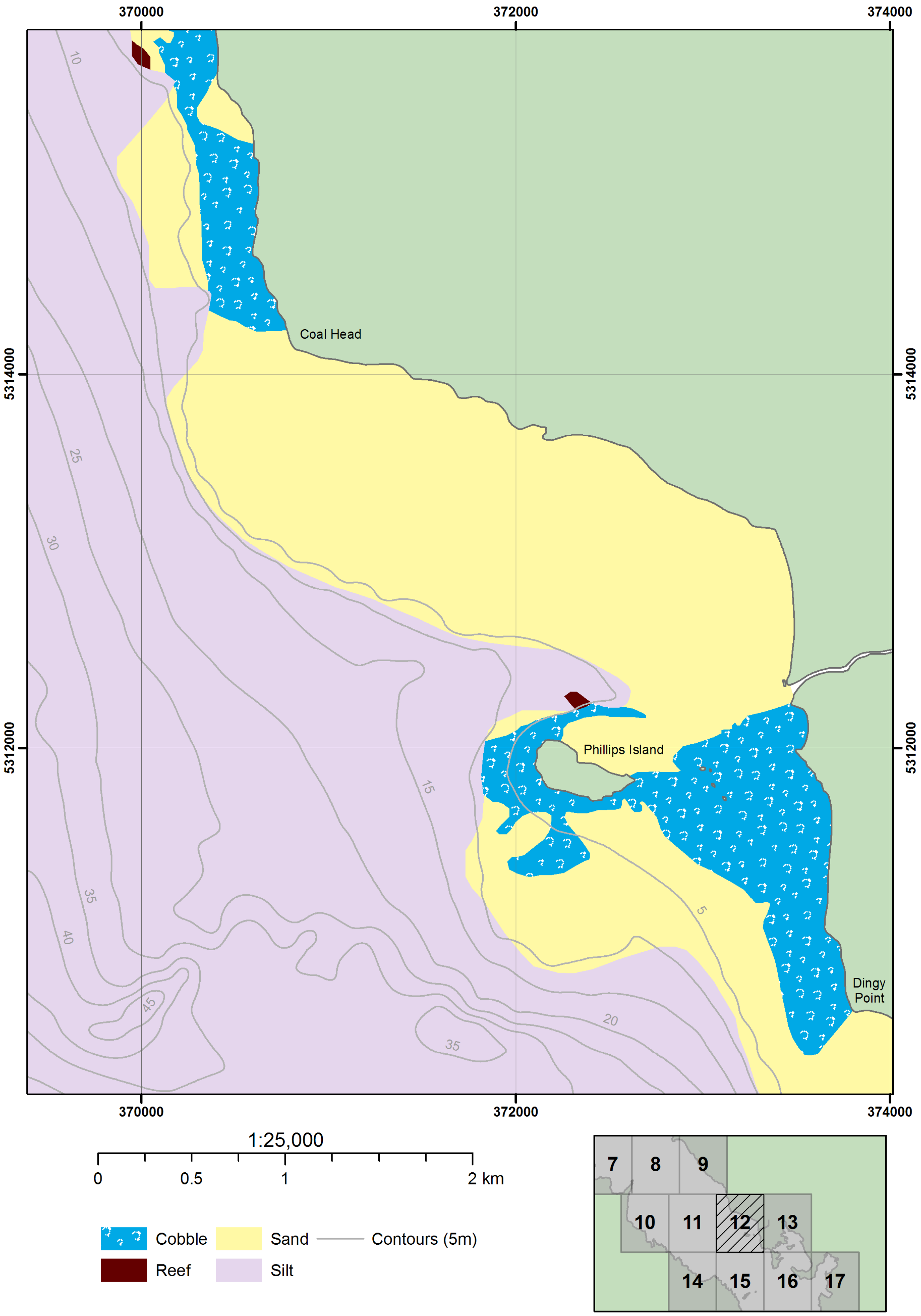

Figure 196. Macquarie Harbour map series map 12 showing bathymetry and habitats from Coal Head to Dingy Point.

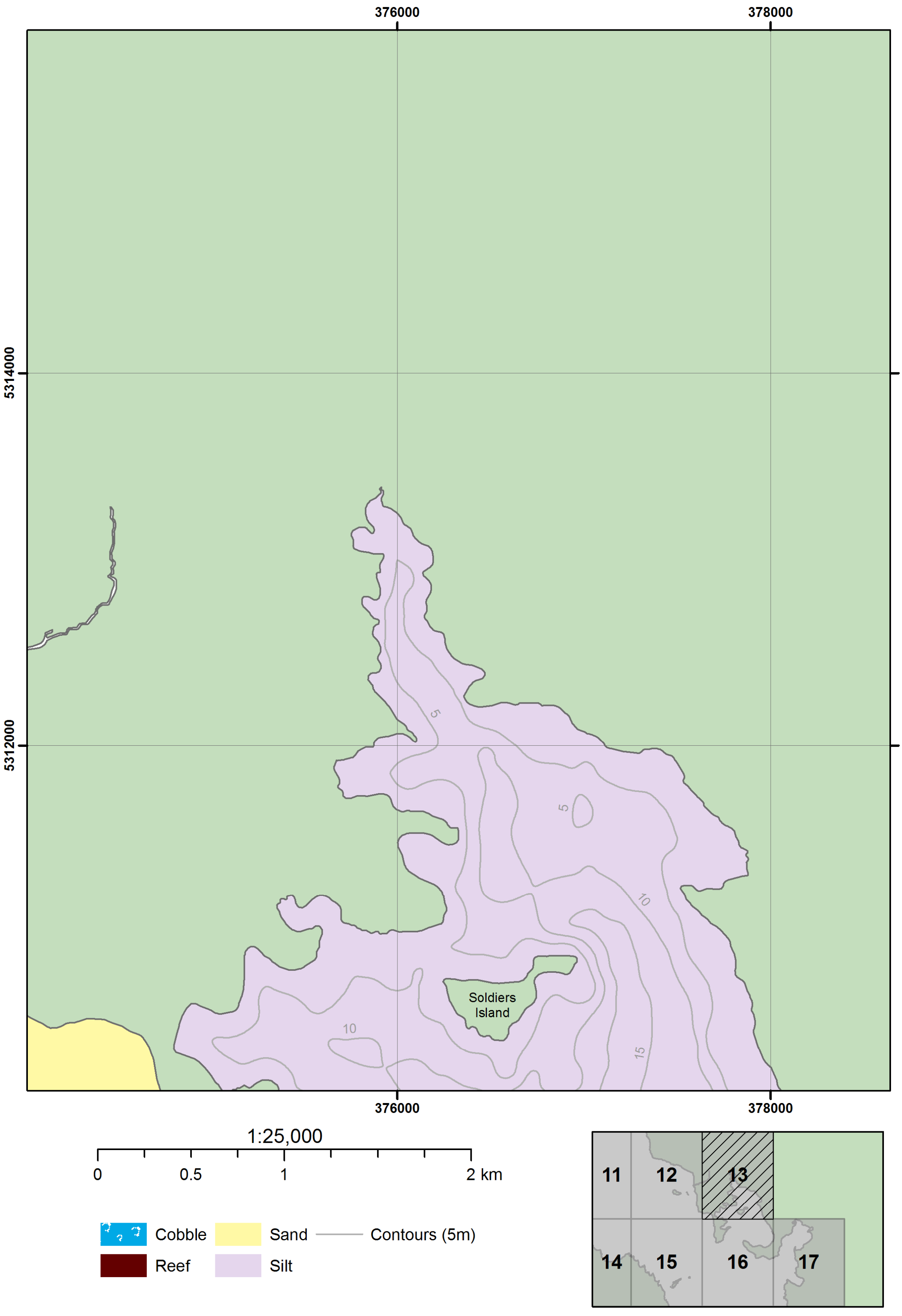

Figure 197. Macquarie Harbour map series map 13 showing bathymetry and habitats around Soldiers Island.

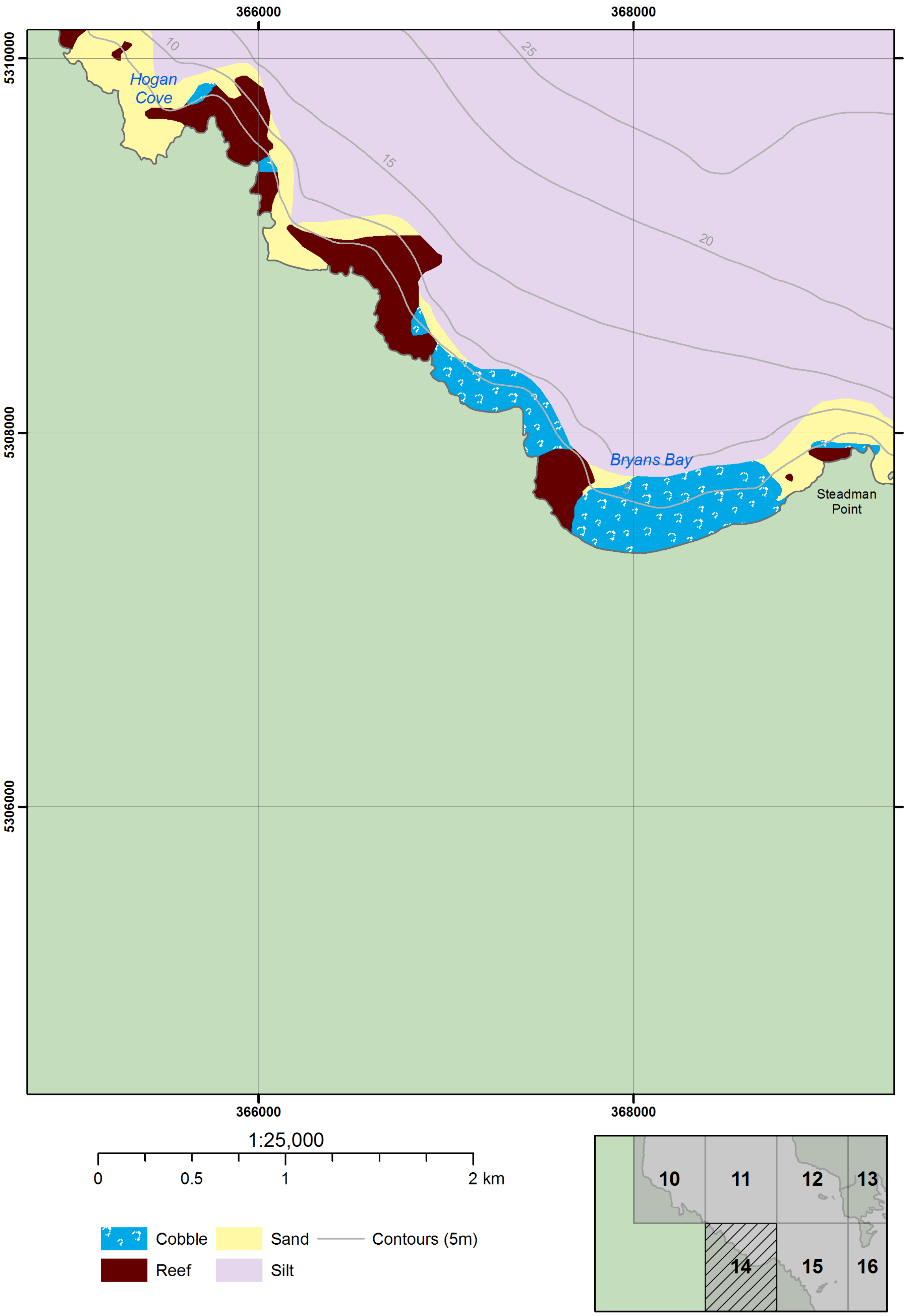

Figure 198. Macquarie Harbour map series map 14 showing bathymetry and habitats between Hogan Cove and Steadman Point.

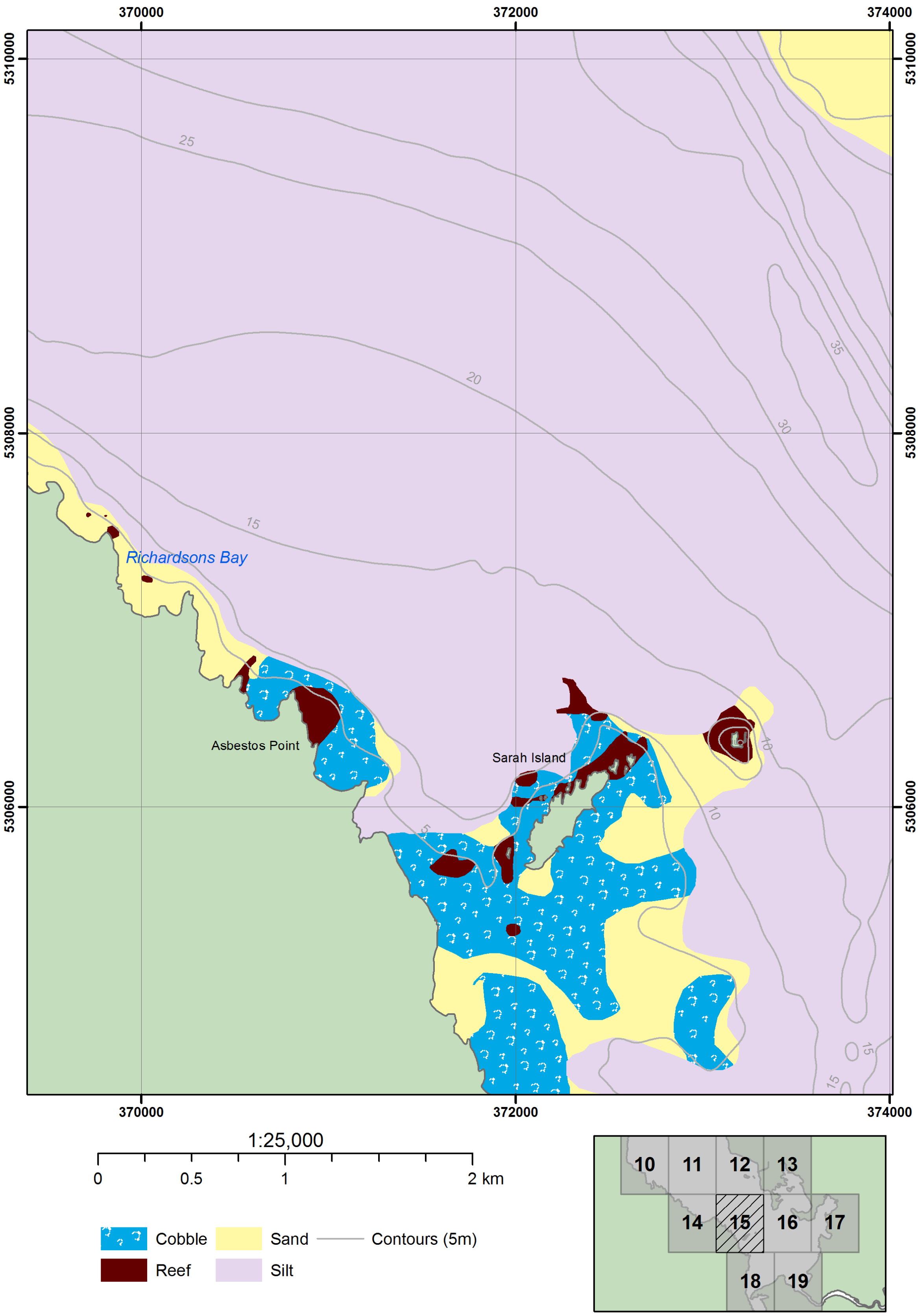

Figure 199. Macquarie Harbour map series map 15 showing bathymetry and habitats between Richardsons Bay and Sarah Island.

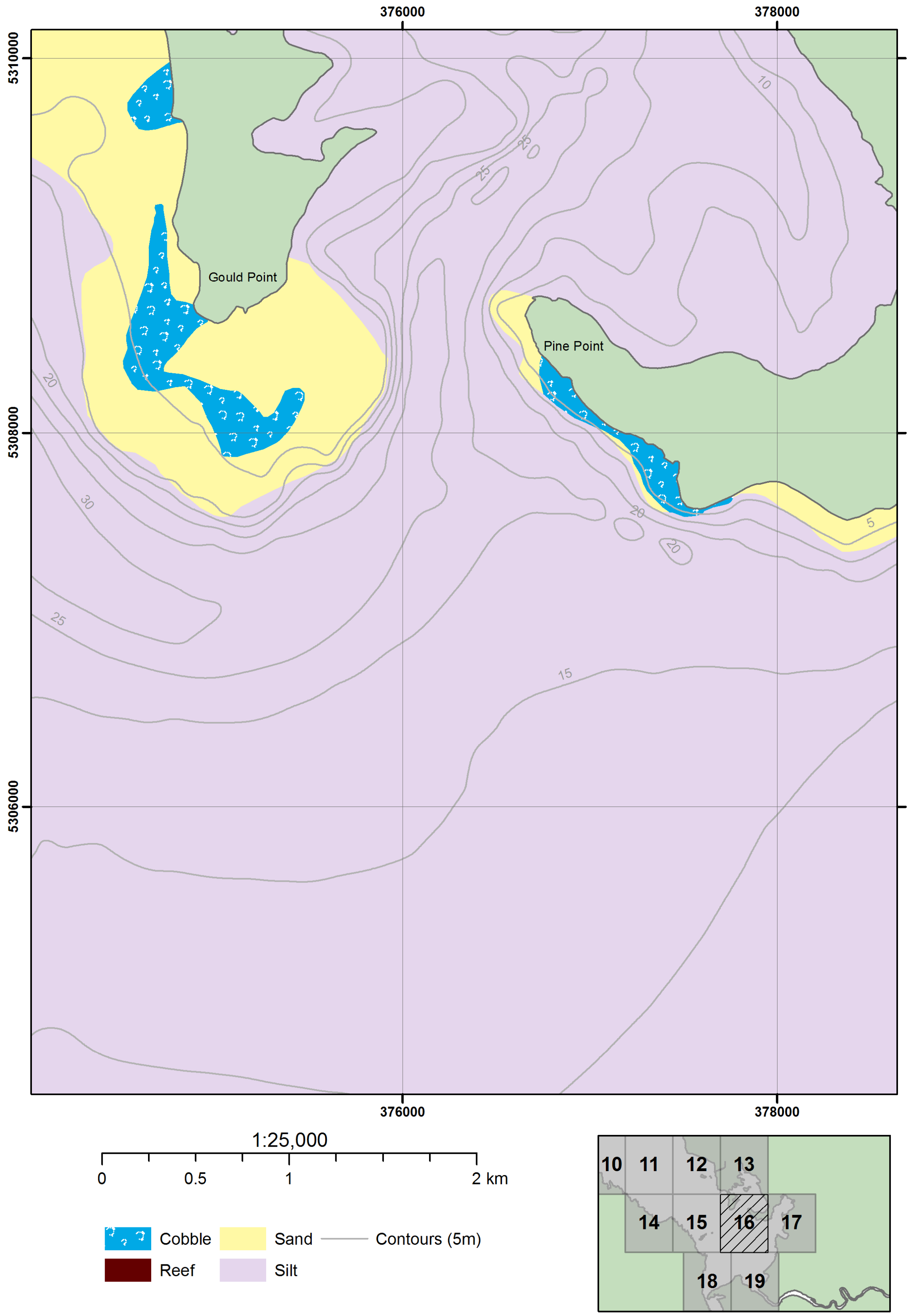

Figure 200. Macquarie Harbour map series map 16 showing bathymetry and habitats between Gould Point and Pine Point.

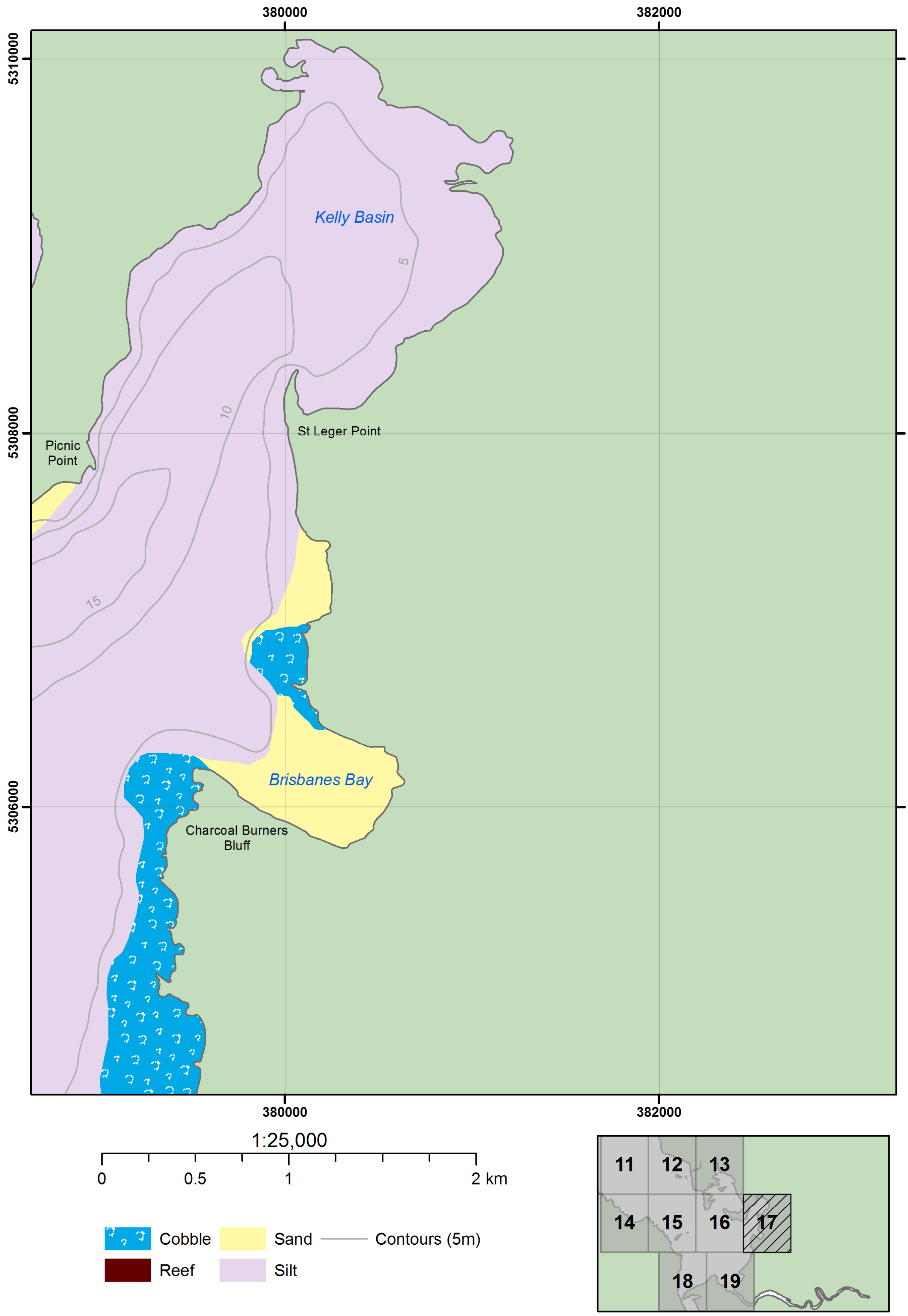

Figure 201. Macquarie Harbour map series map 17 showing bathymetry and habitats between Charcoal Burners Bluff and Kelly Basin.

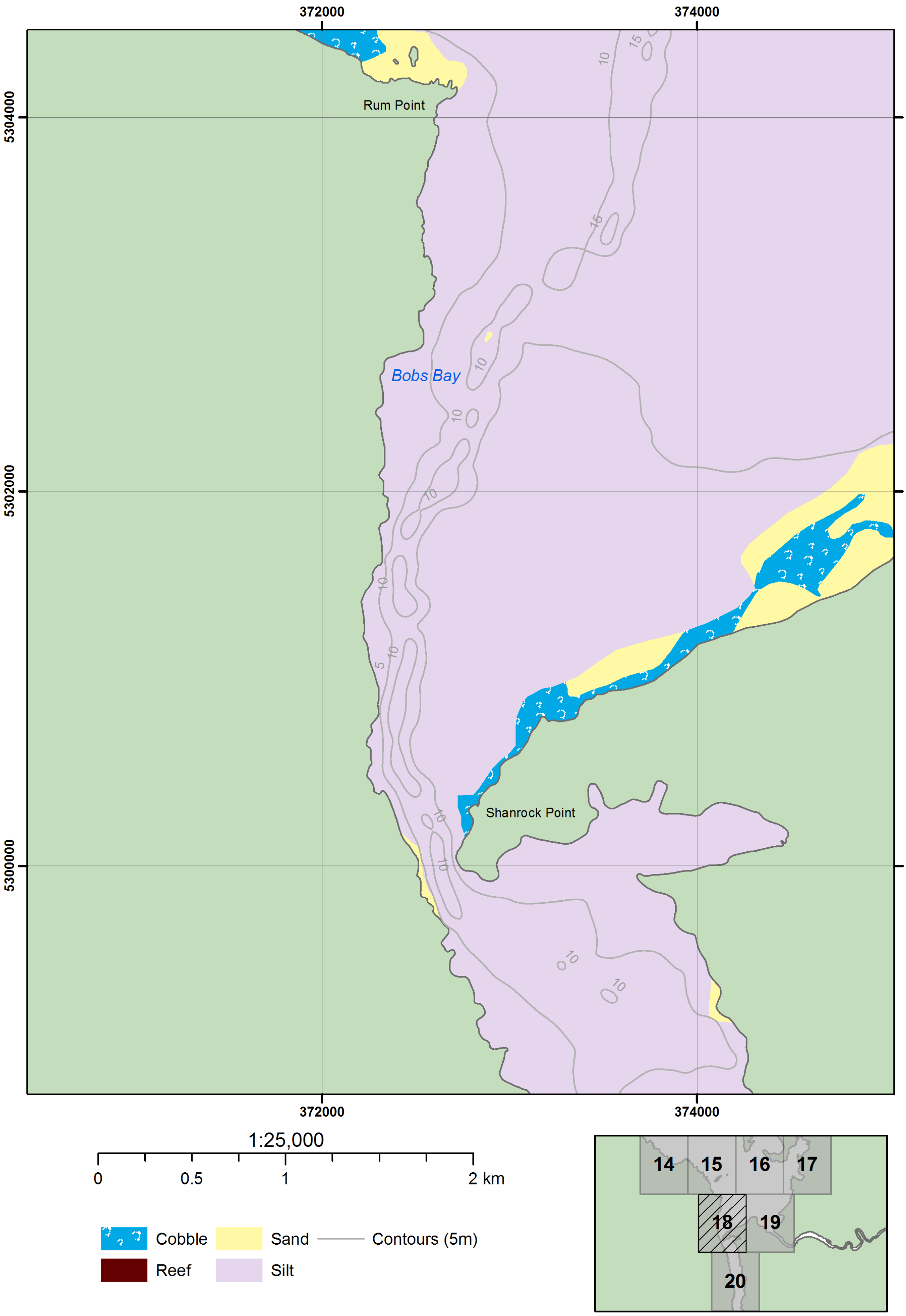

Figure 202. Macquarie Harbour map series map 18 showing bathymetry and habitats between Rum Point and Shamrock Point.

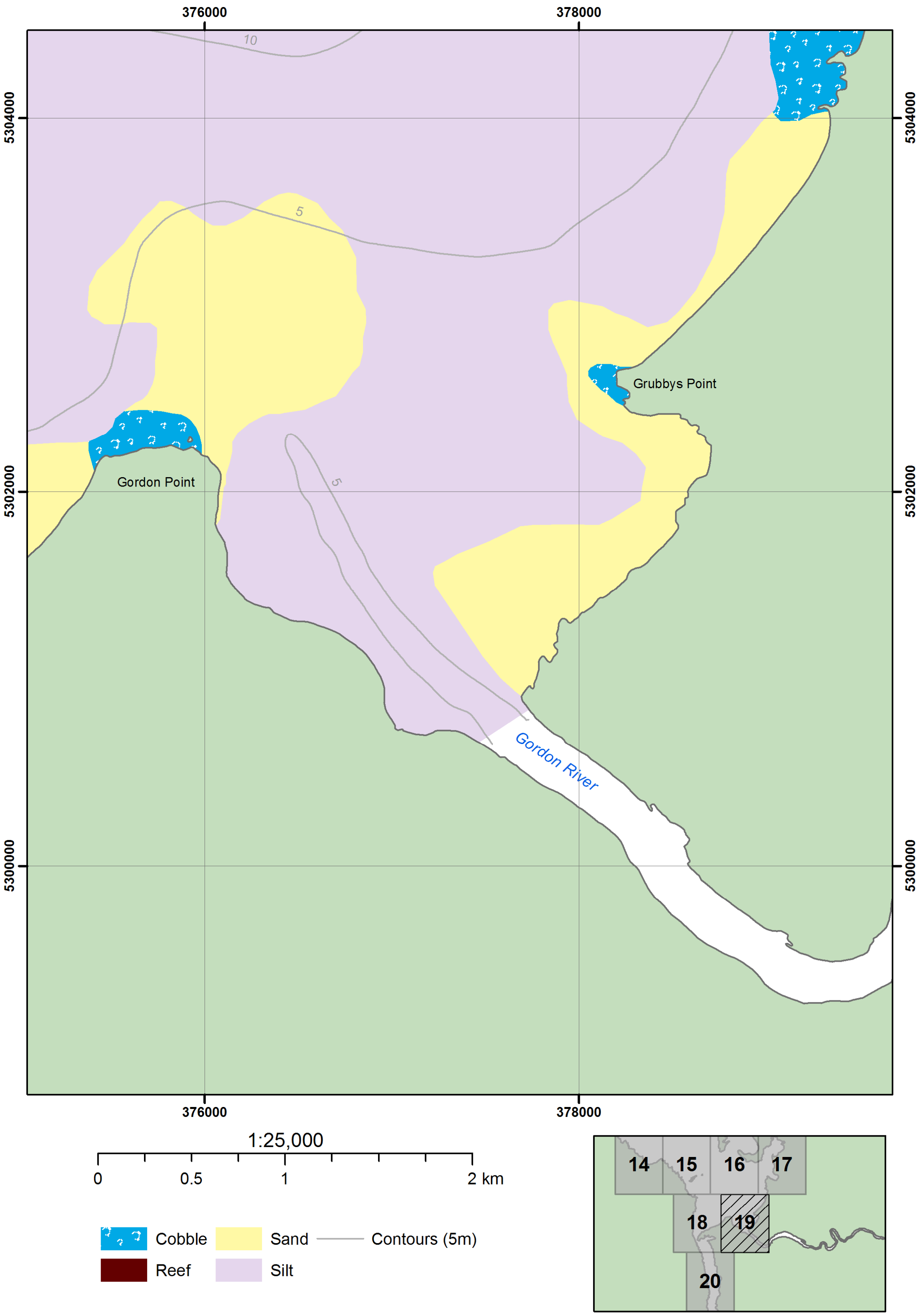

Figure 203. Macquarie Harbour map series map 19 showing bathymetry and habitats between Gordon Point nad Grubbys Point.

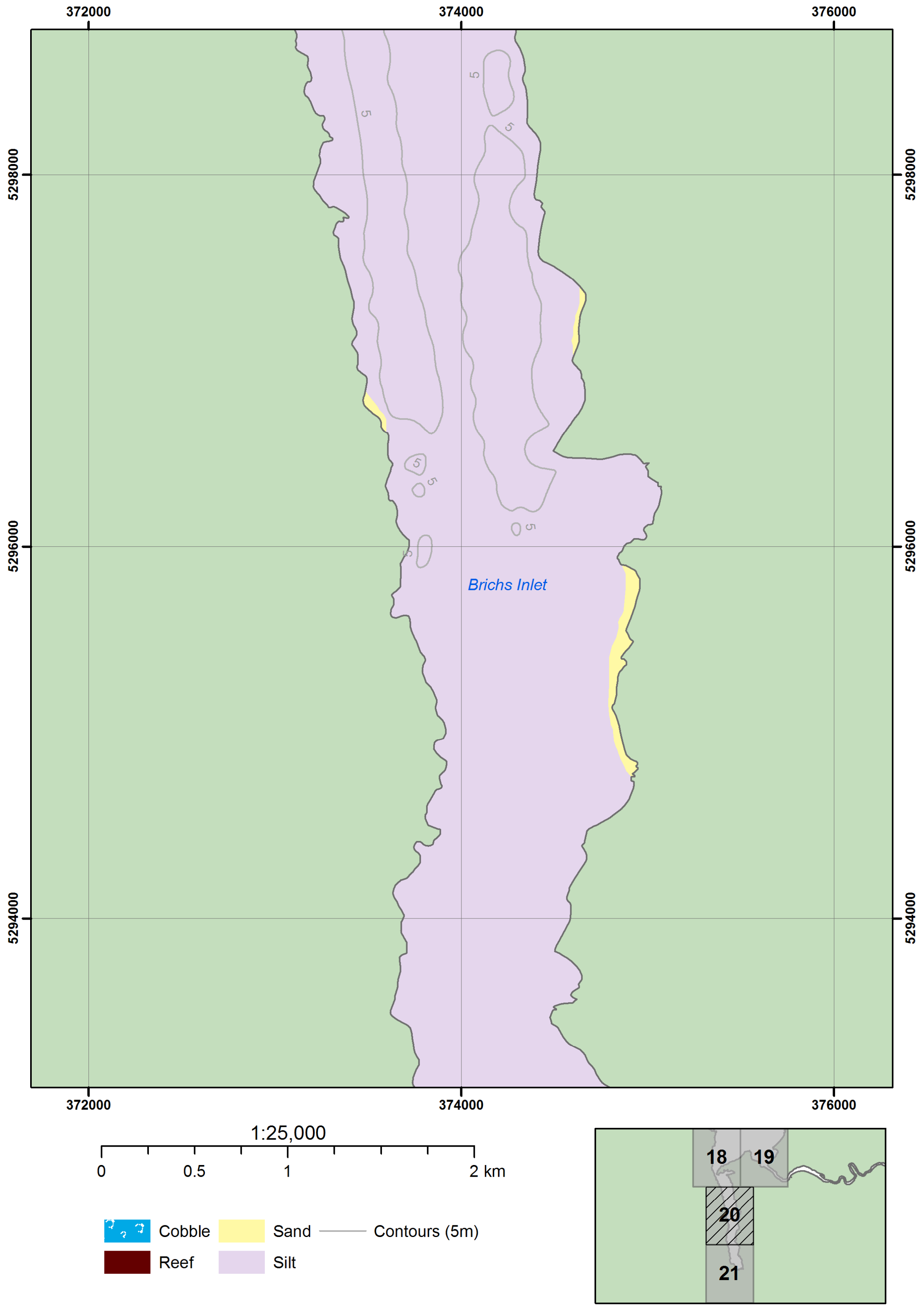

Figure 204. Macquarie Harbour map series map 20 showing bathymetry and habitats in Birchs Inlet.

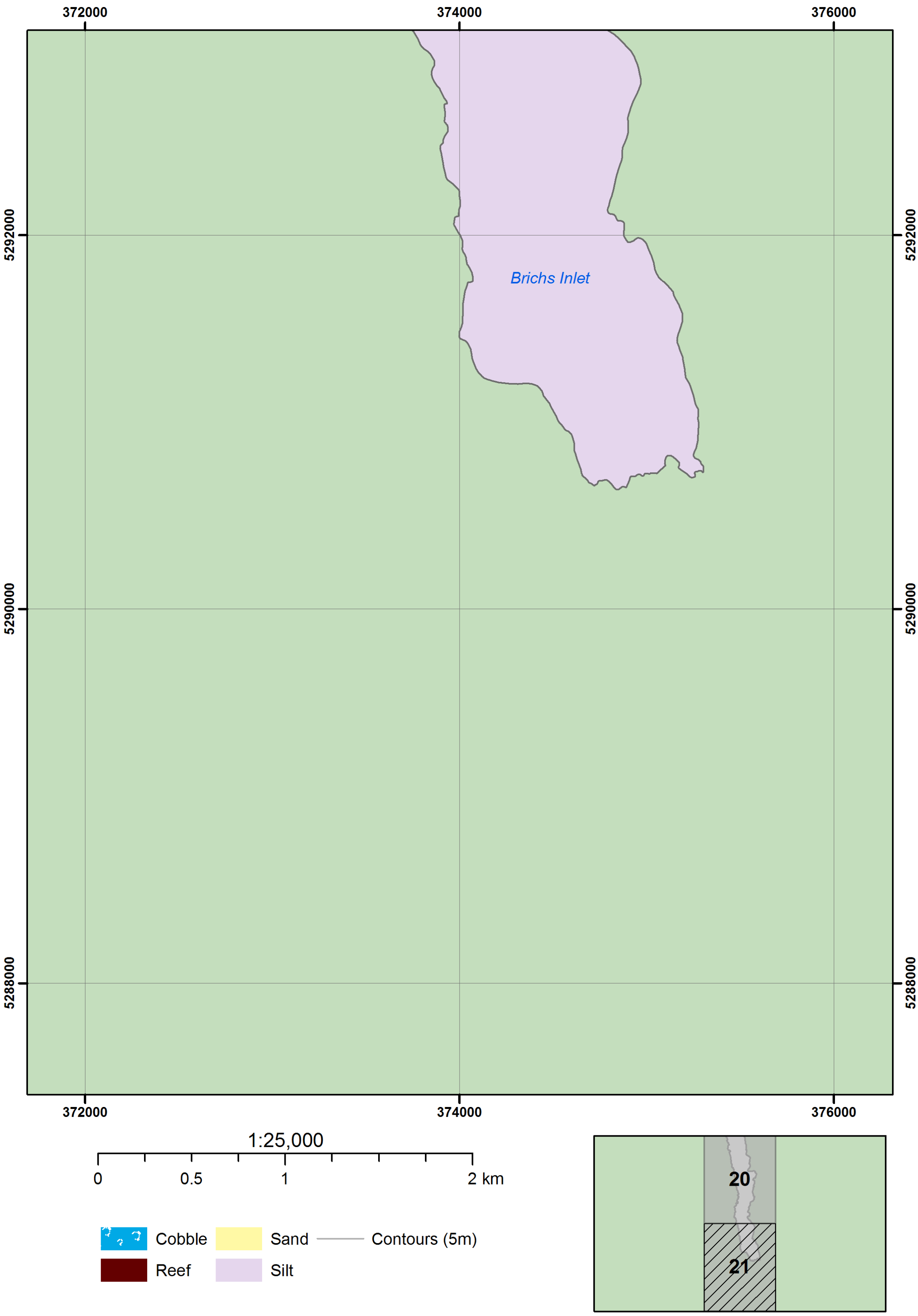

Figure 205. Macquarie Harbour map series map 21 showing bathymetry and habitats in Birchs Inlet.

3.6.2. Section A

3.6.2.1. Habitat Distribution

Within section A, from Hells Gate to Liberty Point and Sophia Point, 62% of the habitat was silt followed by 34% of sand. Some small areas of reef were detected in the fringing zones in less than 15 m water depth. Cobble was also not identified in depths below 15 m (Table 42). The error analysis of section A showed a very high accuracy rate of 96% for the 5 habitat classes (Table 43). Cobble and Seagrass do not have any accuracy result as video transects were not conducted on these habitat types. Sand and reef showed some confusion in their boundary identification likely attributable to the interpolation between transects conducted at 200m interval spacing.

Table 42. Habitat distribution by depth for Section A of Macquarie Harbour.

DEPTH	SUBSTRATE				TOTAL
	Cobble (ha)	Reef (ha)	Sand (ha)	Silt (ha)	
0-5	272.05	16.83	3,140.78	1,264.54	**4,694.20**
5-10	33.36	2.29	395.47	766.84	**1,197.96**
10-15	2.58	1.64	74.99	774.46	**853.67**
15-20	0.75	0.55	26.61	642.83	**670.74**
20-25	0.00	0.00	3.36	533.63	**536.99**
25-30	0.00	0.00	2.58	536.65	**539.23**
30-35	0.00	0.00	5.73	911.47	**917.20**
35+	0.00	0.00	0.00	1,234.01	**1,234.01**
TOTAL	**308.74**	**21.31**	**3,649.51**	**6,664.45**	**10,644.01**
Percentage	*2.90%*	*0.20%*	*34.29%*	*62.61%*	

Table 43. Error analysis for Section A of Macquarie Harbour.

Video Class	Map Class					User Total	User Accuracy
	Cobble	Reef	Sand	Seagrass	Silt		
Cobble	0	0	0	0	0	**0**	0.00%
Reef	0	495	15	0	0	**510**	97.06%
Sand	0	30	180	0	0	**210**	85.71%
Seagrass	0	0	0	0	0	**0**	0.00%
Silt	0	0	0	0	431	**431**	100.00%
Producer Total	**0**	**525**	**195**	**0**	**431**	**1151**	
Producer Accuracy	0.00%	94.29%	92.31%	0.00%	100.00%		
Accuracy:	96.09%						
Kappa:	0.938						

3.6.2.2. Seagrass Distribution Section A

Seagrass was not detected in Section A of Macquarie Harbour.

3.6.2.3. Algal Distribution Section A

Small amounts of fringing reef occurred within Macquarie Harbour, however no algae was detected using the video on these reefs. This may be primarily due to the dark tannin stained waters preventing enough light reaching the substrate to support algal growth.

3.6.3. Section B

3.6.3.1. Habitat Distribution

Within section B of Macquarie Harbour, extending from Liberty and Sophia Point to Steadman Point and Dingy Point, 10,079.28 ha (100.79 km^2) of area was mapped with 84% of the seabed habitat identified as silt (Table 44). Small amounts of fringing reef were again identified in the depth strata < 15m mainly around Double Cove. Sand habitat decreased from the 1-5 m depth range to 15 m and was then replaced by silt habitat to 35+m.

The accuracy assessment of Section B shows some confusion in the identification of the sand and silt boundary with sand being confused as silt habitat (Table 45). This is most likely due to the indeterminate nature of the two soft sediment habitats forming a fuzzy boundary and also the high chance of misclassification of the soft sediment from the video. The boundaries of cobble and silt were also confused showing some uncertainty in the determination of the cobble boundaries from the 200m transect spacing for such small habitat polygons.

Table 44. Habitat distribution by depth for Section B of Macquarie Harbour.

DEPTH	SUBSTRATE				TOTAL
	Cobble (ha)	Reef (ha)	Sand (ha)	Silt (ha)	
0-5	380.01	91.94	739.35	28.03	**1,239.33**
5-10	44.52	19.15	249.24	217.85	**530.76**
10-15	0.00	5.17	47.43	886.59	**939.19**
15-20	0.00	0.00	0.00	1,969.79	**1,969.79**
20-25	0.00	0.00	0.00	1,321.43	**1,321.43**
25-30	0.00	0.00	0.00	930.84	**930.84**
30-35	0.00	0.00	0.00	1,075.08	**1,075.08**
35+	0.00	0.00	0.00	2,072.85	**2,072.85**
TOTAL	**424.53**	**116.26**	**1,036.02**	**8,502.46**	**10,079.28**
Percentage	*4.21%*	*1.15%*	*10.28%*	*84.36%*	

Table 45. Error analysis for Section B of Macquarie Harbour.

Video Class	Map Class					User Total	User Accuracy
	Cobble	Reef	Sand	Seagrass	Silt		
Cobble	80	0	73	0	0	**153**	52.29%
Reef	0	0	0	0	0	**0**	0.00%
Sand	0	0	0	0	0	**0**	0.00%
Seagrass	0	0	0	0	0	**0**	0.00%
Silt	45	0	105	0	355	**505**	70.30%
Producer Total	**125**	**0**	**178**	**0**	**355**	**658**	
Producer Accuracy	64.00%	0.00%	0.00%	0.00%	100.00%		
Accuracy:	66.11%						
Kappa:	0.374						

3.6.3.2. Seagrass Distribution Section B

Seagrass was not identified in Section B of Macquarie Harbour.

3.6.3.3. Algal Distribution Section B

Small amounts of fringing reef occurred within Macquarie Harbour, however no algae was detected using the video on these reefs. This may be primarily due to the dark tannin stained waters preventing enough light reaching the substrate to support algal growth.

3.6.4. Section C

3.6.4.1. Habitat Distribution

Section C of Macquarie Harbour from Steadman and Dingy Point to Birches Inlet and the entrance to the Gordon River was dominated by silt habitat (85.8%) with very little cobble (4.08%) and reef habitat (0.30%) and a marginal strip of sand habitat finishing at the 15-20 m depth contour (Table 46).

The accuracy assessment result for Section C was 79.49% (Table 47). Confusion existed between silt and sand habitats which, as mentioned previously may be due to the inability to identify transition zones from the video and/or acoustic data. Reef and sand habitat was also confused in a few instances which may have been an interpolation inaccuracy around Sarah Island on the small patches of reef in <5 m water depth.

Table 46. Habitat distribution by depth for Section C of Macquarie Harbour.

DEPTH	SUBSTRATE				TOTAL
	Cobble (ha)	Reef (ha)	Sand (ha)	Silt (ha)	
0-5	317.09	17.20	690.44	2,067.82	**3,092.55**
5-10	26.81	4.97	124.52	2,019.53	**2,175.83**
10-15	0.81	2.90	13.77	1,312.17	**1,329.66**
15-20	0.00	0.00	2.00	927.38	**929.38**
20-25	0.00	0.00	0.00	455.23	**455.23**
25-30	0.00	0.00	0.00	262.79	**262.79**
30-35	0.00	0.00	0.00	183.42	**183.42**
35+	0.00	0.00	0.00	22.43	**22.43**
TOTAL	**344.72**	**25.08**	**830.73**	**7,250.76**	**8,451.29**
Percentage	*4.08%*	*0.30%*	*9.83%*	*85.79%*	

Table 47. Error analysis for Section C of Macquarie Harbour.

Video Class	Map Class					User Total	User Accuracy
	Cobble	Reef	Sand	Seagrass	Silt		
Cobble	0	0	0	0	0	**0**	0.00%
Reef	0	88	16	0	0	**104**	84.62%
Sand	0	0	0	0	0	**0**	0.00%
Seagrass	0	0	0	0	0	**0**	0.00%
Silt	0	0	24	0	67	**91**	73.63%
Producer Total	**0**	**88**	**40**	**0**	**67**	**195**	
Producer Accuracy	0.00%	100.00%	0.00%	0.00%	100.00%		
Accuracy:	79.49%						
Kappa:	0.658						

3.6.4.2. Seagrass Distribution Section C

Seagrass was not identified in Section C of Macquarie Harbour.

3.6.4.3. Algal Distribution Section C

Small amounts of fringing reef occurred within Macquarie Harbour, however no algae was detected using the video on these reefs. This may be primarily due to the dark tannin stained waters preventing enough light reaching the substrate to support algal growth.

3.6.5. Macquarie Harbour Region Summary

Habitat distribution in Macquarie Harbour was dominated by silt habitat which extended from the shallow depths through to the deepest depth of 55 m in the central channel. Tables 48-50 illustrate the distribution of habitat by reporting section, by depth strata, by percentage of the entire harbour and by habitat. The majority of reef habitat occurred in section B in the 0-5 m depth strata. Cobble habitat consisted of 3.69% of all habitat types in the harbour and existed out to 20 m water depth. The overall accuracy of the error analysis for Macquarie Harbour was 84.63% (Table 51). Reef was correctly identified and mapped 95% of the time, and silt 100%. Lower producers' accuracies were calculated for cobble (64%) and sand (43%) due to the indeterminate nature of these two habitat types 1) because of the fuzzy nature of their boundaries and 2) due to the accuracy of identifying them correctly from the video analysis. Overall the accuracy results produced very reliable estimates of the habitats of Macquarie Harbour.

Table 48. Habitat distribution by depth for Macquarie Harbour.

DEPTH	SUBSTRATE				TOTAL
	Cobble (ha)	Reef (ha)	Sand (ha)	Silt (ha)	
0-5	969.15	125.97	4,570.57	3,360.39	**9,026.08**
5-10	104.70	26.42	769.22	3,004.22	**3,904.56**
10-15	3.39	9.71	136.19	2,973.22	**3,122.51**
15-20	0.75	0.55	28.61	3,540.00	**3,569.91**
20-25	0.00	0.00	3.36	2,310.29	**2,313.65**
25-30	0.00	0.00	2.58	1,730.28	**1,732.87**
30-35	0.00	0.00	5.73	2,169.97	**2,175.70**
35+	0.00	0.00	0.00	3,329.30	**3,329.30**
TOTAL	**1,077.99**	**162.65**	**5,516.27**	**22,417.67**	**29,174.57**
Percentage	*3.69%*	*0.56%*	*18.91%*	*76.84%*	

Table 49. Habitat distribution by reporting section for Macquarie Harbour.

HABITAT	SECTION			TOTAL
	A	B	C	
Cobble	308.74	424.53	344.72	1,077.99
Reef	21.31	116.26	25.08	162.65
Sand	3,649.51	1,036.02	830.73	5,516.27
Silt	6,664.45	8,502.46	7,250.76	22,417.67
TOTAL	10,644.01	10,079.28	8,451.29	29,174.57

Table 50. Percentage distribution of habitats by reporting section for Macquarie Harbour.

HABITAT	SECTION			TOTAL
	A	B	C	
Cobble	1.06%	1.46%	1.18%	3.69%
Reef	0.07%	0.40%	0.09%	0.56%
Sand	12.51%	3.55%	2.85%	18.91%
Silt	22.84%	29.14%	24.85%	76.84%
TOTAL	36.48%	34.55%	28.97%	100.00%

Table 51. Error analysis for all sections of Macquarie Harbour.

Video Class	Map Class					User Total	User Accuracy
	Cobble	Reef	Sand	Seagrass	Silt		
Cobble	80	0	73	0	0	**153**	52.29%
Reef	0	583	31	0	0	**614**	94.95%
Sand	0	30	180	0	0	**210**	85.71%
Seagrass	0	0	0	0	0	**0**	0.00%
Silt	45	0	129	0	853	**1027**	83.06%
Producer Total	**125**	**613**	**413**	**0**	**853**	**2004**	
Producer Accuracy	64.00%	95.11%	43.58%	0.00%	100.00%		
Accuracy:	84.63%						
Kappa:	0.768						

3.6.6. Reef and Cobble Profile

Macquarie Harbour was characterised by a relatively small proportion of reef habitat, however the reef profile within Macquarie Harbour showed a large amount of variation. In all three sections low profile reef was the dominant profile category, with between 65 % and 94 % (Figure 206). Sections A and C also contained a relatively high proportion of medium profile reef, between 25 and 32 %, these two sections also had small amounts of high profile reef (less than 2 %). In section A, medium profile reef occurred mainly around the entrance to Macquarie Harbour at Hells Gates, while in section C, medium profile reef occurred mainly around Sarah Island.

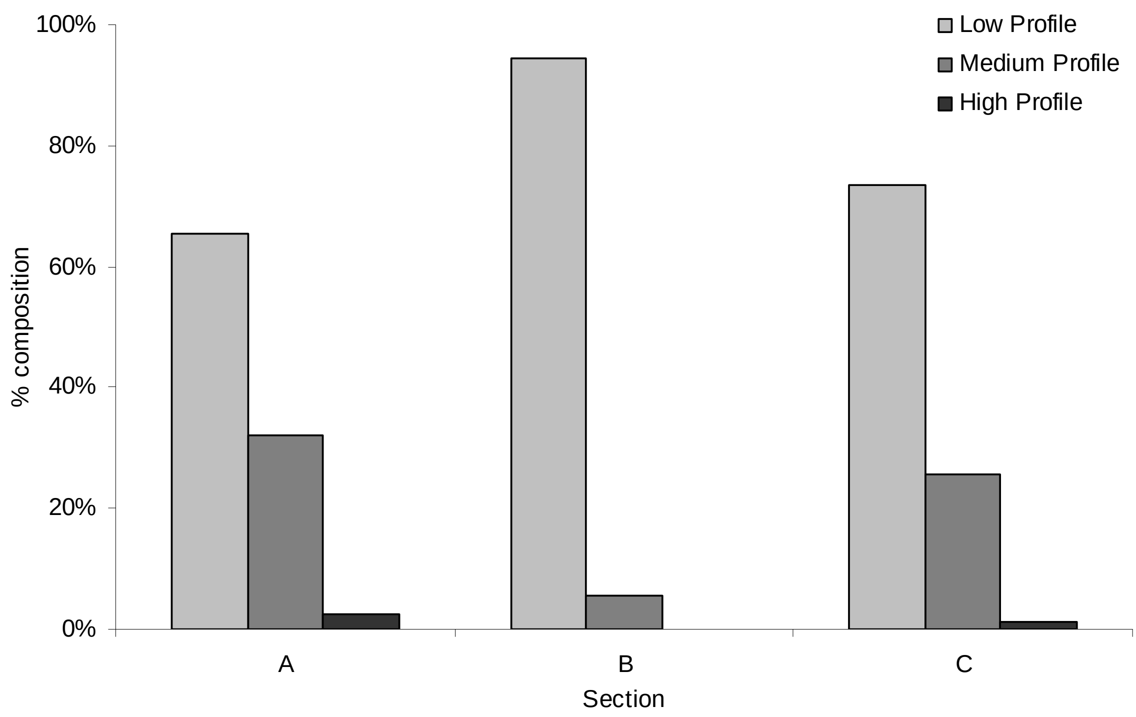

Figure 206. Percentage composition of low profile reef (< 1 m rise and fall), medium profile reef (1 – 4 m rise and fall) and high profile reef (> 4 m rise and fall) for reef substrate by section in Macquarie Harbour.

The cobble habitat within each of the three sections in Macquarie Harbour was found to be dominated by low profile cobble, with over 97 % of all cobble classed as low profile (Figure 207). The small amount of medium profile cobble was primarily due to the steep sides of several of the cobble banks, especially in section A, where medium profile cobble accounted for around 3 % of all cobble substrate.

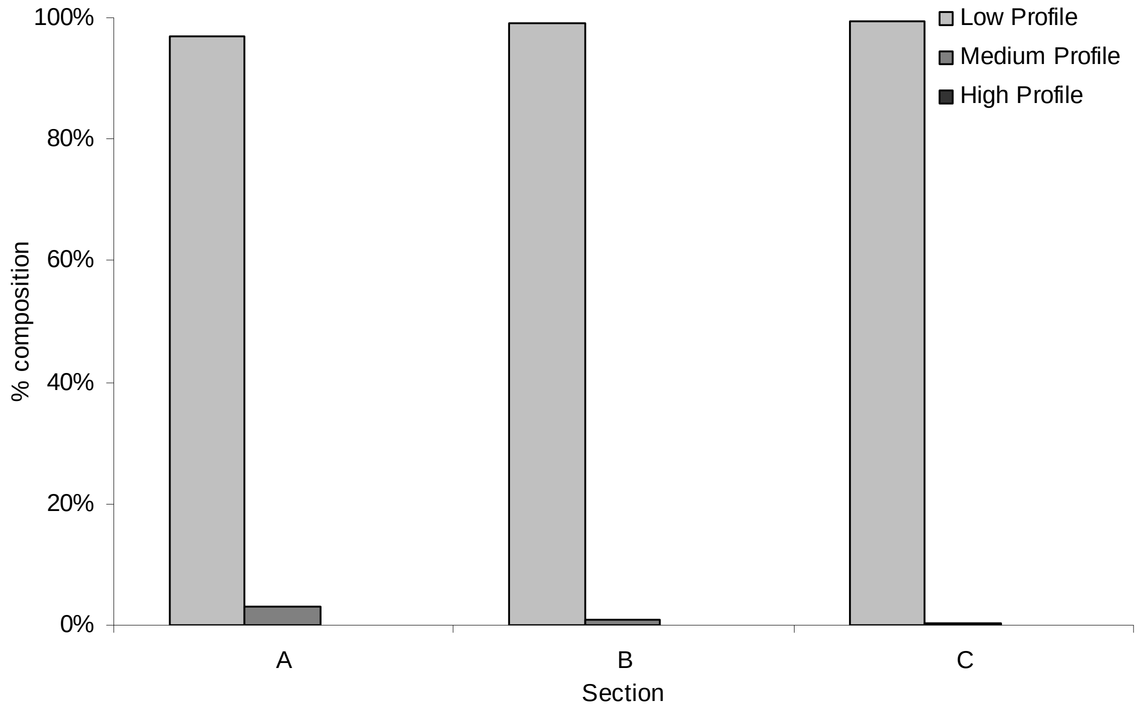

Figure 207. Percentage composition of low profile cobble (< 1 m rise and fall), medium profile cobble (1 – 4 m rise and fall) and high profile cobble (> 4 m rise and fall) for cobble substrate by section in Macquarie Harbour.

3.6.7. Particle Size Analysis

The sediments within Macquarie Harbour were dominated by silt, with median particle size in most samples greater than 4 on the Phi scale (Figure 208 -Figure 229). The shallow sand bank at the entrance to Macquarie Harbour had slightly coarser sediment, with these samples being classified as fine sand; with a median particle size between 2.6 and 2.7 on the Phi scale (Figure 226 and Figure 227). Close to the shore along parts of central Macquarie Harbour were fringing shallow banks which comprised a medium sand, generally to around 1 m depth (Figure 223 and Figure 225).

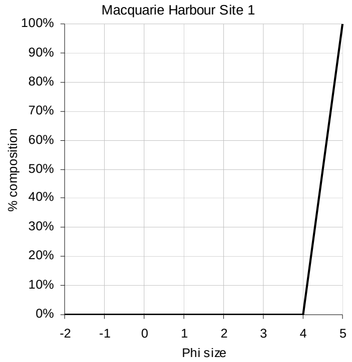

Figure 208. Macquarie Harbour Site 1, Phi 50% > 4.5, Wentworth classification = silt.

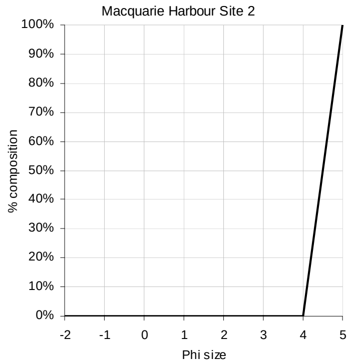

Figure 209. Macquarie Harbour Site 2, Phi 50% > 4.5, Wentworth classification = silt.

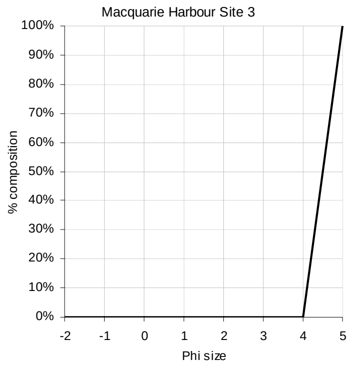

Figure 210. Macquarie Harbour Site 3, Phi 50% > 4.5, Wentworth classification = silt.

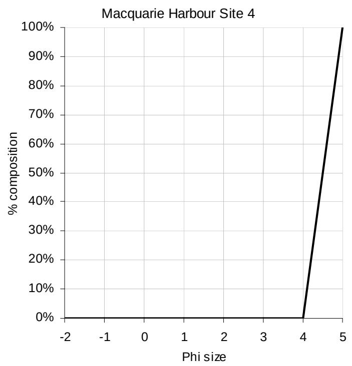

Figure 211. Macquarie Harbour Site 4, Phi 50% > 4.5, Wentworth classification = silt.

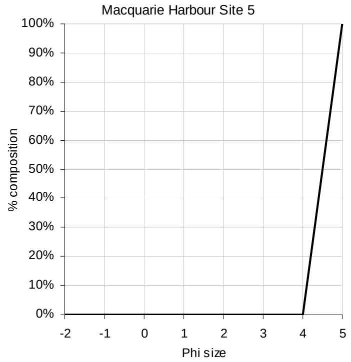

Figure 212. Macquarie Harbour Site 5, Phi 50% > 4.5, Wentworth classification = silt.

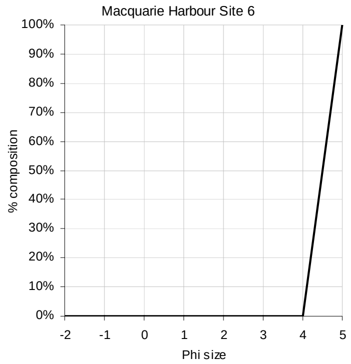

Figure 213. Macquarie Harbour Site 6, Phi 50% > 4.5, Wentworth classification = silt.

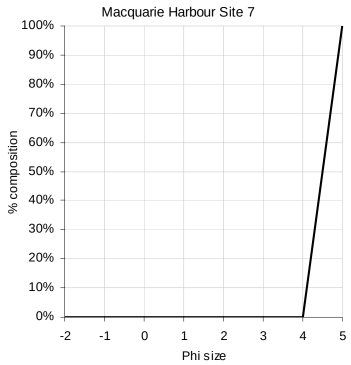

Figure 214. Macquarie Harbour Site 7, Phi 50% > 4.5, Wentworth classification = silt.

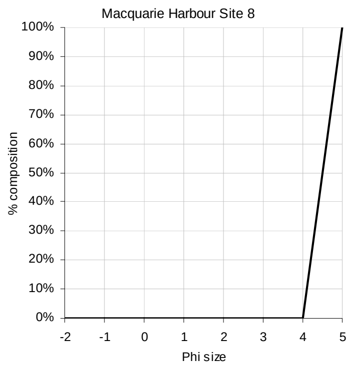

Figure 215. Macquarie Harbour Site 8, Phi 50% > 4.5, Wentworth classification = silt.

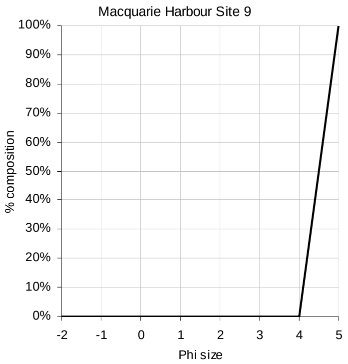

Figure 216. Macquarie Harbour Site 9, Phi 50% > 4.5, Wentworth classification = silt.

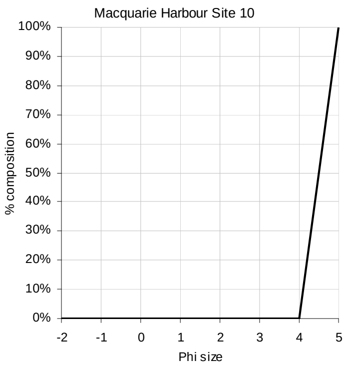

Figure 217. Macquarie Harbour Site 10, Phi 50% > 4.5, Wentworth classification = silt.

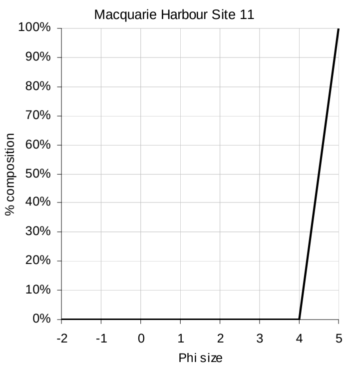

Figure 218. Macquarie Harbour Site 11, Phi 50% > 4.5, Wentworth classification = silt.

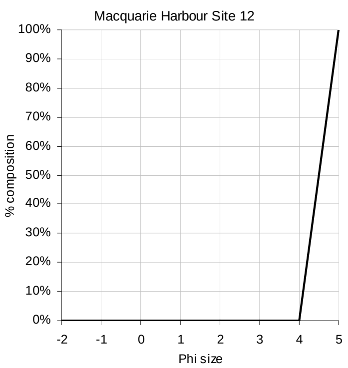

Figure 219. Macquarie Harbour Site 12, Phi 50% > 4.5, Wentworth classification = silt.

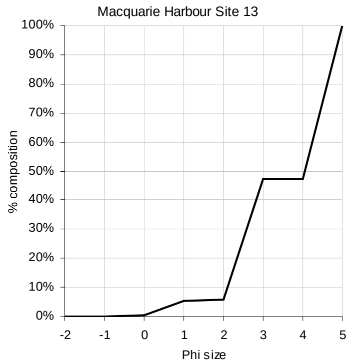

Figure 220. Macquarie Harbour Site 13, Phi 50% = 4.1, Wentworth classification = silt.

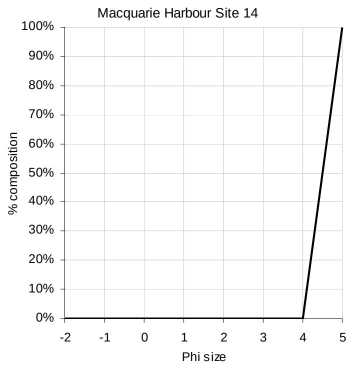

Figure 221. Macquarie Harbour Site 14, Phi 50% > 4.5, Wentworth classification = silt.

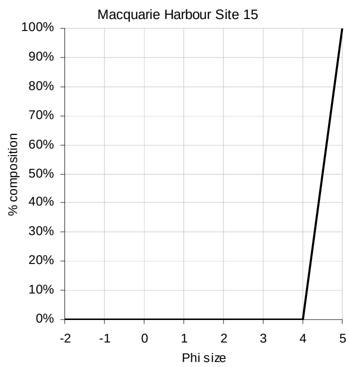

Figure 222. Macquarie Harbour Site 15, Phi 50% > 4.5, Wentworth classification = silt.

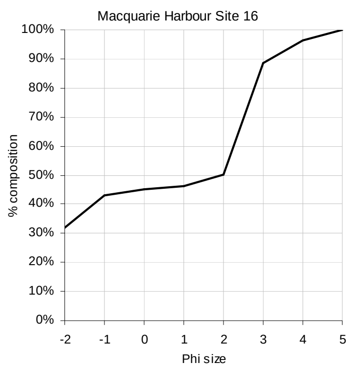

Figure 223. Macquarie Harbour Site 16, Phi 50% = 1.9, Wentworth classification = medium sand.

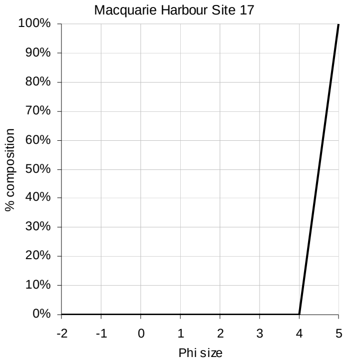

Figure 224. Macquarie Harbour Site 17, Phi 50% > 4.5, Wentworth classification = silt.

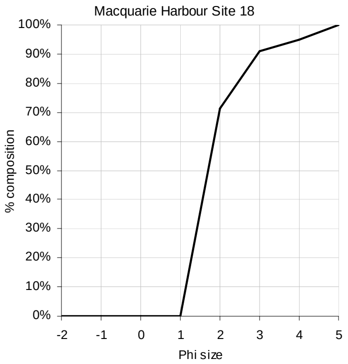

Figure 225. Macquarie Harbour Site 18, Phi 50% = 1.7, Wentworth classification = medium sand.

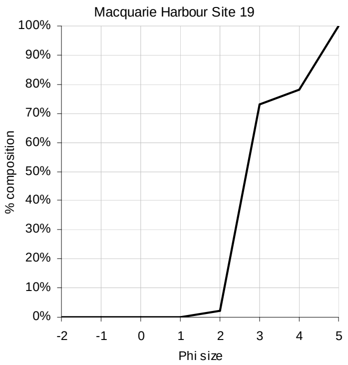

Figure 226. Macquarie Harbour Site 19, Phi 50% = 2.7, Wentworth classification = fine sand.

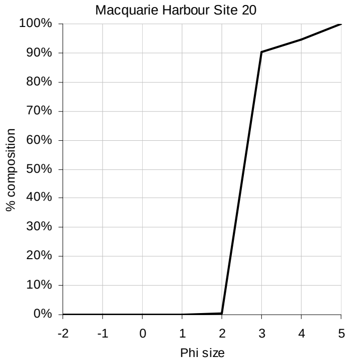

Figure 227. Macquarie Harbour Site 20, Phi 50% = 2.6, Wentworth classification = fine sand.

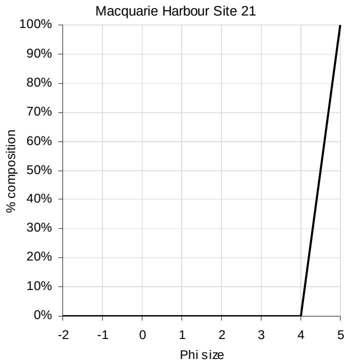

Figure 228. Macquarie Harbour Site 21, Phi 50% > 4.5, Wentworth classification = silt.

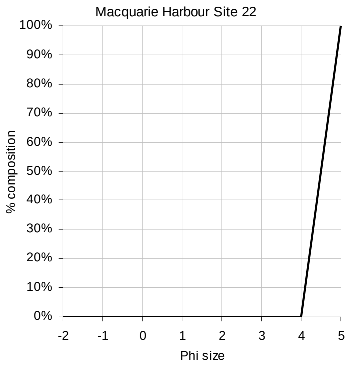

Figure 229. Macquarie Harbour Site 22, Phi 50% > 4.5, Wentworth classification = silt

4. Discussion

This study provides the necessary information required by all three NRM regions within Tasmania to contribute detailed information on the management of the marine environments within their jurisdictions. The results of this study provide a summary of the understanding of broad-scale marine habitats in the selected Tasmanian marine and estuarine waters and greatly add value to databases such as SeaMap Tasmania. These maps are available to all Tasmanians and ultimately assist the Tasmanian community to better manage its marine resources.

The Bicheno to St Helens mapping region on the east coast of Tasmania was characterised by a mix of reef and sand substrates to a maximum depth of around 60 m, although the majority was less than 30 m deep. The algal structure on the reef substrate was typical of east coast reefs (Edgar 1984, Jordan, Lucieer and Lawler. 2005, Lucieer *et. al.* 2007a, Barrett and Willcox 2001), with a mix of *Durvillaea potatorum*, *Phyllospora comosa*, *Ecklonia radiat*a, *Caulerpa* sp. and red algae. In general shallow exposed reefs contained *Durvillaea potatorum* to approximately 2 – 3 m depth, although on rocky headlands this extended deeper. Below the *Durvillaea* was a band of *Phyllospora comosa* which was dominant to 15 – 20 m depth. *Ecklonia radiata* was generally present below 5 m depth, and became the dominant algae below 20 m depth. In sheltered areas, *Ecklonia* was dominant below 5 – 10 m depth. Below 30 m depth the abundance of *Ecklonia* reduced due to limited light. Red algae and *Caulerpa* were present across parts of the coast and in most depth ranges in low cover. *Caulerpa* was particularly common around St Helens Island and St Helens point in the 20 – 30 m depth range.

The giant string kelp, *Macrocystis pyrifera*, has historically been reported along this section of coast including on the reefs off St Helens Point, St Helens Island, Paddys Island, Ironhouse Point, Piccaninny Point, Long Point, and Seymour Beach (Edyvane 2003). The current survey identified a small amount of *Macrocystis* south of Falmouth.

Vegetation on the sand substrate was limited to sparse seagrass in 10 – 25 m depth range in the vicinity of Diamond Island. The majority of the sand habitat within this mapping region is highly exposed to southerly, easterly and northerly swells.

The algal community along the section of coast from Swan Island to the Tamar River was characterised by a mix of algal species typical of the low to medium exposure of this coastline. Much of the coastline was dominated by a combination of *Cystophora* sp. and *Acrocarpia paniculata* in the 0 – 10 m depth range, with varying amounts of *Sargassum* sp., *Caulocystis* sp., *Sporonchus* sp and a suite of other species in low amounts This type of assemblage is typical for much of the moderately exposed north coast (Edgar 1981, Lucieer *et. al.* 2007b, Barrett and Willcox 2001). East of Cape Portland, the algal assemblage more closely reflected the algal assemblages of the east coast (Lucieer *et. al.* 2007a, Jordan *et. al.* 2005), with large amounts of *Phyllospora comosa* in shallow water and increasing amounts of *Ecklonia radiata* below 10 m depth. This section of coast has a north easterly aspect, and is exposed to the east coast swells, with this increased exposure leading to a changed algal community. *Phyllospora comosa* and *Ecklonia radiata* were again prominent on the northern end of Waterhouse Island, which has a higher level of exposure than the majority of the northeast coast. West of Waterhouse Island, reef habitat below 10 – 15 m depth was generally dominated by red algae, with small amounts of sponge and incrusting invertebrates below 20 – 25 m depth.

Cobble habitat was present in small patches from the mouth of the Tamar River to Double Sandy Point, and again around Waterhouse Island and Cape Portland. The cobble habitat on the northeast coast was generally in smaller patches compared to the extensive cobble habitat previously mapped on the northwest coast (Lucieer *et. al.* 2007b). Generally the algal cover on cobble habitat was lower than for reef habitat. Very little cobble was surveyed in the 0 – 5 m depth range. Between 5 and 10 m depth *Cystophora sp.*, *Caulocystis sp*, *Sargassum sp.* and red algae were the dominant component of the algal community, especially west of Waterhouse Island. From Low Head to Five Mile Bluff *Acrocarpia paniculata*, mixed red and brown turfing algae, and *Caulerpa* sp. were also present in this depth range. Below 10 m the cobble habitat was dominated by red algae, with the exception of the region between low head and Five Miles Bluff, which also contained large amounts of red and brown turfing algae, and from Five Mile Bluff to Double Sandy Cape, which had a large amount of filamentous brown algae, especially below 20 m depth.

The algal communities within the Tamar River displayed strong trends with both depth and also distance from the mouth of the river. At the mouth of the Tamar, the algal community was typical of exposed sections of the north coast, with a mix of *Phyllospora comosa*, *Ecklonia radiata*, *Cystophora* sp., *Caulocystis* sp., *Acrocarpia paniculata*, *Carpoglossum confluens* and *Sargassum* sp. in depths less than 10 m, with red algae becoming dominant below 10 m depth (Lucieer *et. al.* 2007b, Barrett and Willcox 2001). From the mouth of the Tamar to Beauty Point the algal community changed to reflect the increasing influence of the river water, with *Ecklonia radiata*, *Sargassum* sp. and red algae common to 10 m depth, below which red algae were the dominant group. Finally south of beauty point the algal community was typical of low light and relatively sheltered waters, with a mix of *Sargassum* sp., turfing red and brown algae, and red algae to approximately 5 m depth, below which very little algae growth existed.

The changing structure of the algal community from the mouth of the Tamar River to the Batman Bridge is a reflection of the change from Bass Strait influence to the river influence. Algal communities at the mouth of the Tamar are structured by medium levels wave action and good light penetration. From Low head to Beauty Point light penetration reduces with the increasing influence of the highly turbid river water, and wave action is reduced to low levels. South of Beauty Point light levels are low and so is wave action.

The Tamar River contains extensive invertebrate communities in depths below 15 – 20 m from Low Head to Beauty Point. These invertebrate communities are dominated by sponges (Phylum porifera), but also have significant amounts of octocorals (including soft corals, octocorals and gorgonians), Hydroids, and Bryozoans, with small amounts of zoanthids and anemones. Ascidians were also a small component of this community, and although more closely related to vertebrates were included in the analysis due to their growth habit. The mouth of the Tamar is a particularly unique area along the north coast due to a combination of strong tidal currents, deep water (to 55 m depth), extensive reef and cobble habitat and a combination of both Bass Strait and estuarine water. Previously extensive invertebrate communities have been identified along the north coast off Rocky Cape and Sisters beach (Lucieer *et. al.* 2007b) and in the north east off Waterhouse island (Barrett and Willcox 2001), where reef habitat extends below 20 m depth, with sufficient current flows.

Orielton Lagoon is a Ramsar listed wetland and is an important habitat for migratory birds. The lagoon is degraded due to land clearing in the catchment and the surrounding urban development. Algal Blooms within the lagoon were frequent in the 1990's (Jones *et. al.* 1994, Davies *et. al.* 2006), primarily attributed to large nutrient influx from Midway Point (Davies *et. al.* 2006). Modification of the culvert infrastructure to enhance tidal exchange was conducted in 1998 to help disperse nutrient loads and stabilise salinity within the lagoon (Davies *et. al.* 2006). The small amount of hard substrate within Orielton Lagoon was dominated by a mix of *Codium* sp. and red algae, which are common in sheltered and often nutrient rich waters. On the unconsolidated substrate there were also small amounts of filamentous algae, including *Gracilaria* sp., which is often associated with increased levels of nutrients. Interestingly no seagrass was observed in Orielton Lagoon, compared to nearby Pitt Water which contains large amounts of seagrass (Mount *et. al.* 2005).

Moulting Lagoon, like Orielton Lagoon, is a Ramsar listed wetland, and supports a large number of water birds (Tasmanian Parks and Wildlife Service 2007). It is a shallow lagoon, which is dominated by dense beds of the seagrass *Ruppia* sp., with small amounts of the seagrasses (*Heterozostera tasmanica* and *Zostera muelleri*) and hornwort (*Ceratophyllum* sp.?). The *Ruppia* comprises at least two species *R. megacarpa* and *R. polycarpa* (Tasmanian Parks and Wildlife Service 2007). *Heterozostera* and *Zostera* were confined to the banks of the entrance channel and the lower part of Moulting Lagoon.

Macquarie Harbour supported little algal and seagrass growth, primarily because of the lack of light penetrating the water column (due to the highly tannin stained freshwater layer that occupies the euphotic zone) (O'Connor *et. al.* 1996). Previous studies have only identified small amounts of the seagrass *Zostera muelleri* at Yellow Bluff and Swan Basin, with the brown algae *Ectocarpus fasciculatus* collected from fish farm nets near Liberty Point (O'Connor *et. al.* 1996).

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Appendix 1. Image Mapper (on DVD)

The habitat maps with linked video, images and statistical results of the individual reporting sections can be viewed on the attached DVD.

Appendix 2. Algal identification images (on DVD)

ID images of algae identified in this region can be viewed in the HTML document on the attached DVD.

Appendix 3. Aerial Photograph Record.

Aerial photographs sourced for digitisation in this research indicating Photo ID number, Scale and Date of Photo Acquisition.

1393-10	1:42000	02/03/2005
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1404-162	1:24000	14/02/2006
1404-163	1:24000	14/02/2006
1404-177	1:24000	14/02/2006
1404-179	1:24000	14/02/2006
1404-186	1:24000	14/02/2006
1404-198	1:24000	14/02/2006
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