

ESTUARINE HABITAT MAPPING IN THE
DERWENT – 2007
A Resurvey of Marine Habitats by SeaMap Tasmania

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June 2007



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Summary

The Derwent Estuary is a large drowned river valley situated in south-east Tasmania that extends for a distance of 52 kilometres and covers an area of around 195 km² between Iron Pot and New Norfolk. The physical structure of the estuary varies substantially along its length, with the upper reaches highly stratified due to consistent freshwater input from the Derwent River and the lower reaches generally well mixed. The freshwater tends to flow on the surface along the eastern shore with saline water travelling upstream on the bottom.

In 2001 the Derwent Estuary was first mapped by SeaMap Tasmania (Marine Research Laboratories, Tasmanian Aquaculture and Fisheries Institute). This year (2007), TAFI along with the Derwent Estuary Program (DEP) initiated a remap of the Derwent Estuary to update the bathymetric and habitat distribution GIS databases.

The Derwent Estuary Program is committed to improving the environmental management strategy for the Derwent Estuary, together with an associated long-term monitoring program and agreements for implementation of specific environmental improvement programs. The results of this co funded survey provide natural resource managers, industry and the community with the information needed to contribute to biodiversity conservation and natural resource management of the Derwent Estuary.

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1. Introduction

The distribution of the Derwent Estuary's sub-tidal habitats between Iron Pot and New Norfolk were remapped between April and June 2007 in a study initiated by the Derwent Estuary Program. This report details marine habitats that were identified through field mapping using a combination of an echo-sounder and video assessment. Habitats were classified into several categories that generally represent seagrass, consolidated habitat and unconsolidated habitats. A number of video transects were also conducted across different habitats in order to describe the dominant flora.

The estuary was classified and analysed in three sections, identified as the lower, middle and upper reaches, due to differences in the physical aspects of shoreline morphology, bathymetry and salinity. Rocky reef habitats occurred primarily in the lower reaches of the Derwent Estuary, although some narrow margins of reef were also present in the middle reaches. The structure of the macroalgae assemblages that occurred on these reefs varied substantially between eastern and western shorelines, position along the estuary and depth consistent with the results of the initial survey in 2001 (Jordan et al, 2001). In general, the habitat was dominated in the shallow depths by *Lessonia corrugata* and *Ecklonia radiata* while *Carpoglossum confluens*, *E. radiata*, *Caulerpa* sp., and unidentified red algae dominated the deeper section. Parts of the reef along the western shoreline also had a canopy *Macrocystis pyrifera*. The introduced algae *Undaria pinnatifida* also occurred in small amounts on the western shoreline between Tinderbox and the Alum Cliffs (Edgar 1997). The diversity and abundance of macroalgae decreased in the northern part of the lower reaches, with only small amounts of red and brown algae present on the rocky substrates within the middle reaches.

Seagrass habitats were restricted to small beds within the lower (Halfmoon Bay and Opossum Bay) and middle parts (Cornelian Bay, Wilkinsons Point, Dogshear Point, Woodville Bay and Old Beach) of the Derwent Estuary that had a combined area of around 0.17 km². The beds consist primarily of *Heterozostera tasmanica*, although small amounts of *Zostera muelleri* were present on the inner margin of beds in the middle reaches. No beds of seagrass were found in either the northern or southern end of Ralphs Bay. The survey of 2001 was conducted in early winter and so it was not possible to compare to the results of this study (2007) which was conducted in early Autumn.

Aquatic macrophytes occurred in large beds in the northern part of the middle section and southern part of the upper section of the Derwent Estuary. In the middle section, extensive beds occurred in the mouth of the Jordan River, southern side of the channel at Granton and northern side of the channel adjacent to Woods Point, usually from the shoreline to around 3 m deep. These beds had a combined area of around 2.5 km², with *Ruppia megacarpa* the dominant component, and smaller amounts of *Heterozostera tasmanica*. *Ruppia megacarpa* is able to tolerate the wide range of salinities (Edgar 1997) which occur in this middle and upper section of the Derwent River estuary. The density of *Ruppia* was high and evenly distributed across the beds in all areas, with often a large biomass of filamentous algae also present in the beds.

Unvegetated habitats were the most dominant habitat type within the Derwent Estuary representing around 40 % of all sub tidal habitats, although large differences occurred in the distribution of sediment type between the lower, middle and upper reaches. The lower reaches were represented by sand all depth zones in the mouth, the northern and southern parts of Ralphs Bay and in shallow depths on both eastern and western shores. Silt and sand occurred in the deeper section from around Halfmoon Bay to Gellibrand Point and the northern end of Ralphs Bay and in middle depths on the western shore from Cartwright Point to Sullivans Cove. On the eastern shore north of Droughty Point, sand/silt occurred adjacent to the sand beach habitats up to Kangaroo Bluff. The silt habitat occurred in the deeper parts of the lower reaches north of Gellibrand Point.

The middle reaches of the estuary was dominated by silt habitat, although areas of sand occurred in shallow depths on the western shore up to Cornelian Bay and the eastern shore almost continuously up to Woodville Bay. A large area was also present between Dogshear Point and the eastern shoreline. Silt was restricted to several small areas including Elwick Bay and east of Dogshear Point. The channel region of the upper reaches was found to contain mostly silt, which also dominated the deeper sections.

Approximately 70 introduced and cryptogenic species have been identified from within the Derwent River estuary (Aquenal 200, 2002). Several of these species have broad distributions within the lower and middle reaches of the river, including the introduced marine algae *Undaria pinnatifida*, the seastars *Asterias amurensis*, and *Patiriella regularis*, the screwshell *Maoriculpus roseus*, the Pacific oyster *Crassostrea gigas*, and the fan worm *Myxicola infundibulu* (Morrice 1995, Coughanowr 1997, Macleod and Helidoniotis 2005). Information on the distribution of these species was collected through these surveys.

The main objectives of this survey were to:

- Provide detailed marine habitat maps at 1:12,500 scale of the Derwent Estuary from New Norfolk to the Iron Pot.
- Compile a spatial database (GIS) for all the seagrass and adjacent habitat types and publish the maps on the Land Information System Tasmania (LIST) web mapping site and the SeaMap Tasmania website (<http://www.utas.edu.au/tafi/SeaMap/>).
- To provide crucial information to the Derwent Estuary Program to assist in the establishment of a database for decision-making

The outputs of the survey include:

- The production of 1:12,500 marine habitat maps in the identified areas published in hardcopy and on the Internet.
- Production of an internal report to the Derwent Estuary Program, detailing the biological and physical structure within the mapping areas and the extent of

key habitat types (spatial statistics from the GIS).

- Generation of a CD with *Image Mapper* software for viewing video linked to habitat maps and representative images and statistics of biological communities (Appendix 3)

The results of this study contribute to the SeaMap Tasmania (TAFI) database providing natural resource managers, industry and the community with up to date information on the distribution and extent of marine habitats in Tasmanian waters.

2. Methods

Information on the distribution of benthic habitats in this report was collected through acoustic surveys, underwater video and visual observations. A review of the aerial photographs in DPIW's archives for the period 2001-2007 did not present any photographs that were very useful to the delineation of marine habitat boundaries. This was either due to the scale of the photograph or due to the suspended matter in the water column making the differentiation of habitat types difficult. Field ground-truthing and survey work involved a series of transects perpendicular to the coast at distances no greater than 200 m apart. The final maps were produced based on the 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 Acoustic Data Collection

Habitat boundaries were identified from 0-45 m using a Simrad ES60 acoustic echo sounder and video surveys. A series of parallel transects were conducted along the coastline spaced approximately 200 m apart. 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 per the classifications detailed in Table 1.

Field data was sampled at fixed time intervals adhering to a "zigzag" pattern of transects perpendicular to the coast (Figure 1). These transects were run at 200 m intervals along the coastline, 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.

2.2 Bathymetry

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.

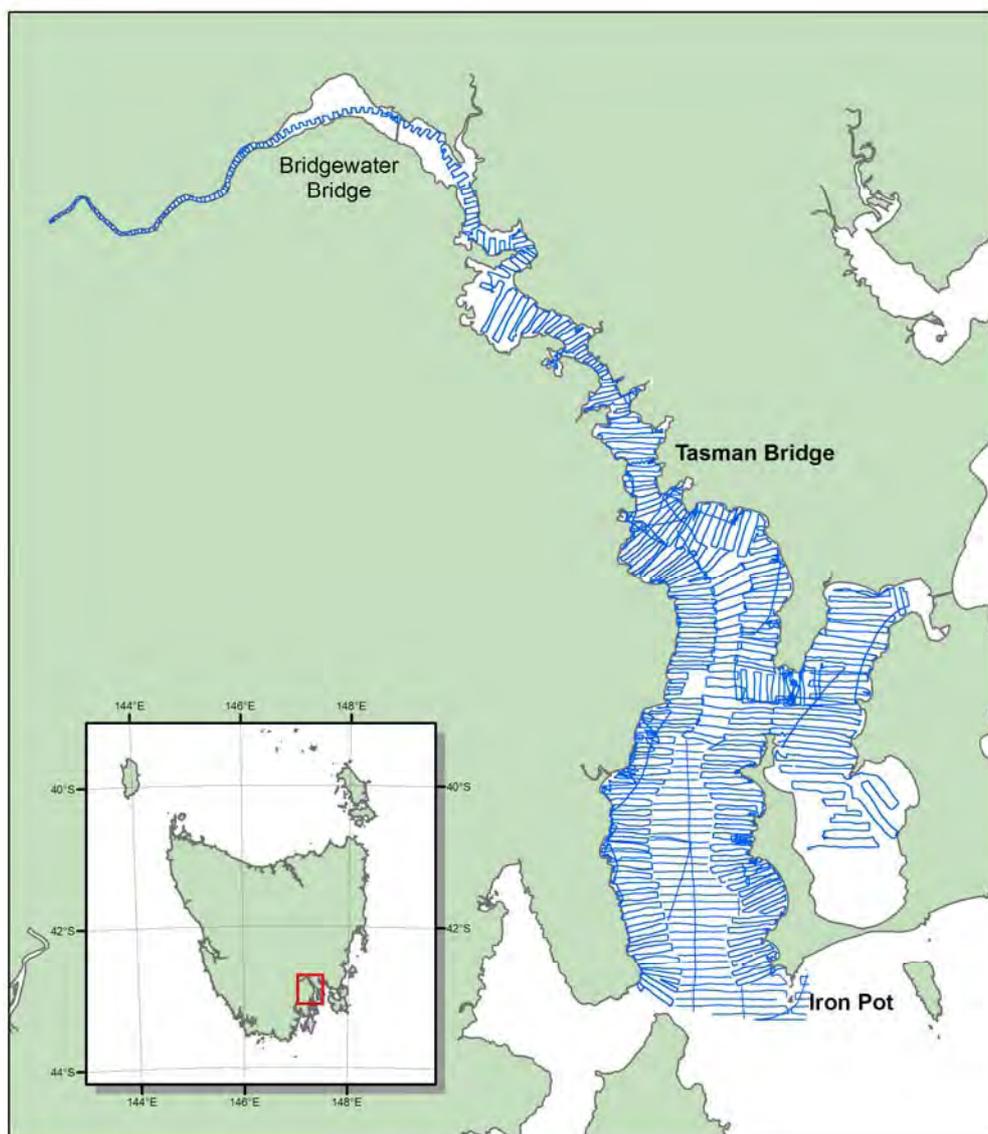


Figure 1. Acoustic transects sampled from the Iron Pot to New Norfolk.

2.2.1 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.

2.2.1 Bathymetric contour generation

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 (Burrough and McDonnell, 1998). 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, then to create a smooth contour set the TIN was converted to a 5m grid and a 5x5 mean focal filter applied to the grid. 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 at 5 m, 10 m, 20 m, 30 m, 40 m, and 50 m.

2.3 Video Data Collection

A submersible digital video camera, MorphCam (MorphVision, NSW, Australia) was deployed at selected locations throughout the study region (Figure 2). This was used to verify the echo sounder substrate classification and obtain more detailed information on algal distribution. Positional information was recorded for each video drop as a series of GPS co-ordinates and also as a direct overlay of the GPS output (position, date and time) onto the video. The video was analysed for dominant flora and fauna for each habitat type. Algae and seagrasses were identified to the lowest taxonomic level possible, For many of the large brown algae, identification could be done to species level, where as red algae were only able to be identified as a group due to a combination of the resolution of the video and the general difficulty in identifying red algae (Fuhrer 1988). Appendix 1 and 2 detail the video analysis by site.

2.4 Cartography

The classified data files from Echo View 3.30 were imported into ArcGIS 9.1 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 underwater video documentation was used to help verify the habitat type and the interface between different substrates. The classification table followed for the mapping of habitats on this section of coast is shown in Table 1.

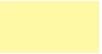
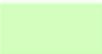
| | |
|---|---|
| Reef | |
|  | REEF The term “reef” applied to any consolidated substrate, though typically consists of rocky outcroppings. It may be of any profile or rugosity. |
|  | COBBLE This definition referred to a hard bottom type consisting of boulders and smaller rocks. This category was usually found in the main channel areas with high flow rates, either tidal or fluvial and occasionally overlapped with the hard sand categories. |
| Unconsolidated Substrates | |
|  | SAND Sand was the most commonly encountered unconsolidated substrate. It represents the coarser end of a scale of sediments from silt to sand, though was mostly found to be fine sand. |
|  | SILT Silt substrate was only found in the deepest and largest central basins. This habitat category represents the finest unconsolidated substrate. Silt is characterised on the sounder by a lack of a second echo and often little scatter in the trace tail. |
| Vegetated unconsolidated substrate | |
|  | SEAGRASS The “seagrass” category referred to the ‘dense’ areas of seagrass where the substrate, usually sand, was completely covered by seagrass and the patch size is greater than 20 m wide. The dominant seagrass type mapped in the region was <i>Heterozostera tasmanica</i> . The habitat mapping presented here, details the extent of the larger beds of this species. |
|  | AQUACTIC MACROPHYTES This category covers all the vegetated areas that are either unclear as to their specific habitat type, or are a habitat type that is not being mapped for this project. Almost all of the “vegetated” category mapped for this project consisted of saltmarsh within the intertidal zone within section A of the estuary. |
|  | VEGETATED The term “vegetated” habitat referred to areas of dense vegetation that included seagrasses and other aquatic macrophytes that were so densely mixed it was difficult to map them as separate classes. In the case of the Derwent this included the seagrass species <i>Heterozostera tasmanica</i> and <i>Ruppia megacarpa</i> . |

Table 1. Habitat classes identified within the Derwent Estuary in 2007.

Appendix 3 contains the habitat maps linked with the video file footage in Image Mapper for further display, query and analysis. Appendix 4 contains the ESRI shapefiles of the marine habitats and contours for the exclusive use of the Derwent Estuary Program.

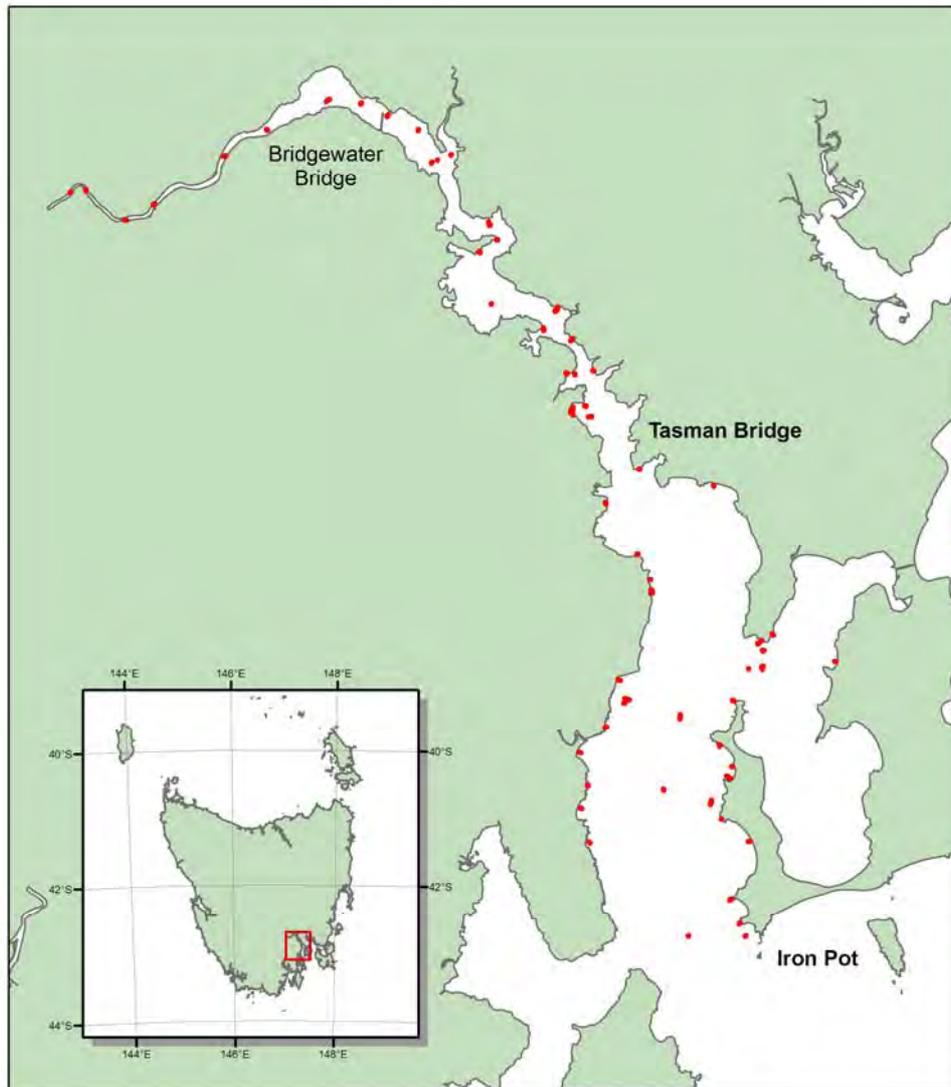


Figure 2. Video transect points collected within the Derwent Estuary in 2007.

3. Results

For this report, the results and analysis have been divided into three reporting sections as shown in Figure 3. A table detailing the extent of each habitat type is presented for each of these areas in the following section.

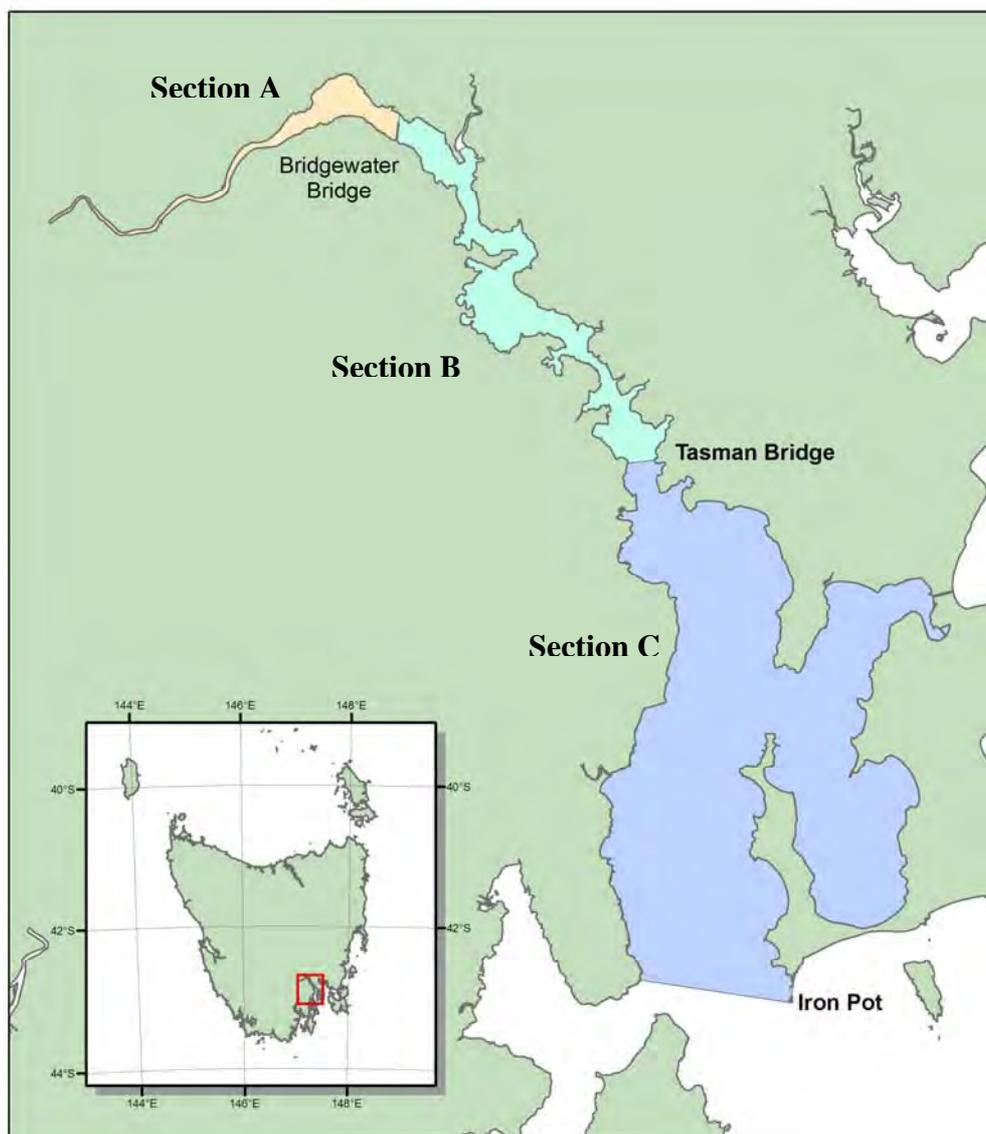


Figure 3. Reporting regions for the Derwent Estuary 2007 resurvey.

3.1 Bathymetry

Depth and GPS position were constantly recorded during the field surveys. From this data bathymetric contours were generated. While the fine scale contours are printed on the 1: 12,500 habitats maps an overview of the bathymetry of the estuary is presented in Figure 4.

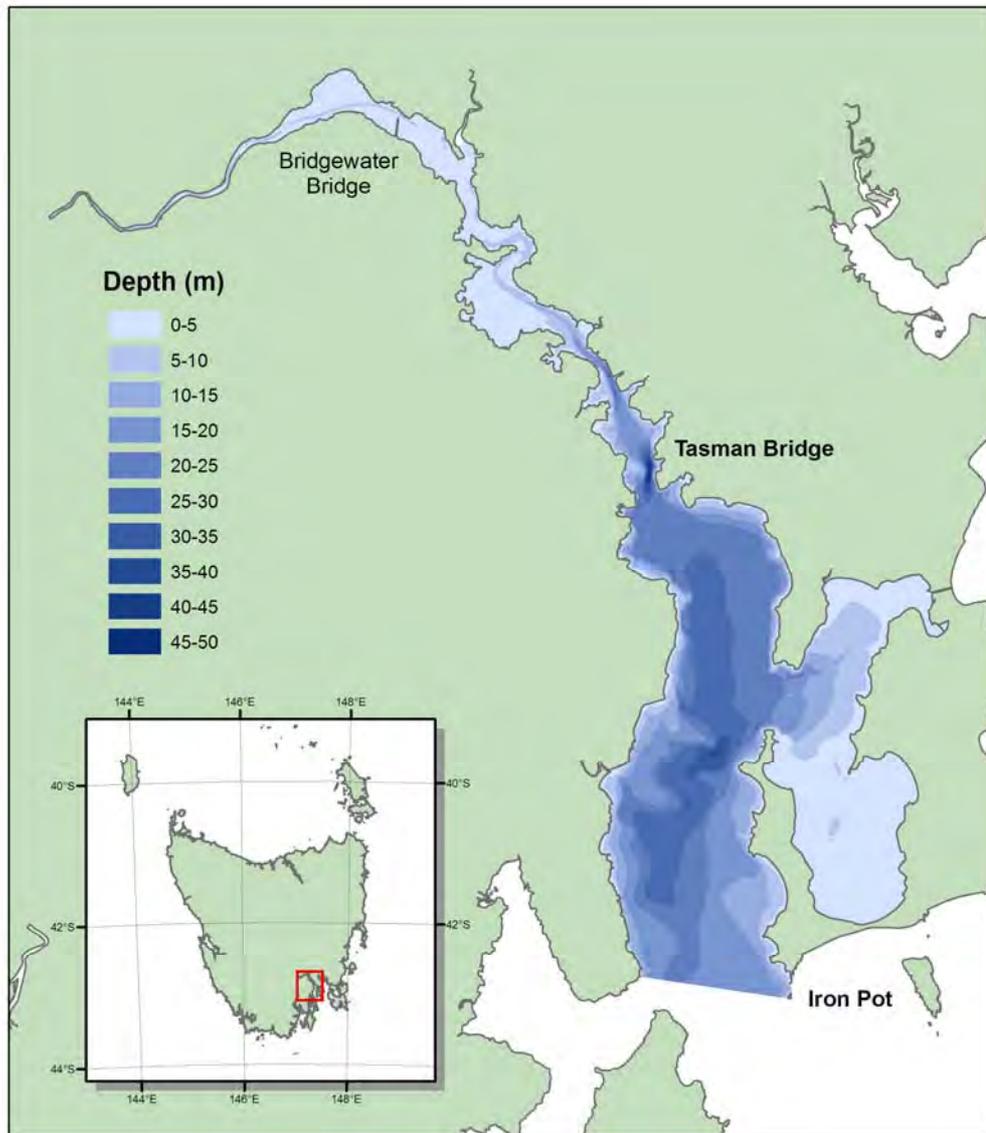


Figure 4. Bathymetry of the Derwent Estuary 2007.

3.2 Section A: Upper: Bridgewater Bridge to New Norfolk

The bathymetric record for Section A is shown in Figure 5. The habitat maps are presented in section 3.7 of this report. The bathymetric map shows that the region above the Bridgewater Bridge is mainly 5 m or less except for the main channel that is 10 m deep on average.

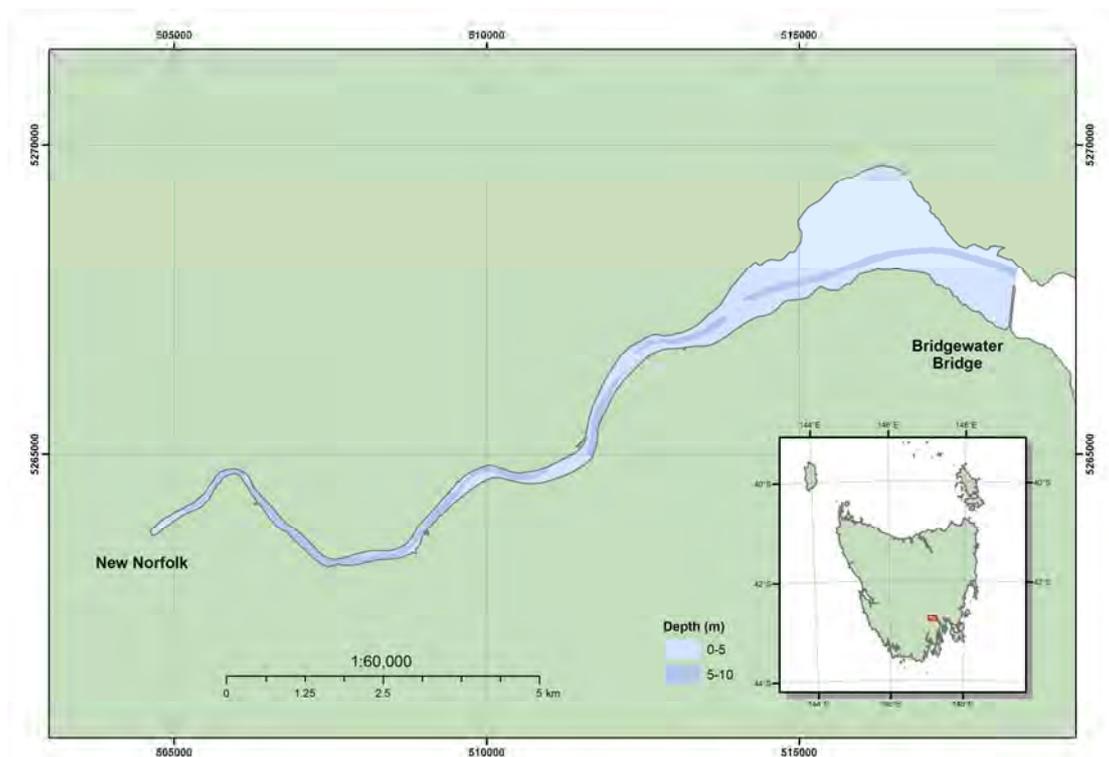


Figure 5. Section A Bathymetry from New Norfolk to Bridgewater Bridge

3.2.1 Habitat Distribution

The distributions of habitats (ha) by depth in Section A are shown in Table 2. At the top end of the estuary the majority of habitat consists of aquatic macrophytes and silt below low water mark and vegetated habitat from the low water mark to high water mark which could not be surveyed with by acoustic methods.

| Depth range | Aquatic Macrophyte | Cobble | Reef | Sand | Seagrass | Silt | Vegetated |
|-------------|--------------------|----------|----------|------|----------|----------|-----------|
| 0-5 | 259.79 | 11.78 | 13.90 | | | 163.53 | 197.71 |
| 5-10 | | 15.38 | 13.77 | | | 105.01 | |
| 10-15 | | | | | | | |
| 15+ | | | | | | | |
| Total | 259.79 ha | 27.16 ha | 27.67 ha | 0 | 0 | 268.54ha | 197.71 ha |

Table 2. Distribution of marine habitats by depth in Section A.

3.2.2 Algal Distribution

There was very little consolidated substrate in the upper Derwent. The majority of the consolidated substrate occurred in the main river channel around New Norfolk, which was dominated by cobble and rocky ridges. There was little algal growth on the consolidated substrate partially due to the lack of light penetrating through the water column, and partially due to the high sediment load covering the consolidated substrate.

3.2.3 Seagrass Distribution

Extensive beds of the aquatic macrophyte *Ruppia megacarpa* and the seagrass *Heterozostera tasmanica* occurred on the shallow mud flats between the Bridgewater

Bridge and Dromedary. These beds were a mixture of both species, with *Ruppia* being the dominant component. The seagrass species, *Heterozostera* extended to approximately 2 m depth on the margins of the beds, with *Ruppia* common in less than 1 m depth.

3.3 Section B: Middle: Tasman Bridge to Bridgewater Bridge

The bathymetric record for Section B is shown in Figure 6. The bathymetric map shows that the upper region below the Bridgewater Bridge has a depth of < 5 m and starts to become deeper from Cornelian Bay to the southern end of the estuary.

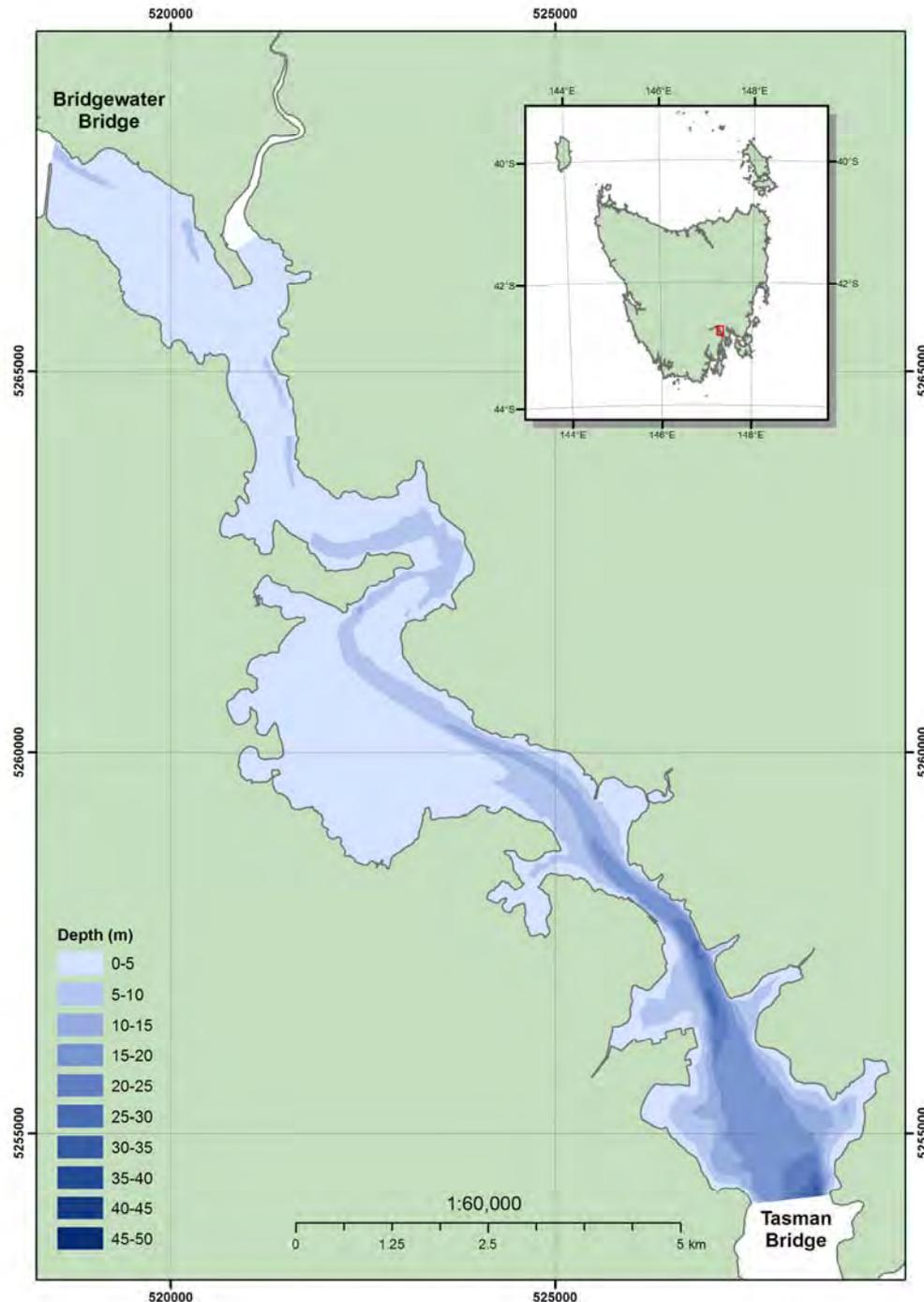


Figure 6. Section B Bathymetry from Bridgewater Bridge to Tasman Bridge

3.3.1 Habitat Distribution

The distributions of habitats (ha) by depth in Section B are shown in Table 3. A substantial amount of aquatic macrophytes (404 ha) was present to the southern side of the Bridgewater Bridge. The unconsolidated habitat was dominated by silt with only a small proportion of sand in this section of the estuary.

| Depth | Aquatic Macrophyte | Cobble | Reef | Sand | Seagrass | Silt |
|-------|--------------------|--------|---------|-------|----------|-----------|
| 0-5 | 404.05 | | 46.98 | 1.7 | 9.27 | 1297.75 |
| 5-10 | 0.0029 | | 0.18 | | | 411.04 |
| 10-15 | | | | | | 138.44 |
| 15+ | | | | | | 257.74 |
| Total | 404.05ha | 0 | 47.16ha | 1.7ha | 9.27ha | 2104.97ha |

Table 3. Distribution of marine habitats by depth in Section B.

3.3.2 Algal Distribution

There was very little reef in the mid Derwent section, with the majority of the reef fringing the shoreline and extended to less than 2 m deep. The reef in the mid Derwent section was generally barren with little algal growth. The algae that was present was commonly filamentous red and brown algae.

3.3.3 Seagrass Distribution

In the middle reaches of the Derwent, between the Tasman Bridge and the Bridgewater Bridge there were numerous large beds (9.27 ha or 0.09km² in total) of *Heterozostera tasmanica*, often mixed with the aquatic macrophyte *Ruppia megacarpa*. The major beds were located south of the Bridgewater Bridge, in the mouth of the Jordan River, and opposite Austins Ferry. There was also a small bed of *Heterozostera tasmanica* in Cornelian Bay. This section of the river also has small amounts of the intertidal seagrass *Zostera mulleri* in some of the sheltered bays on the western shoreline, including Cornelian Bay and Prince of Wales Bay.

3.4 Section C: Lower: Tasman Bridge to Iron Pot

The bathymetric record for Section C is shown in Figure 7. The bathymetric map shows that below the Tasman Bridge a deep channel to 50 m is present. Ralphs Bay is characterised by depths of less than 5 m. Overall, the majority of area in the centre of the Derwent Estuary is characterised by depths between 20 and 30 metres.

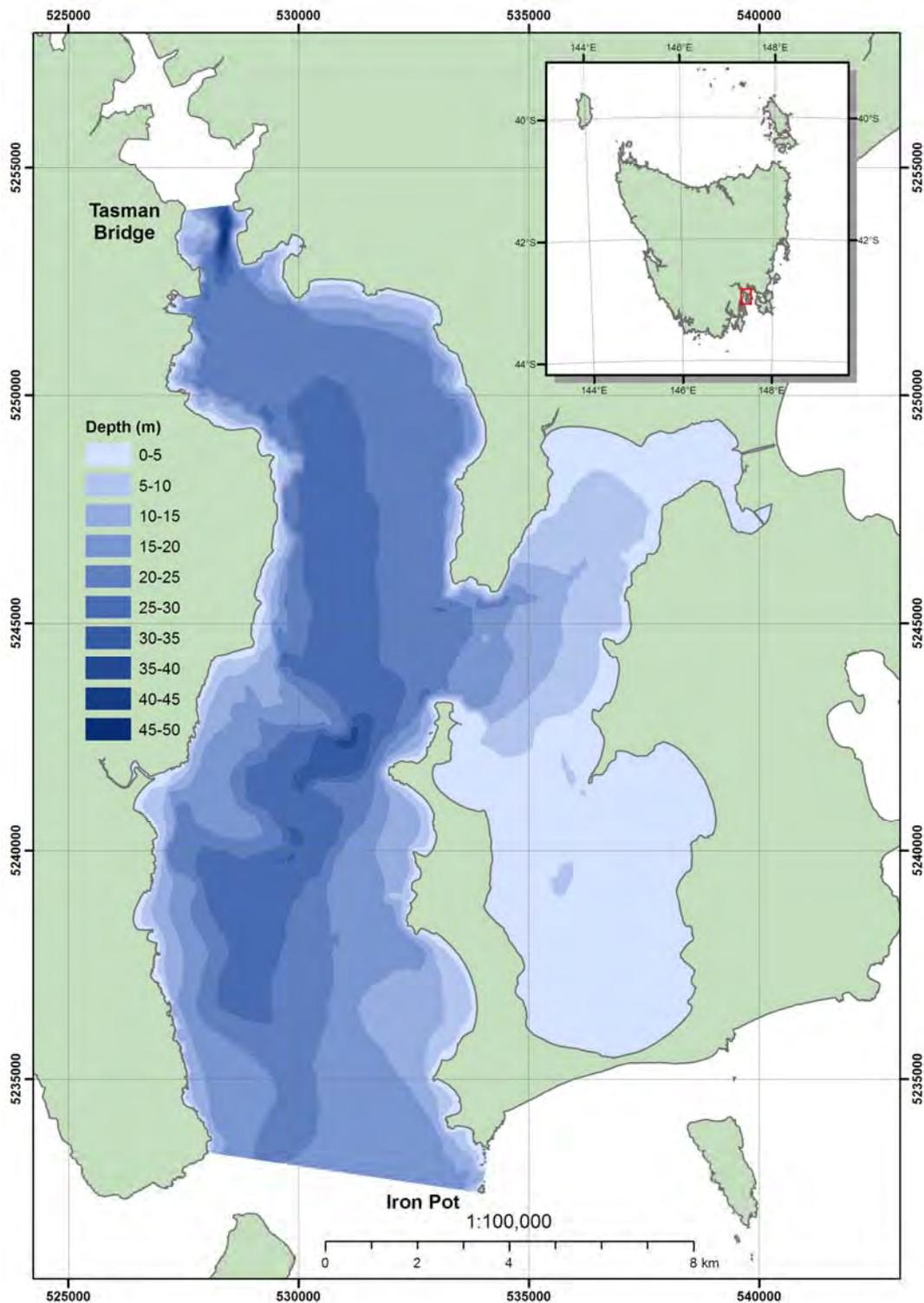


Figure 7. Section C Bathymetry from the Tasman Bridge to Iron Pot

3.4.1 Habitat Distribution

The distribution of habitats by depth in Section C is shown in table 4. The majority of reef habitat in this section was present in the 0-5 m depth range. Cobble and aquatic macrophytes were not mapped in this section. The deeper areas of this section consisted of silt habitat moving sand up into the shallower regions.

| Depth | Aquatic Macrophyte | Cobble | Reef | Sand | Seagrass | Silt |
|-------|--------------------|--------|-----------|--------------|----------|-----------|
| 0-5 | | | 251.84 | 3977.12 | 8.712 | 38.84 |
| 5-10 | | | 62.75 | 1461.70 | 0.007 | 95.5 |
| 10-15 | | | 19.15 | 1300.22 | | 300.74 |
| 15+ | | | 1.64 | 3699.44 | | 4996.82 |
| Total | | | 335.38 ha | 10,438.48 ha | 8.719 ha | 5431.9 ha |

Table 4. Distribution of marine habitats by depth in Section C.

3.4.2 Algal Distribution

The majority of the macro algae occurred in this section of the Derwent. The waters of the lower Derwent have a stronger marine influence than further up the estuary, with the algal communities reflecting this influence. The algae on the eastern and western shorelines and Ralphs Bay showed differences in the algal composition, and so are described separately.

3.4.2.1 Western Shoreline

The section of coast from Tinderbox to Sandy Bay contains a significant proportion of the reef habitat within the Derwent Estuary. The distribution of algae along this section of coast reflects the more oceanic influence of Storm Bay. A mix of brown algae including *Ecklonia radiata*, *Lessonia corrugata*, *Cystophora confluens*, *Acrocarpia paniculata* and *Carpoglossum confluens* dominated the shallow water. Smaller amounts of *Sargassum* sp., *Caulocystis* sp., mixed red algae, *Ulva* and *Caulerpa* sp. were also present along this section of coast. Beyond 5 metres, where light was limited, red algae became the more dominant component, although this became sparse and patchy below 7 metres depth. The introduced kelp, *Undaria pinitifida* was also present in small quantities below 5 metres depth. On the fringes of the deeper sections of reef occasional sponges were noted. *Macrocystis pyrifera* was present on the shoreline from Tinderbox to Tarroona, especially just south of Blackmans Bay.

3.4.2.2 Eastern Shoreline

The eastern shoreline of the Derwent River has less of an oceanic influence than the western shoreline. This is reflected in the algal community structure. Around South Arm, at the entrance to the river a suite of algae including *Ecklonia Ulva*, *Acrocarpia*, *Cystophora* and *Sargassum* occur in the shallow water, with *Carpoglossum* and mixed red algae generally in the deeper water. Further up the river past Opossum Bay *Ecklonia radiata*, *Cystophora* sp. and mixed reds dominated in shallow water to around 3 metres depth. Below this depth, the algae generally dropped out, with the reef remaining relatively barren. The further north the samples were taken, the less the large macro algae were noted.

3.4.2.3 Ralphs Bay

There was little reef mapped within Ralph's Bay, however at the entrance to the bay a significant area was identified. A mix of *Codium* sp., filamentous brown algae and mixed red algae dominated the habitats in less than 3 metres. Invertebrate communities generally dominated deeper reef in this area, with the reef in this area being covered in fine sediments.

3.4.3 Seagrass Distribution

In the lower reaches, below the Tasman Bridge, *Heterozostera tasmanica* was the dominant seagrass species. Beds were observed between the 1 m and 5 metre depth range in Halfmoon Bay, Opossum Bay, and off Taroona. These beds generally had short to medium blade length, with sparse to dense growth. In 2000, a large bed of seagrass was mapped in the northern part of Opossum Bay. This bed was lost in early 2001 during a large storm event, which washed most of the sand away and exposed the underlying reef.

3.5 Introduced Species

Several introduced species were observed on the video including the seastar *Asterias amurensis*, the New Zealand screwshell *Maoriculpus roseus*, the fan worm *Myxicola infundibulum*, the Pacific oyster, *Crassostrea gigas*, and the kelp *Undaria pinnatifida*. A total of 63 video transects were used to identify the broad patterns of these species distribution in the river (Appendix 1 and 2). However, as this was not a comprehensive video survey for introduced species, these ranges are indicative only. The seastar, *Asterias amurensis*, showed a broad distribution through the lower and middle Derwent, including Ralphs Bay. This species was predominantly observed on soft sediment habitat, but also occurred on reef. In the middle reaches, between Sullivans Cove and Dogshear Point, the seastar *Patiriella regularis* was observed on silt habitat in many of the video transects. This seastar is believed to have been introduced from New Zealand with the introduction of oysters in the early 1900s (Edgar 1997).

The New Zealand screw shell, *Maoriculpus roseus*, was only observed in the lower Derwent, especially around Opossum Bay, Taroona, and the entrance to Ralphs Bay. The majority of the shells were observed on soft sediment habitat, with a small amount occurring within gutters in reef. Live screw shells were observed in the mid Derwent between Opossum Bay and Taroona, however the majority of screw shells observed were dead shell.

The fan worm, *Myxicola infundibulum*, was observed on silt substrate in the mid Derwent between Elwick bay and Sandy Bay, and also in Ralphs Bay. Burrows were also observed between Bridgewater and Opossum Bay. As this species has the ability to quickly retract its feeding tentacles, these burrows may have belonged to this species, but it is impossible to determine using towed video.

Oysters were observed on the video in the mid Derwent, especially between Cornelian Bay and Austins Ferry. This species predominantly occurs in the intertidal zone, which was unable to be surveyed using the vessel towed video. Thus, this distribution reflects the subtidal distribution of this species and not those found on intertidal rock platforms.

The introduced kelp *Undaria pinnatifida* was found to occur on the deeper margins of reef along the western shoreline of the lower Derwent, from Tinderbox to Taroona. This species was first noted in the Tinderbox marine reserve in the late 1990 and this distribution represents the population spreading from this site.

3.6 Summary of habitats across the Derwent Estuary

Tables 5 to 8 summaries the distribution of marine habitats of the Derwent Estuary by section; by depth; and across the entire estuary as a per centage cover of all habitats identified.

Table 5 summarised the marine habitats by section. The majority of the area in Section A is characterised by aquatic macrophytes, silt and vegetated habitat in the zone between the high and low water mark. Small amounts of reef and cobble were also present. In section B larger amounts of reef were identified with silt and aquatic macrophytes still being the dominant habitats. In section C aquatic macrophytes or cobble were not mapped. This section contained the largest proportion of reef and sand habitat with silt habitat dominating the deeper waters in the centre of the estuary.

| Habitat | Section A | Section B | Section C | Total (ha) |
|---------------------|-----------|-----------|-----------|------------|
| Aquatic Macrophytes | 259.8 | 404.05 | 0 | 663.85 |
| Cobble | 27.16 | 0 | 0 | 27.16 |
| Reef | 27.68 | 47.16 | 335.38 | 410.20 |
| Sand | 0 | 1.70 | 10438.48 | 10440.18 |
| Seagrass | 0 | 9.24 | 8.72 | 17.96 |
| Silt | 268.55 | 2104.97 | 5431.91 | 7805.42 |
| Vegetated | 197.71 | | | 197.71 |

Table 5. Summary of marine habitats by Section.

Table 6 presents the distribution of all habitat types across the entire estuary by depth. Aquatic macrophytes occurred predominantly in the 0-5 metre depth range of the estuary. Cobble was identified in depths between 0 and 10 metres. Fringing reef dominated in the 0-5 m depth range but was present in all depth strata of the estuary. Seagrass was mainly present in the 0-5 depth strata with a small amount identified in the 5- 10 metre depth range. Sand was the dominant unconsolidated habitat type in the Section C of the estuary but was replaced by silt in the deeper margins.

| Depth | Aquatic Macrophytes | Cobble | Reef | Sand | Seagrass | Silt | Vegetated |
|-------|---------------------|---------|----------|------------|----------|-----------|-----------|
| 0-5 | 663.85 | 11.78 | 312.72 | 3978.82 | 17.95 | 1500.13 | 197.71 |
| 5-10 | 0.0029 | 15.38 | 76.7 | 1461.70 | 0.007 | 611.55 | |
| 10-15 | | | 19.15 | 1300.22 | | 439.18 | |
| 15+ | | | 1.64 | 3699.44 | | 5254.56 | |
| Total | 663.85ha | 27.16ha | 410.20ha | 10440.18ha | 17.96ha | 7805.42ha | 197.71ha |

Table 6. Distribution of marine habitats by depth across the entire estuary

Table 7 and 8 show the percentage cover of each habitat type by section and across the whole estuary. The estuary is dominated by unconsolidated habitats with sand representing 53.37% and silt 39.9% of all habitats surveyed. Aquatic macrophytes were the next dominant habitat at 3.39% followed by reef, 2.1%.

| Section | Aquatic Macrophytes | Cobble | Reef | Sand | Seagrass | Silt | Vegetated | Total |
|---------|---------------------|--------|-------|--------|----------|-------|-----------|-------|
| A | 33.3 % | 3.48% | 3.54% | 0% | 0% | 34.4% | 25.32% | 100% |
| B | 15.74% | 0% | 1.84% | 0.066% | 0.36% | 82% | 0% | 100% |
| C | 0% | 0% | 2.06% | 64.38% | 0.054% | 33.5% | 0% | 100% |

Table 7. Percentage of habitat cover across each section of the estuary

| Aquatic Macrophytes | Cobble | Reef | Sand | Seagrass | Silt | Vegetated | Total |
|---------------------|--------|------|--------|----------|-------|-----------|-------|
| 3.39% | 0.14% | 2.1% | 53.37% | 0.09% | 39.9% | 1.01% | 100% |

Table 8. Percentage of habitat cover across the whole estuary

3.7 Benthic habitat maps of the Derwent Estuary

The habitat maps of the Derwent Estuary, as determined by the map index in Figure 8, are presented in this section.

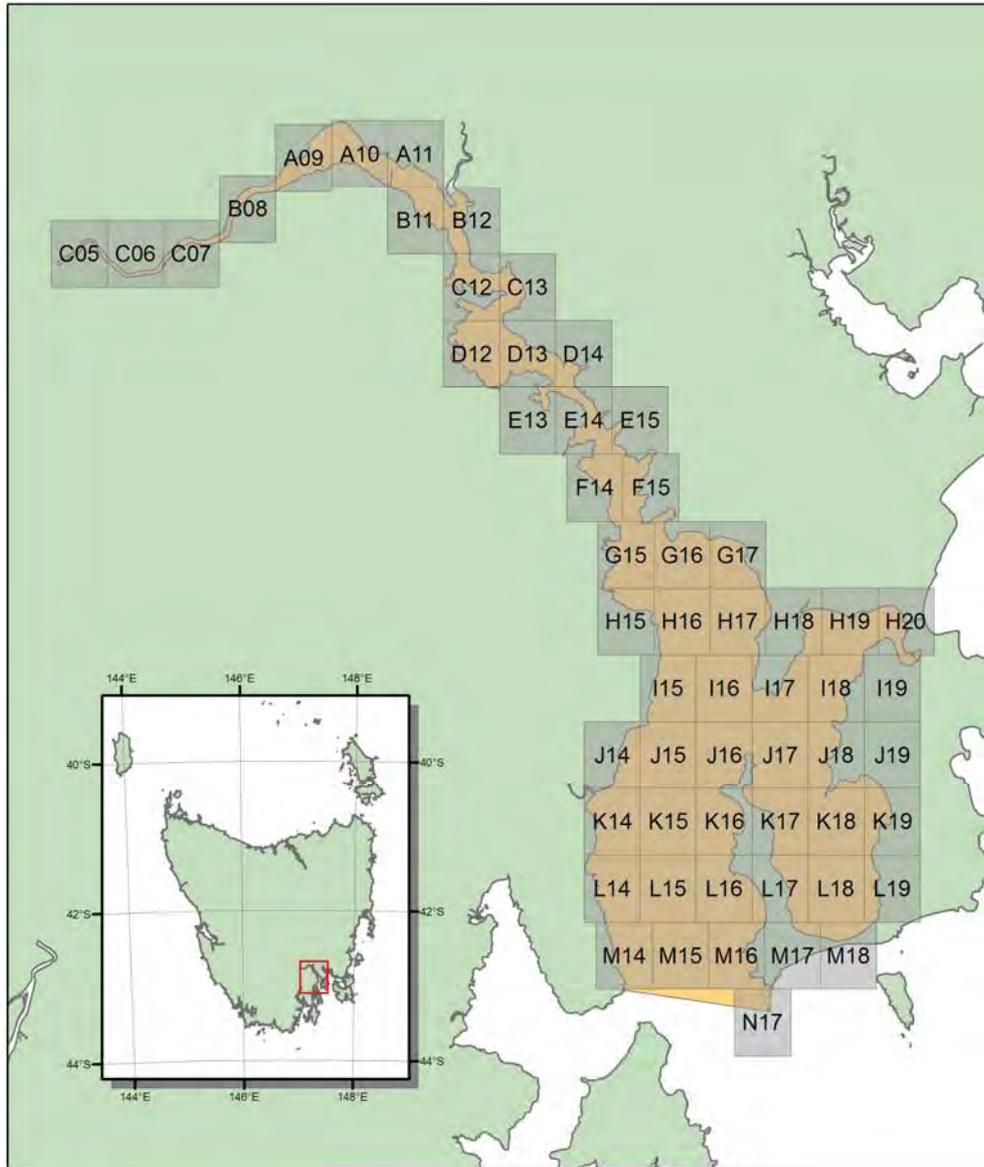
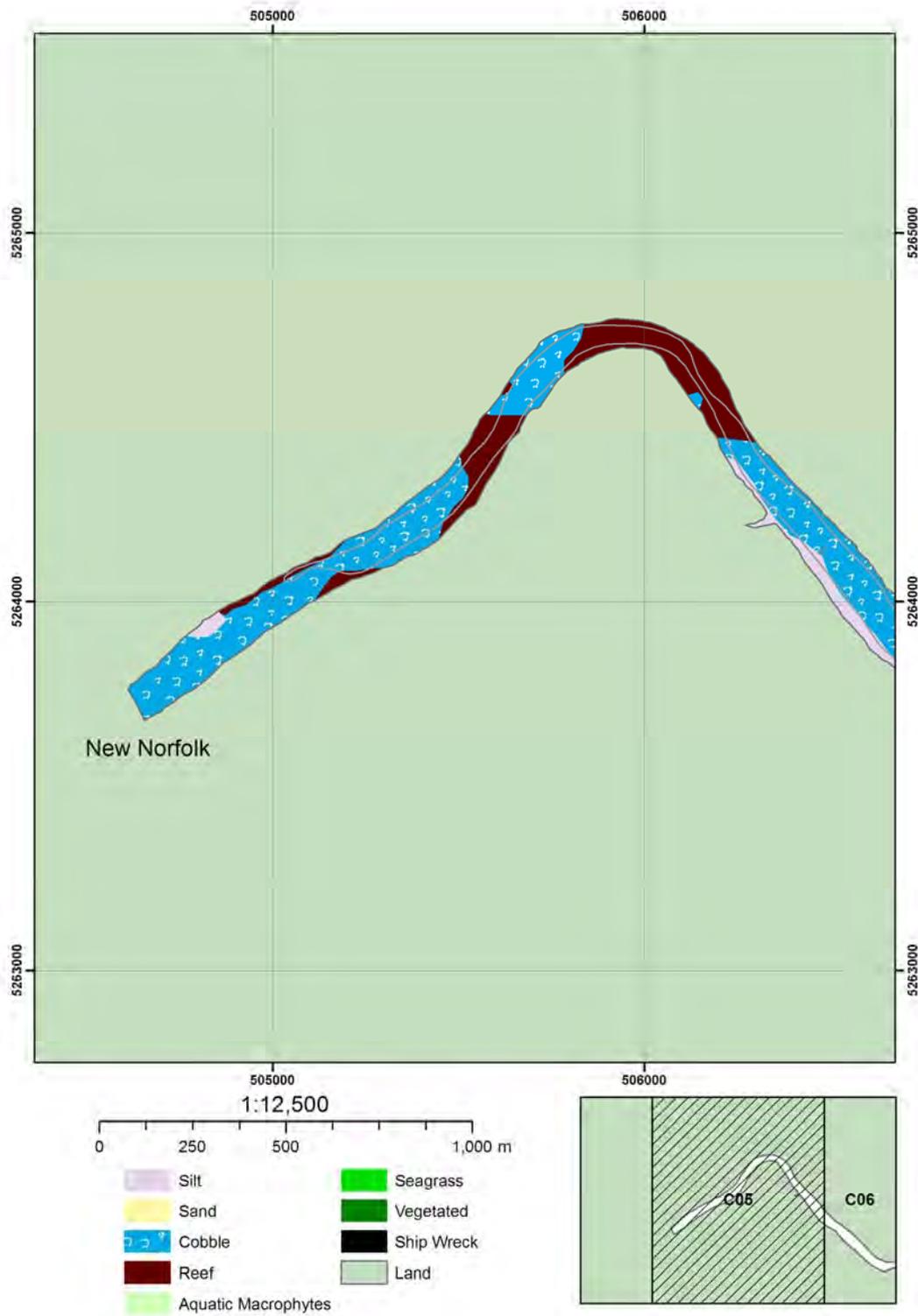
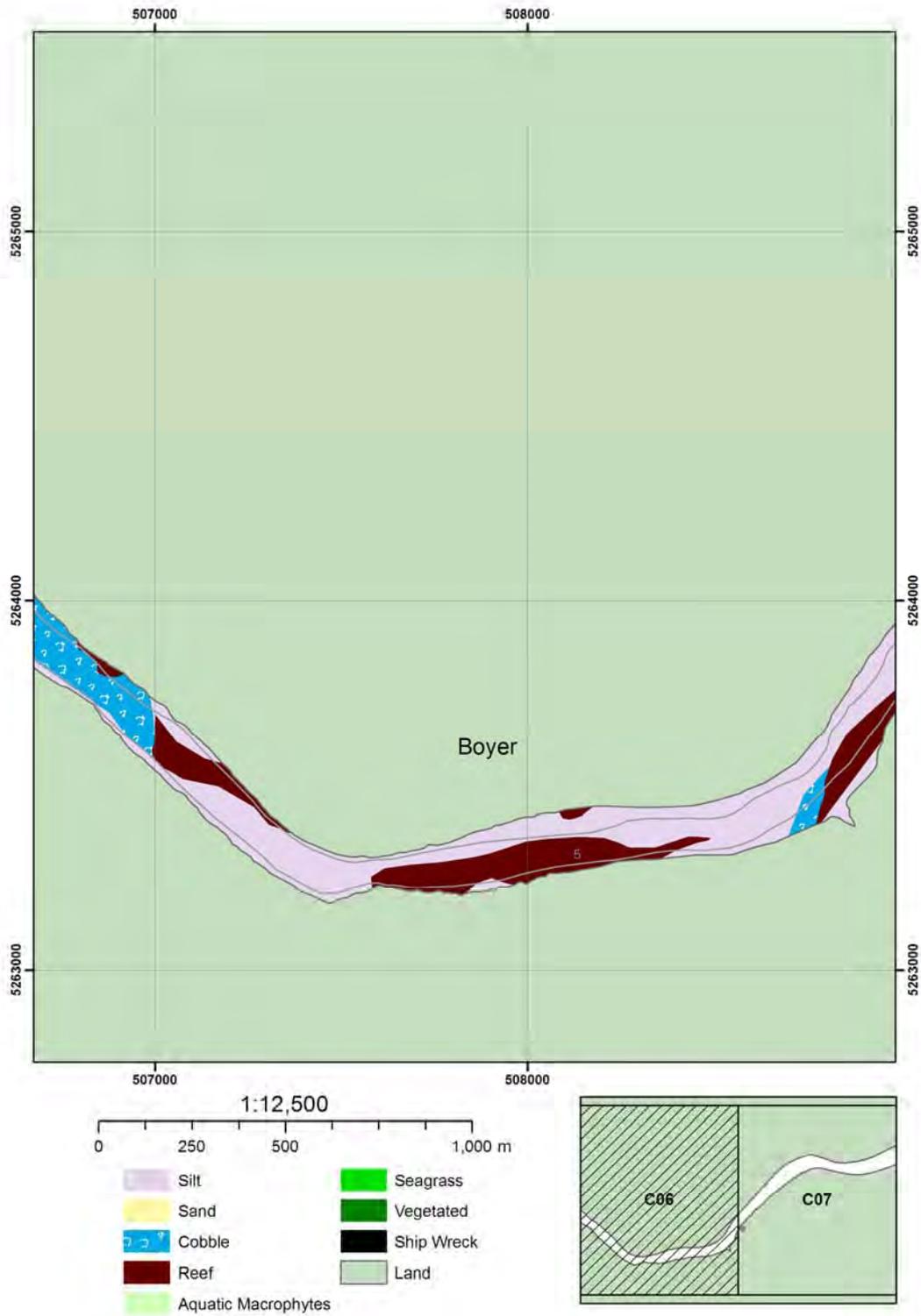
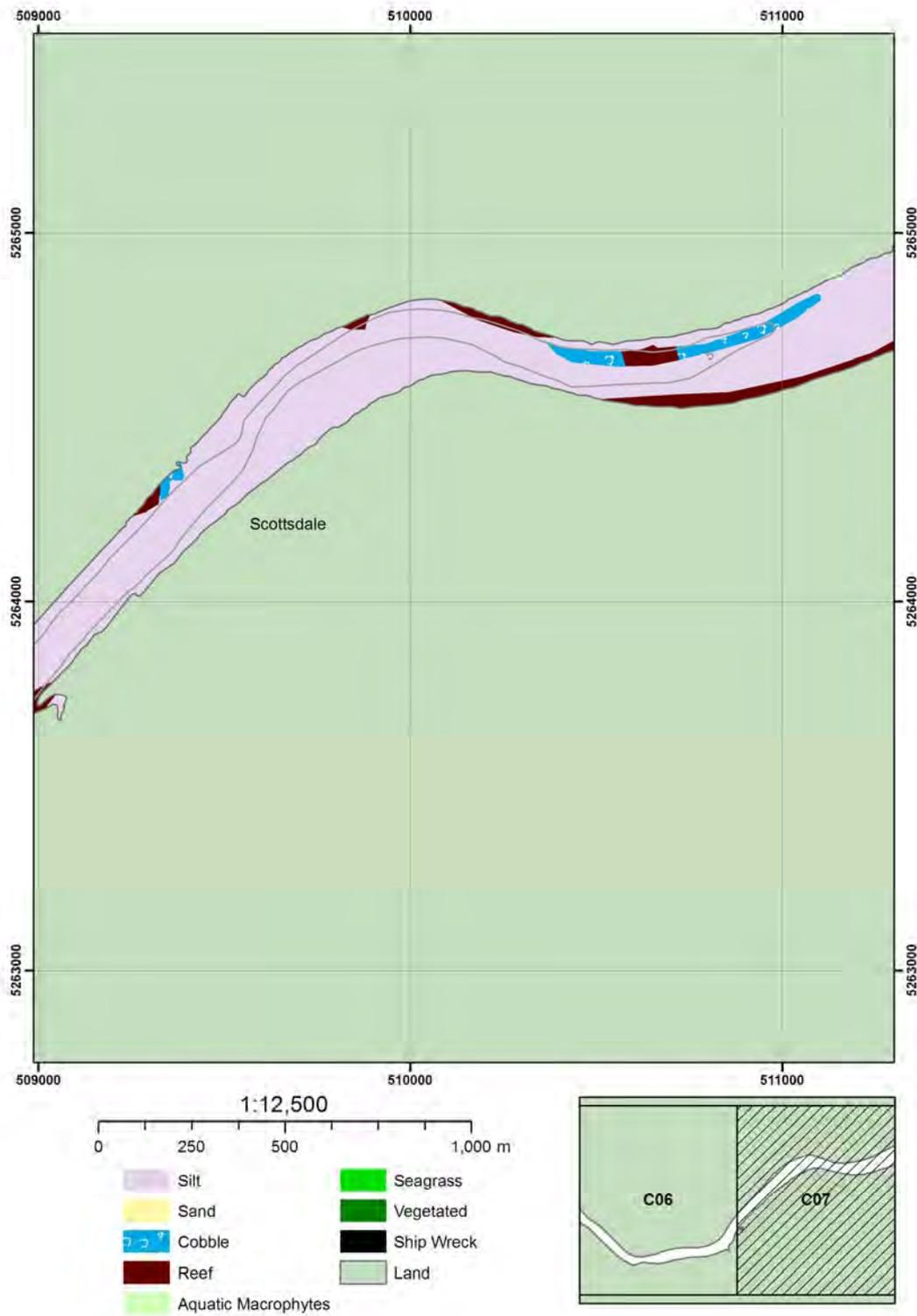
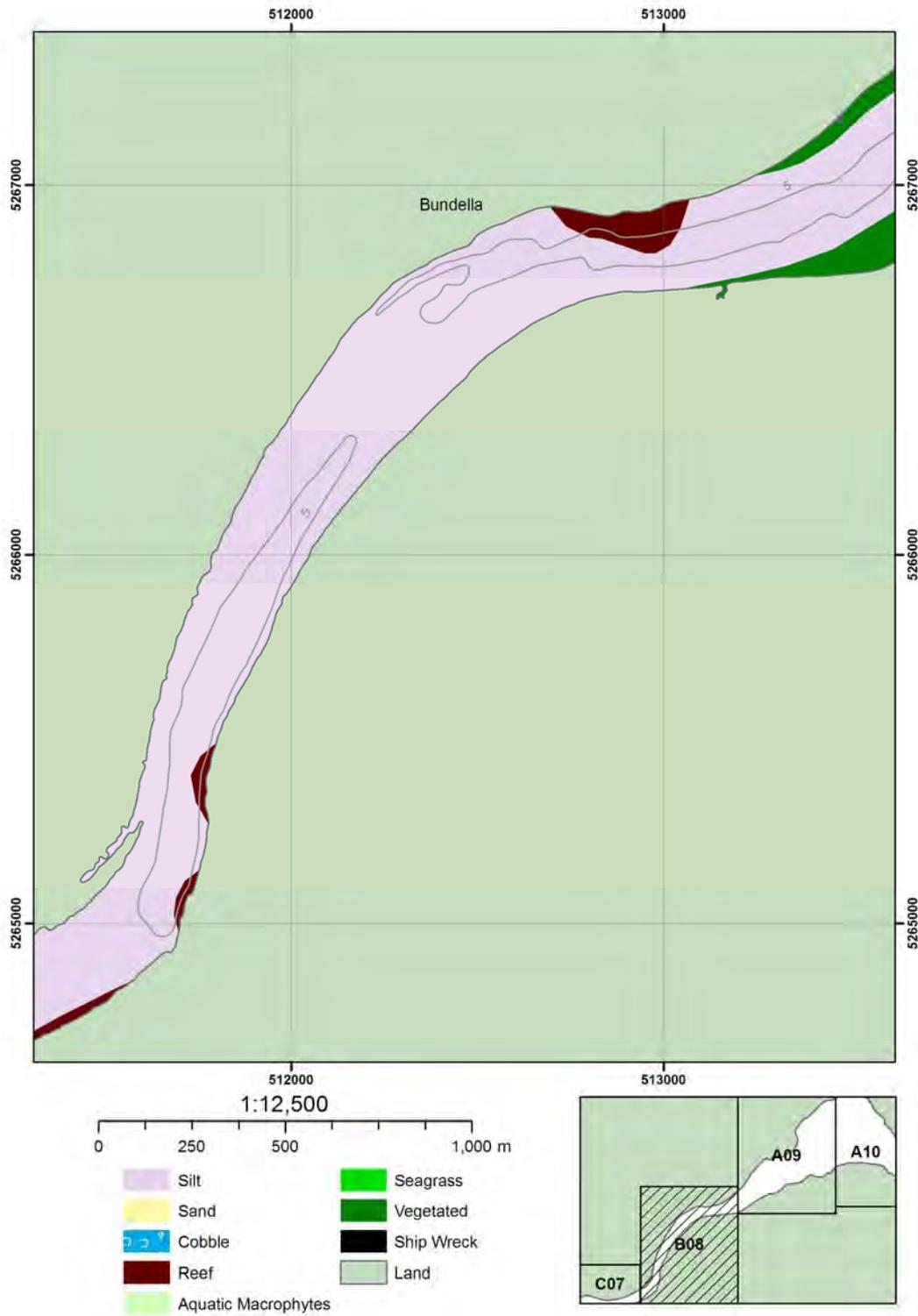


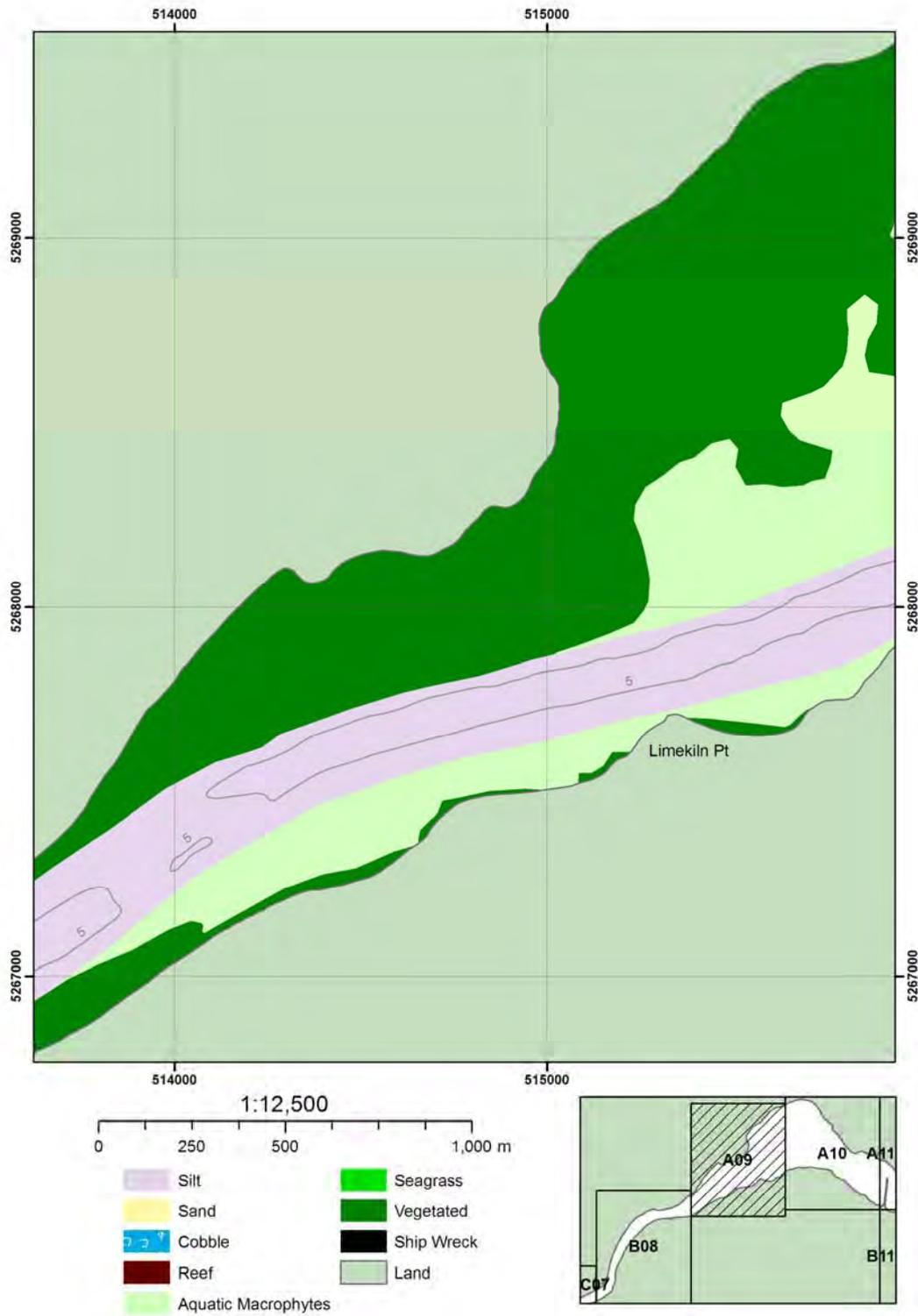
Figure 8. Map Index for marine habitat maps from New Norfolk to Iron Pot

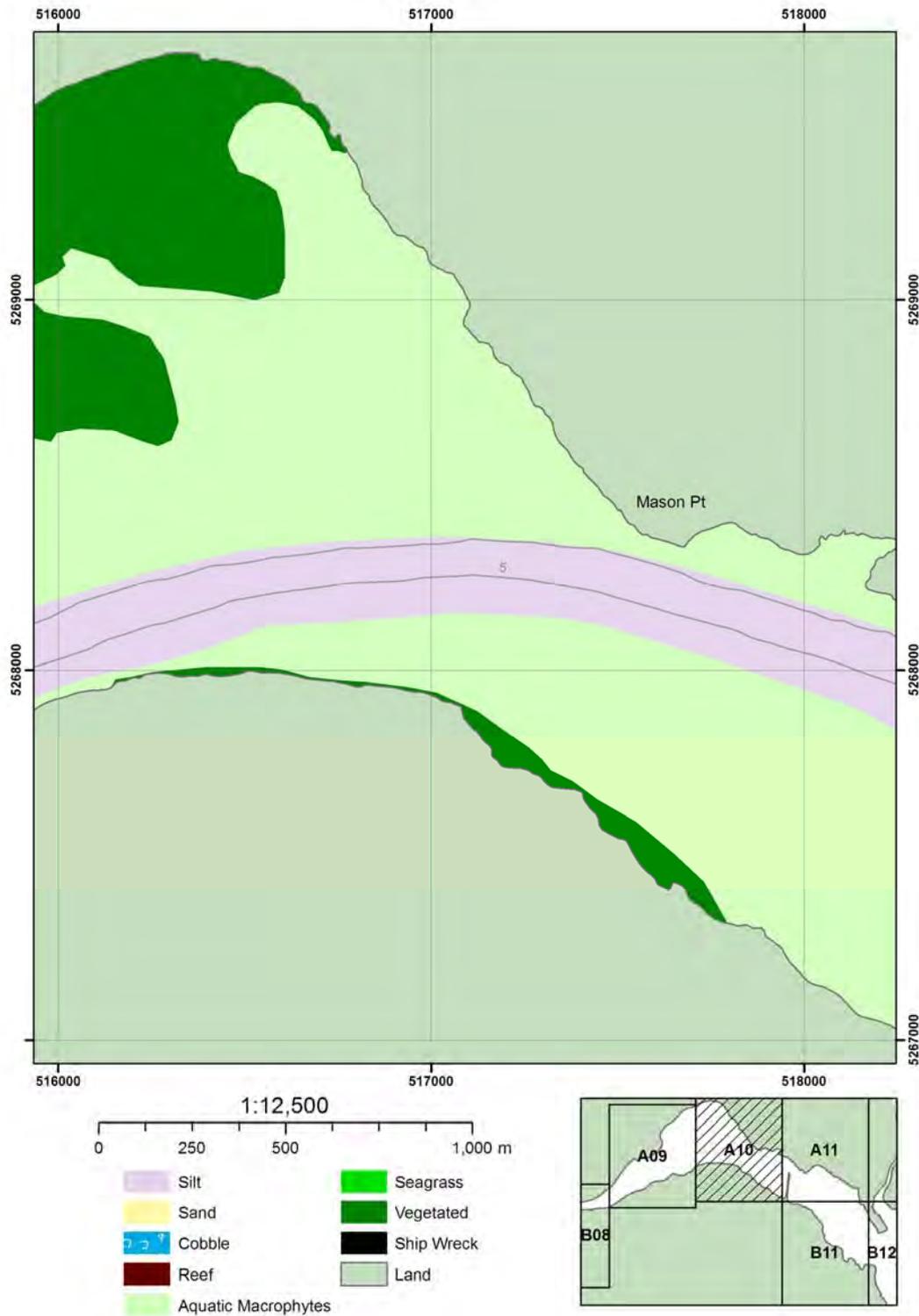


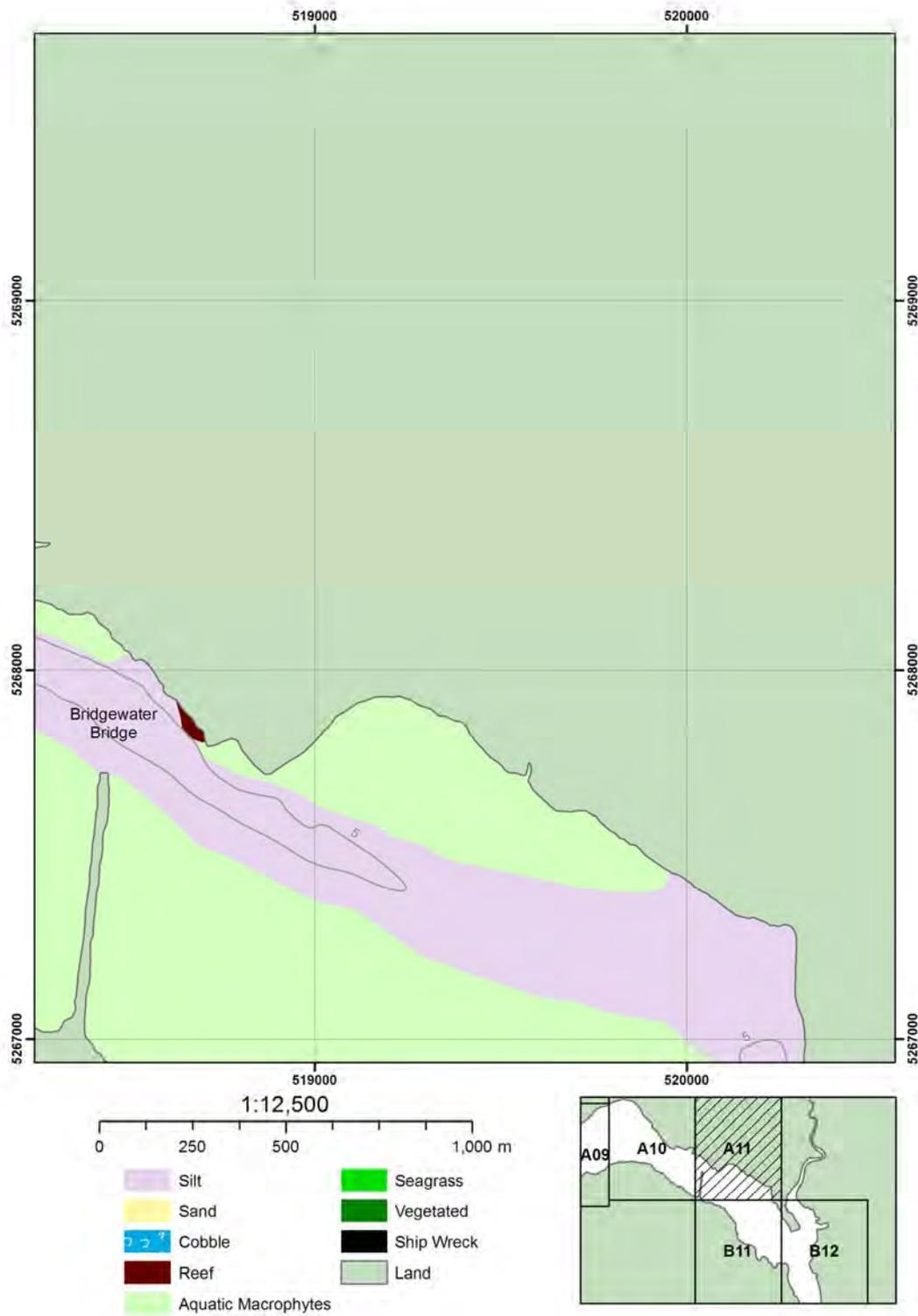


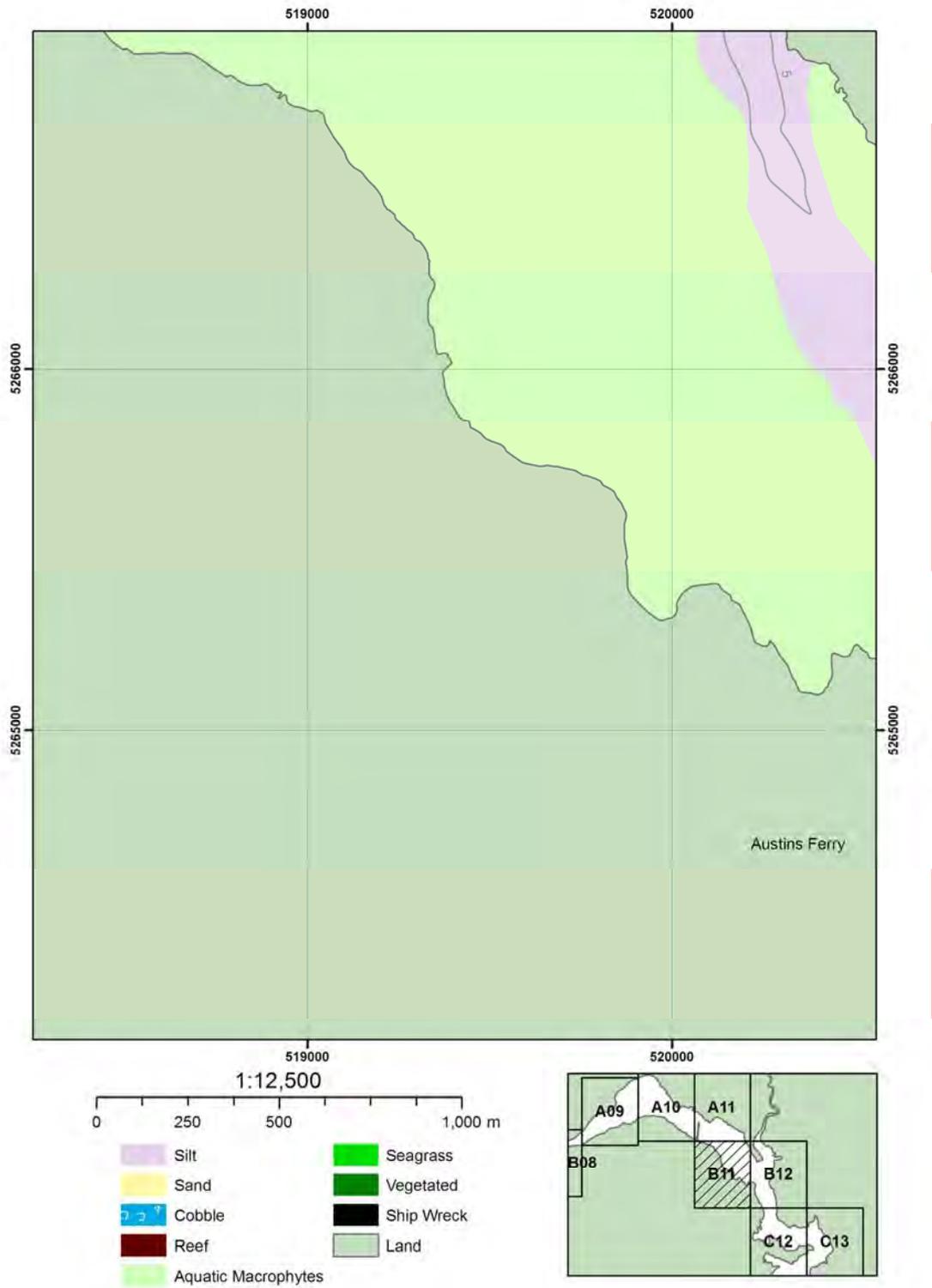


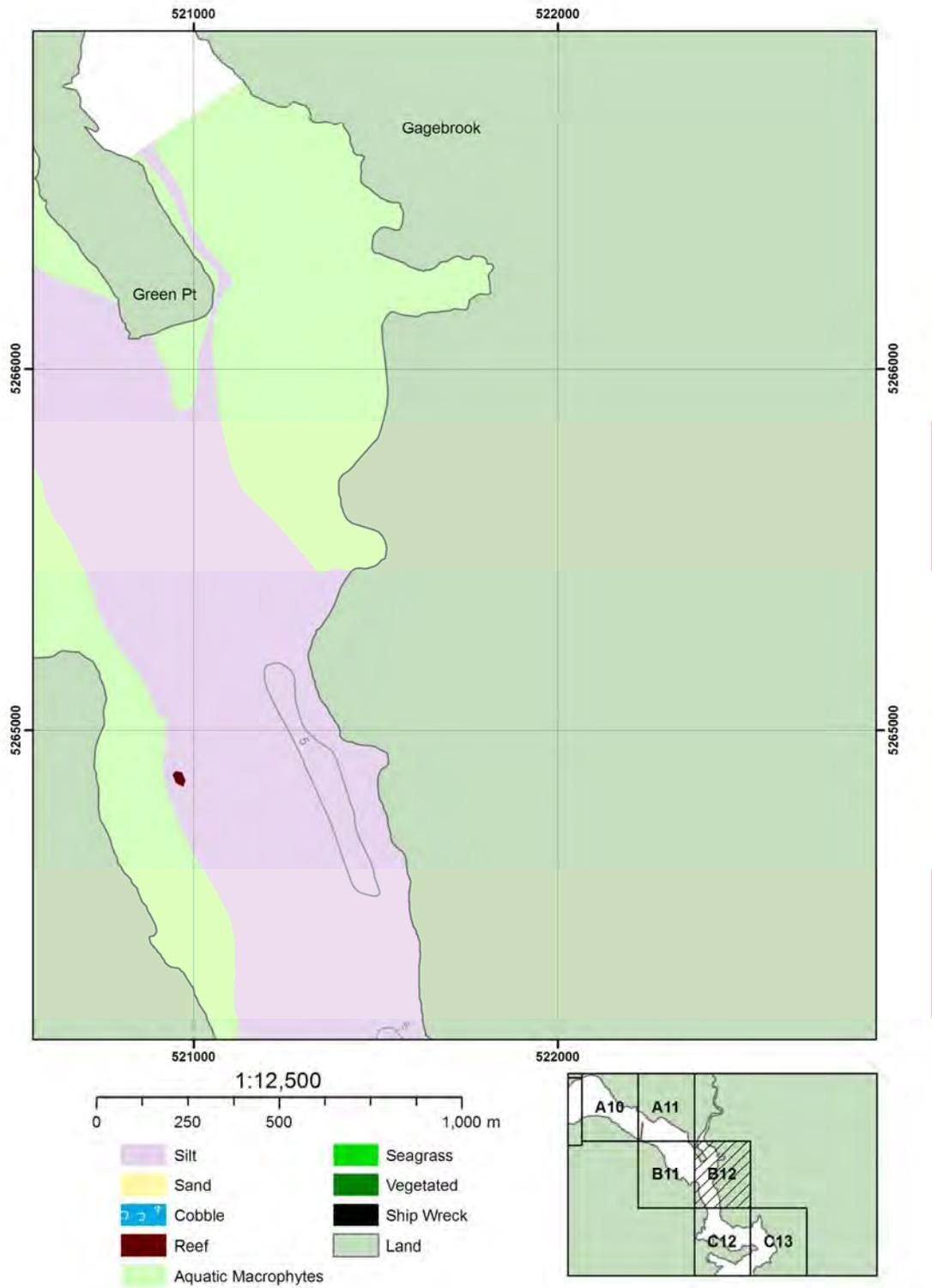


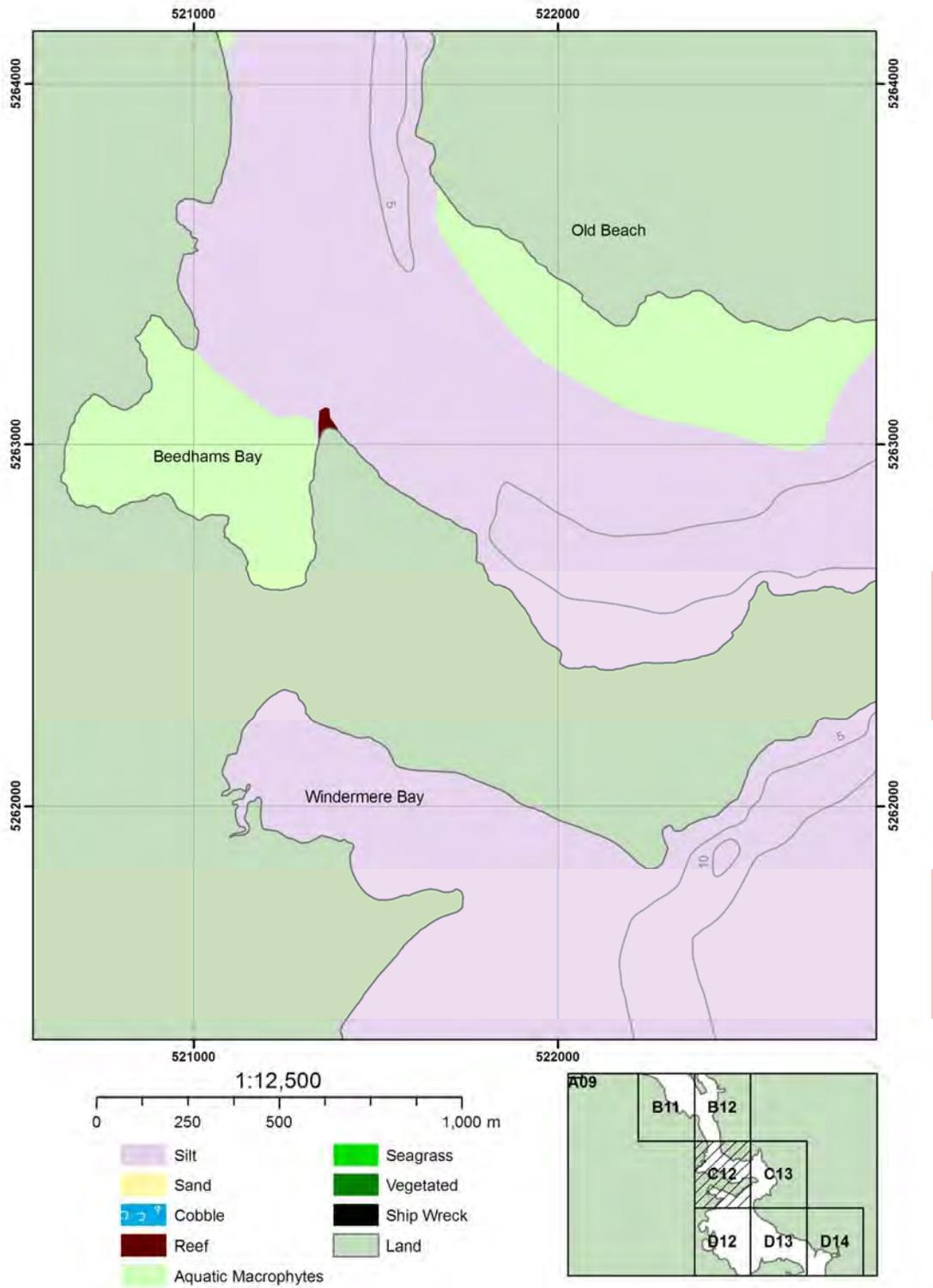


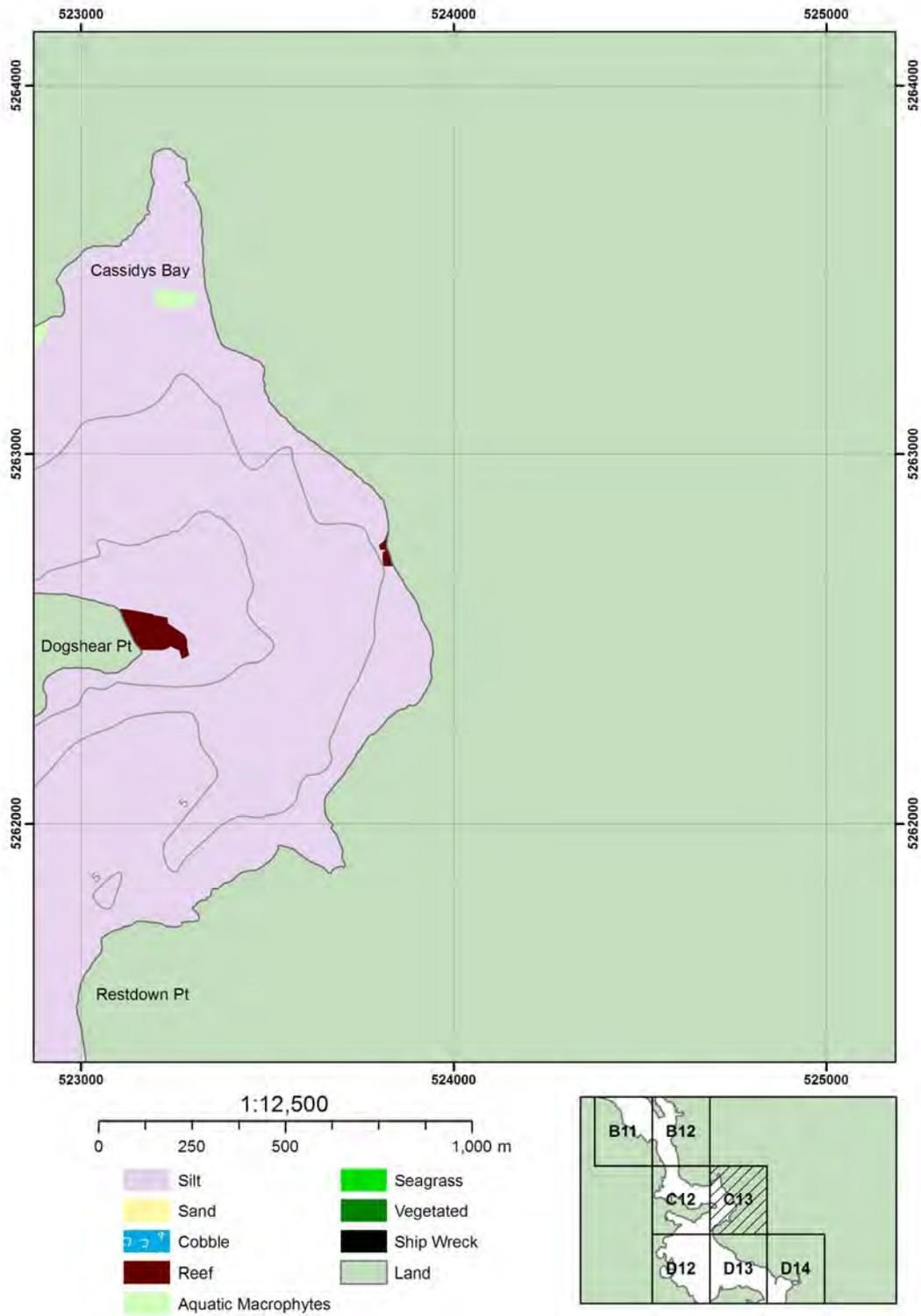


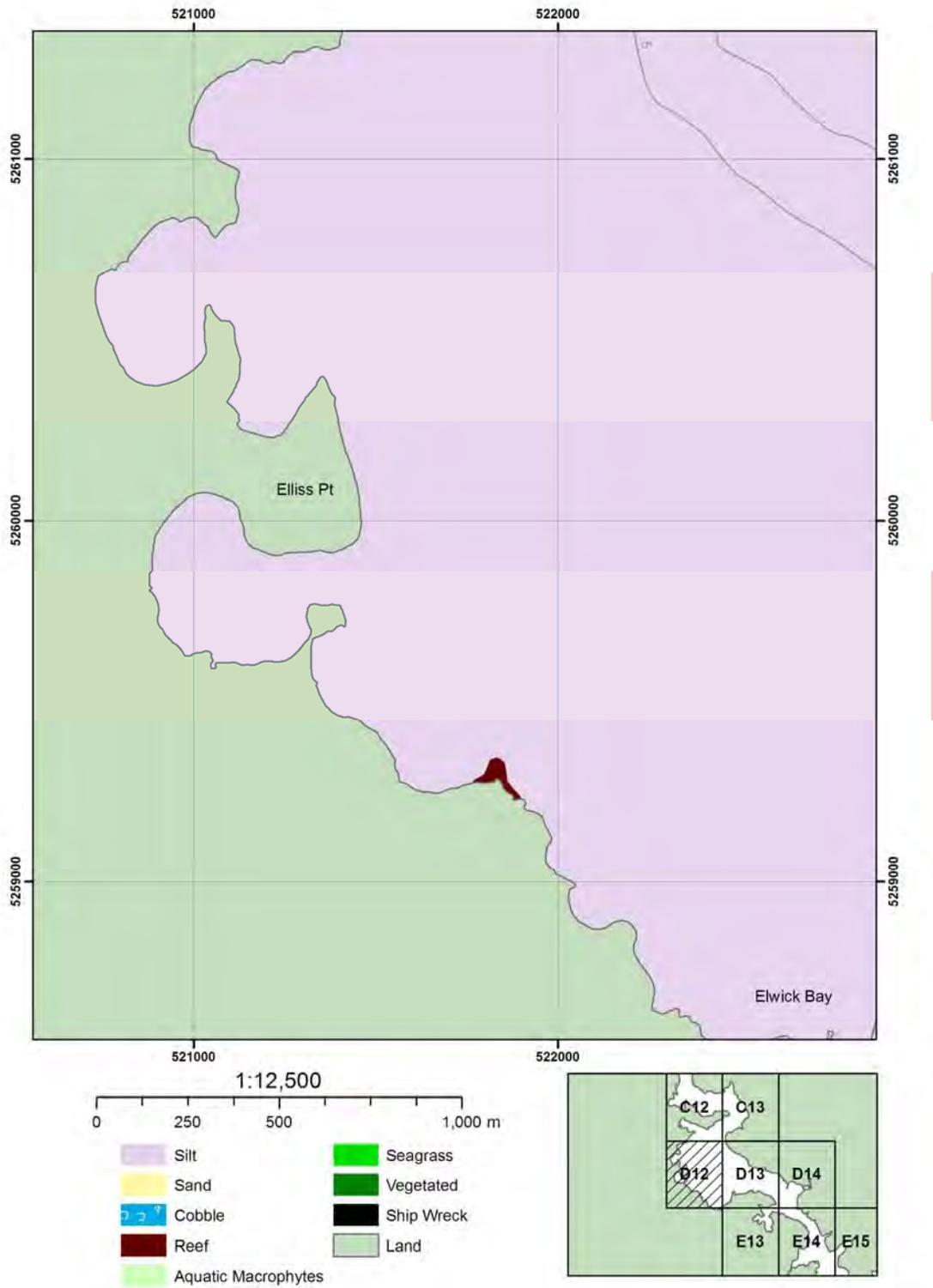


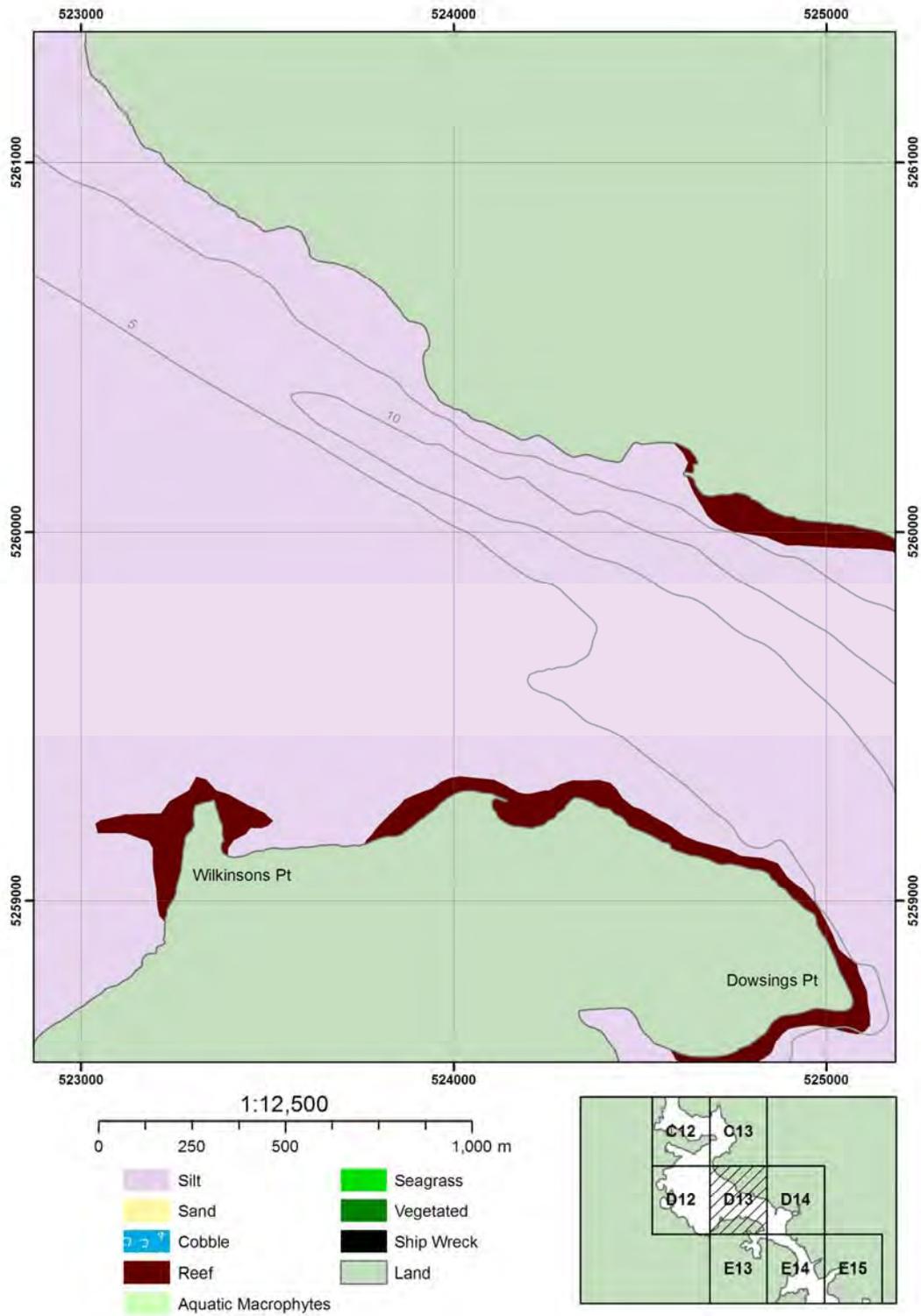


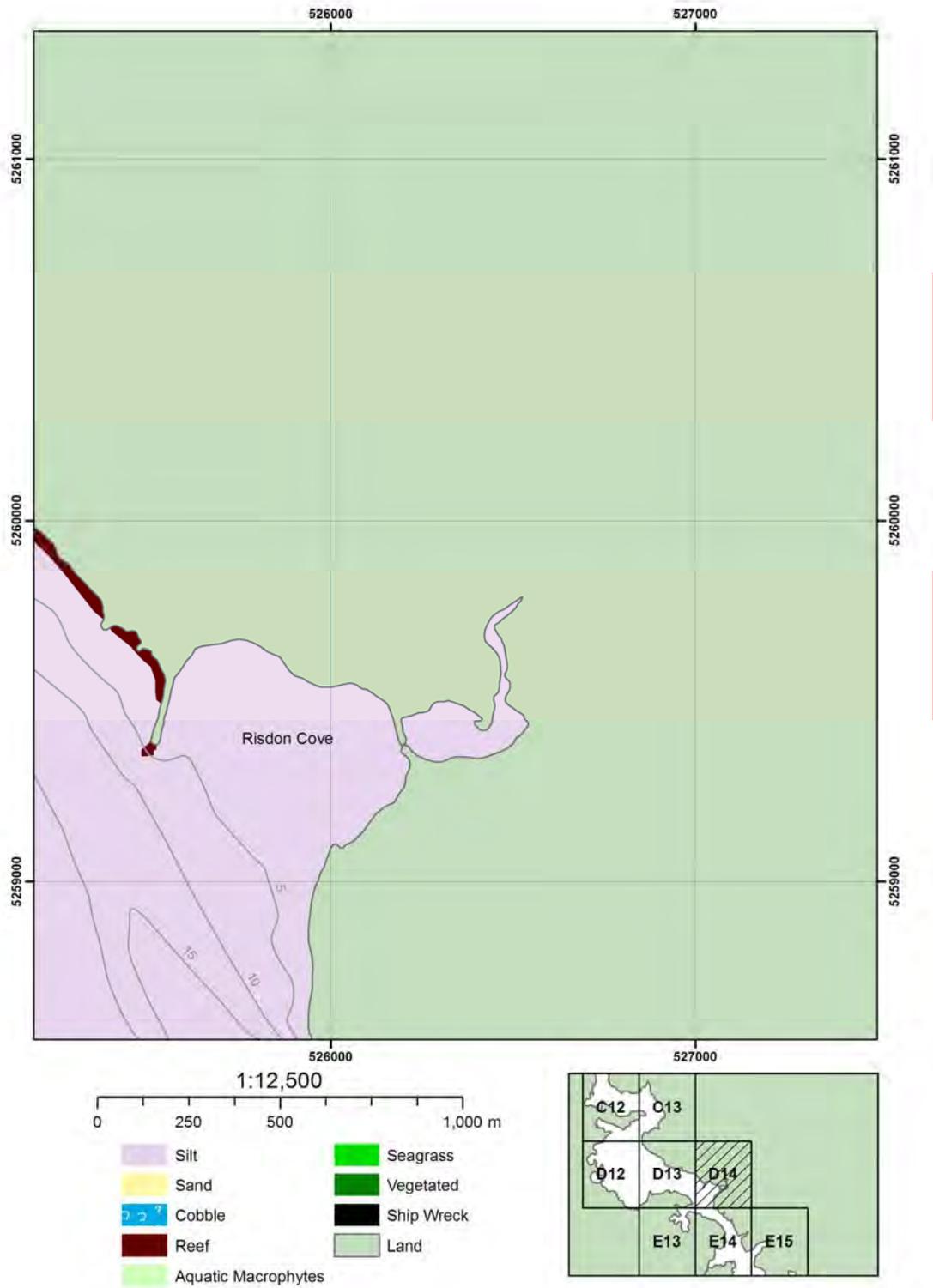


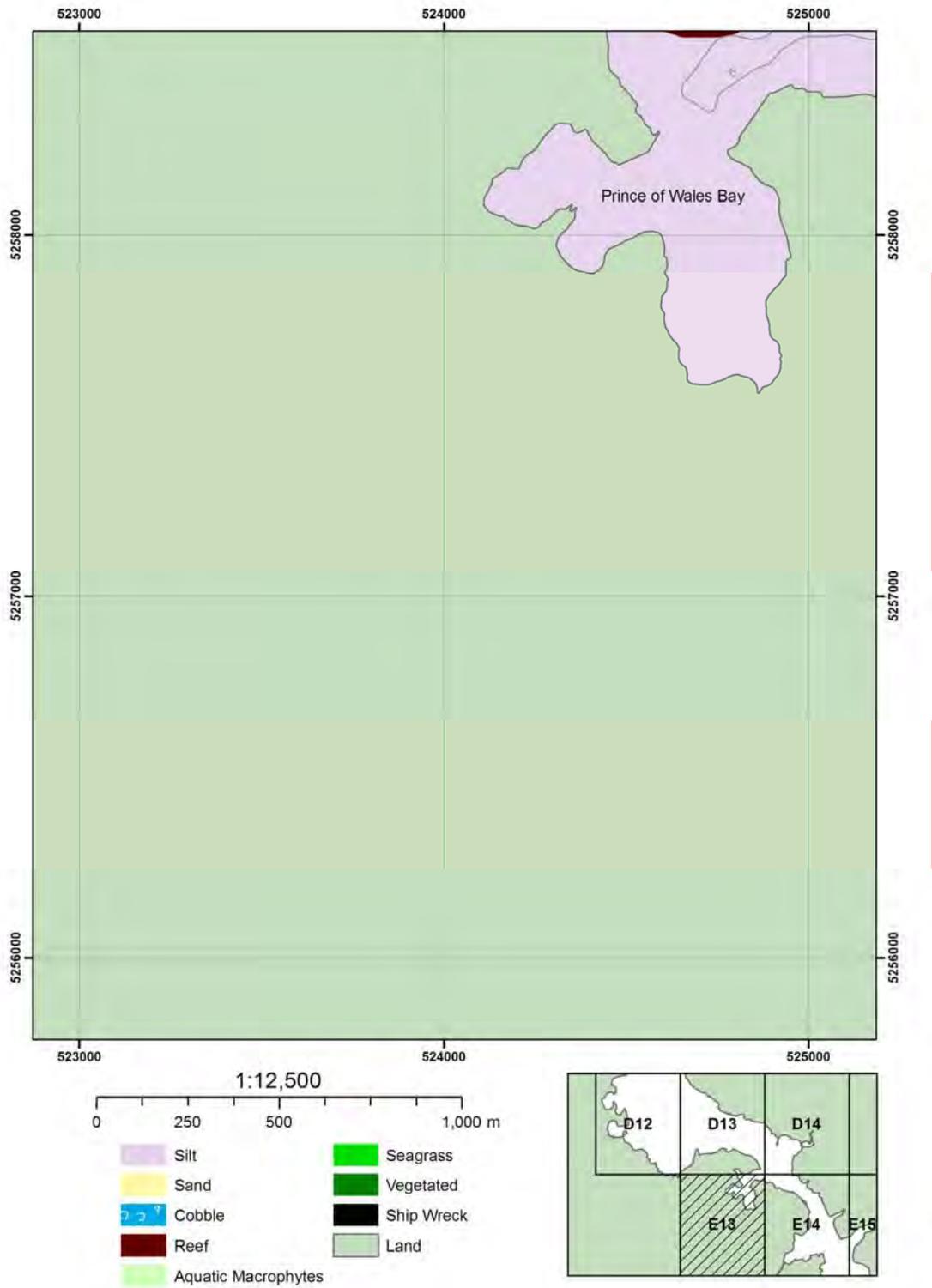


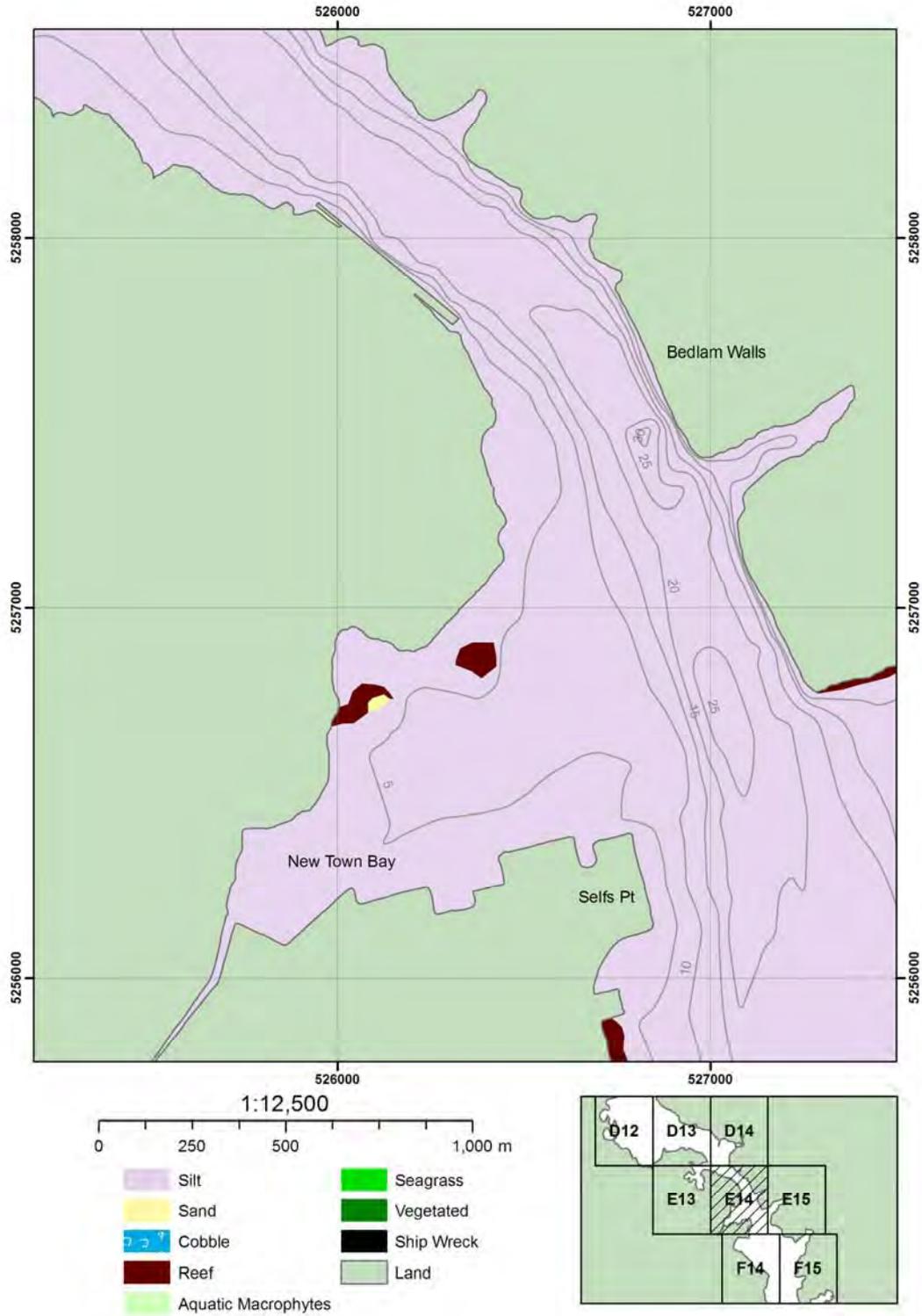


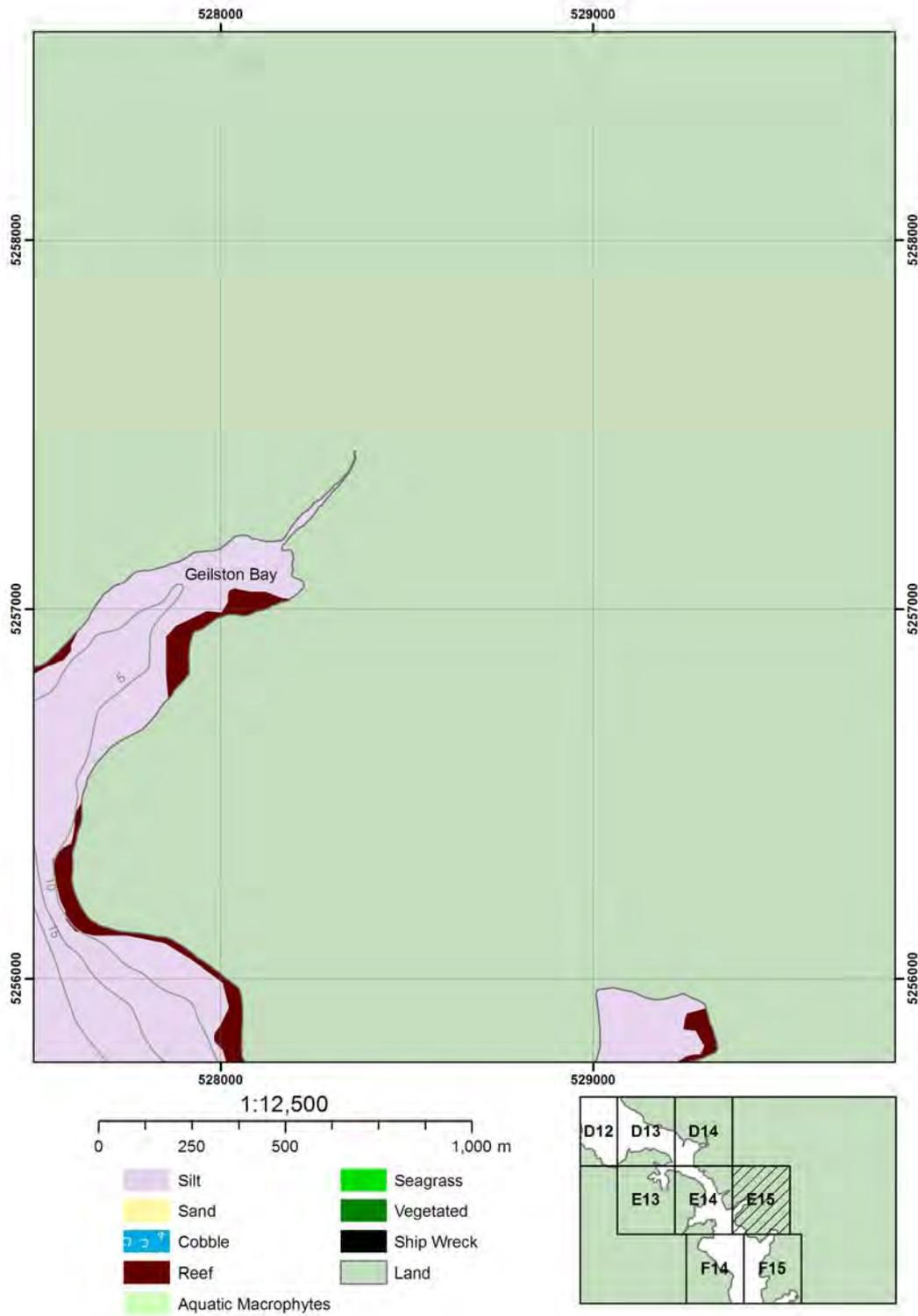


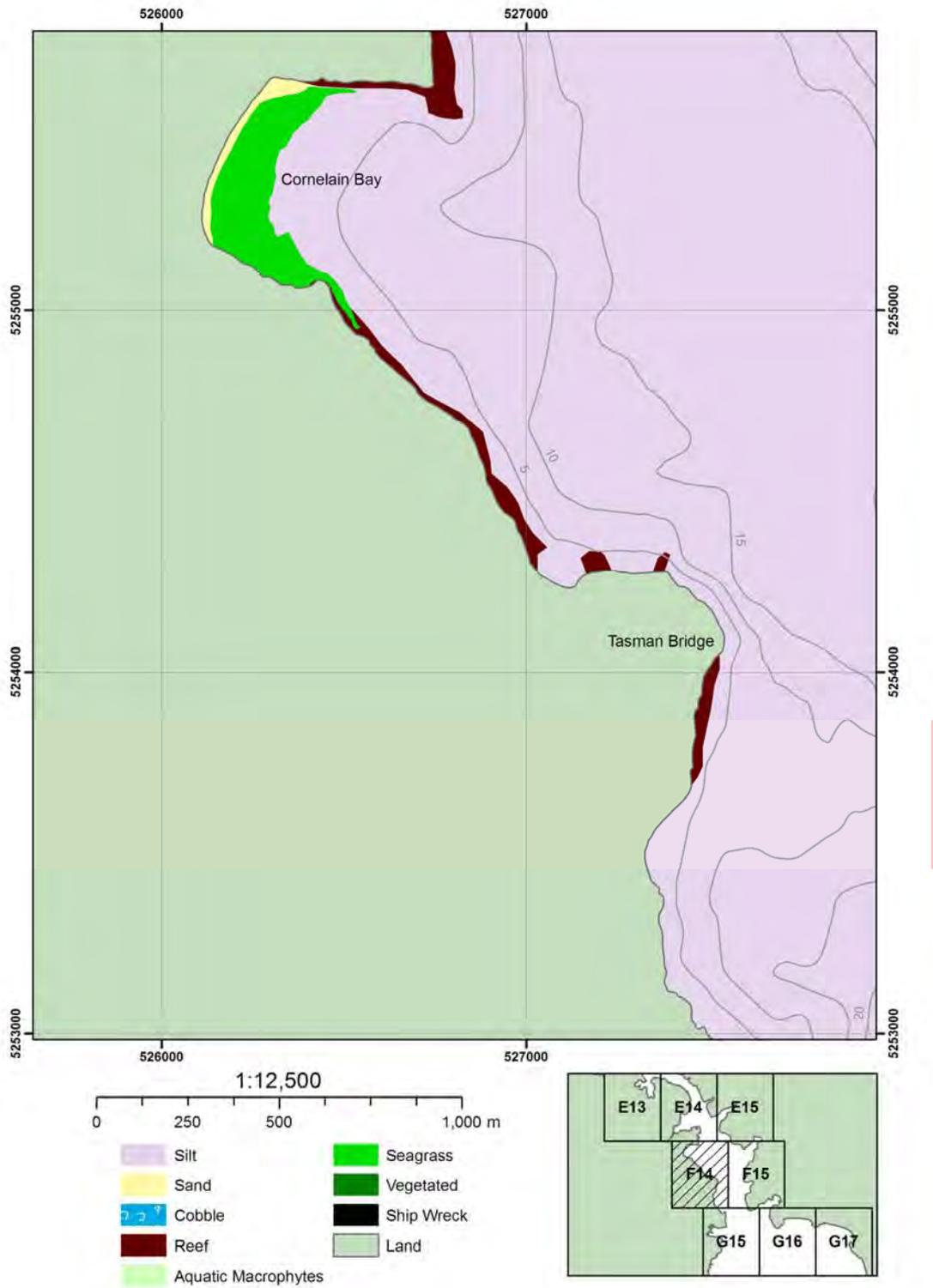


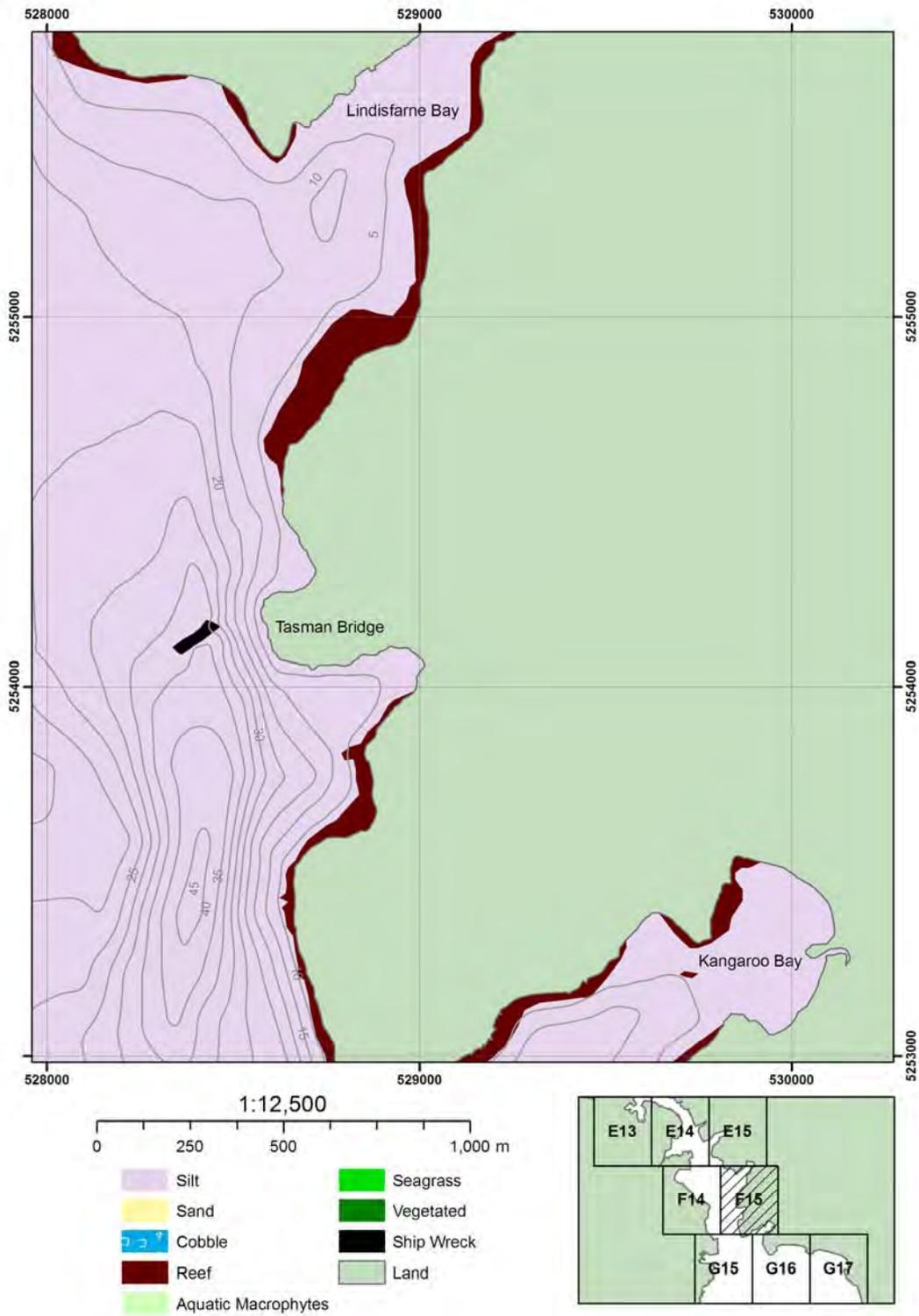


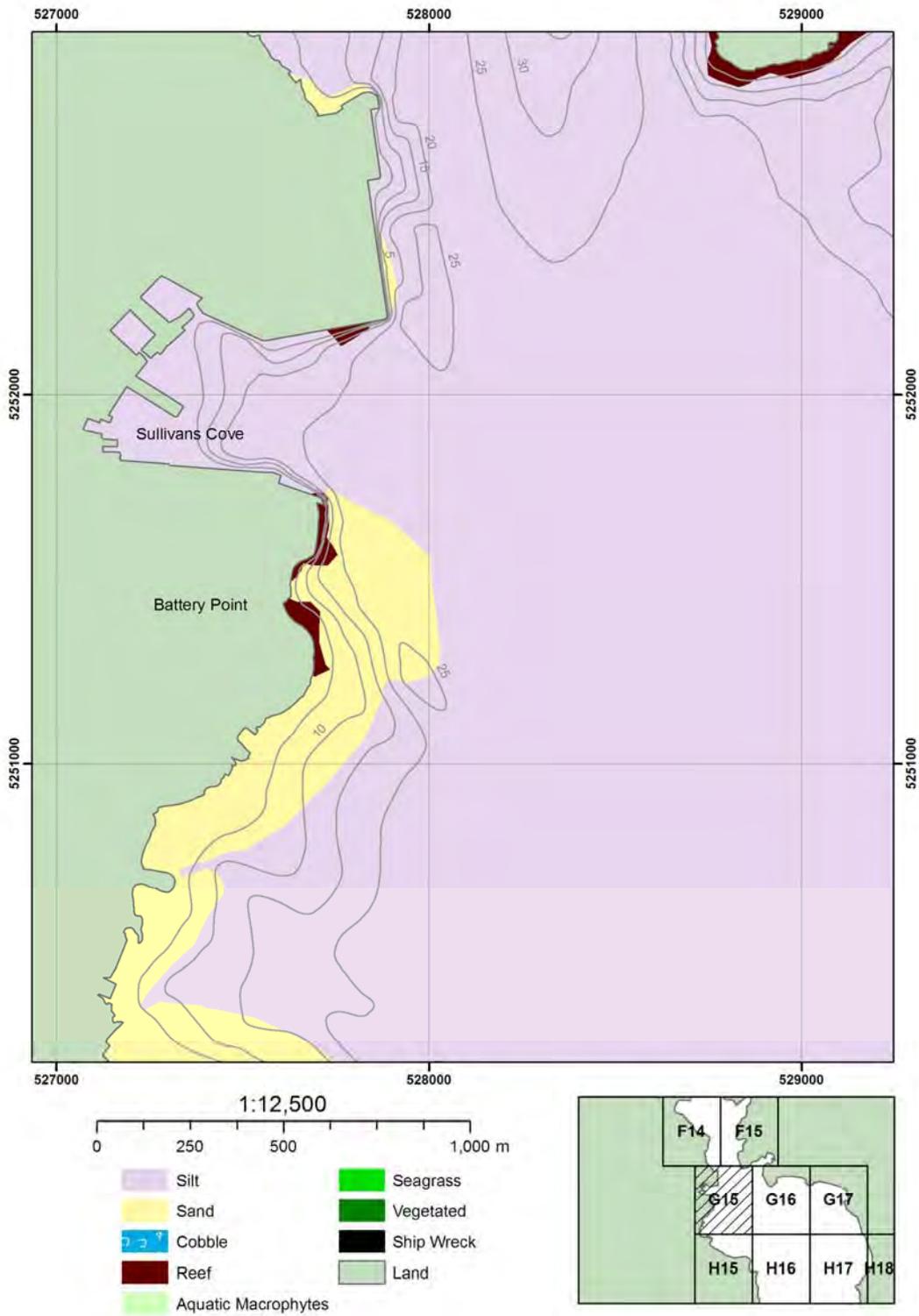


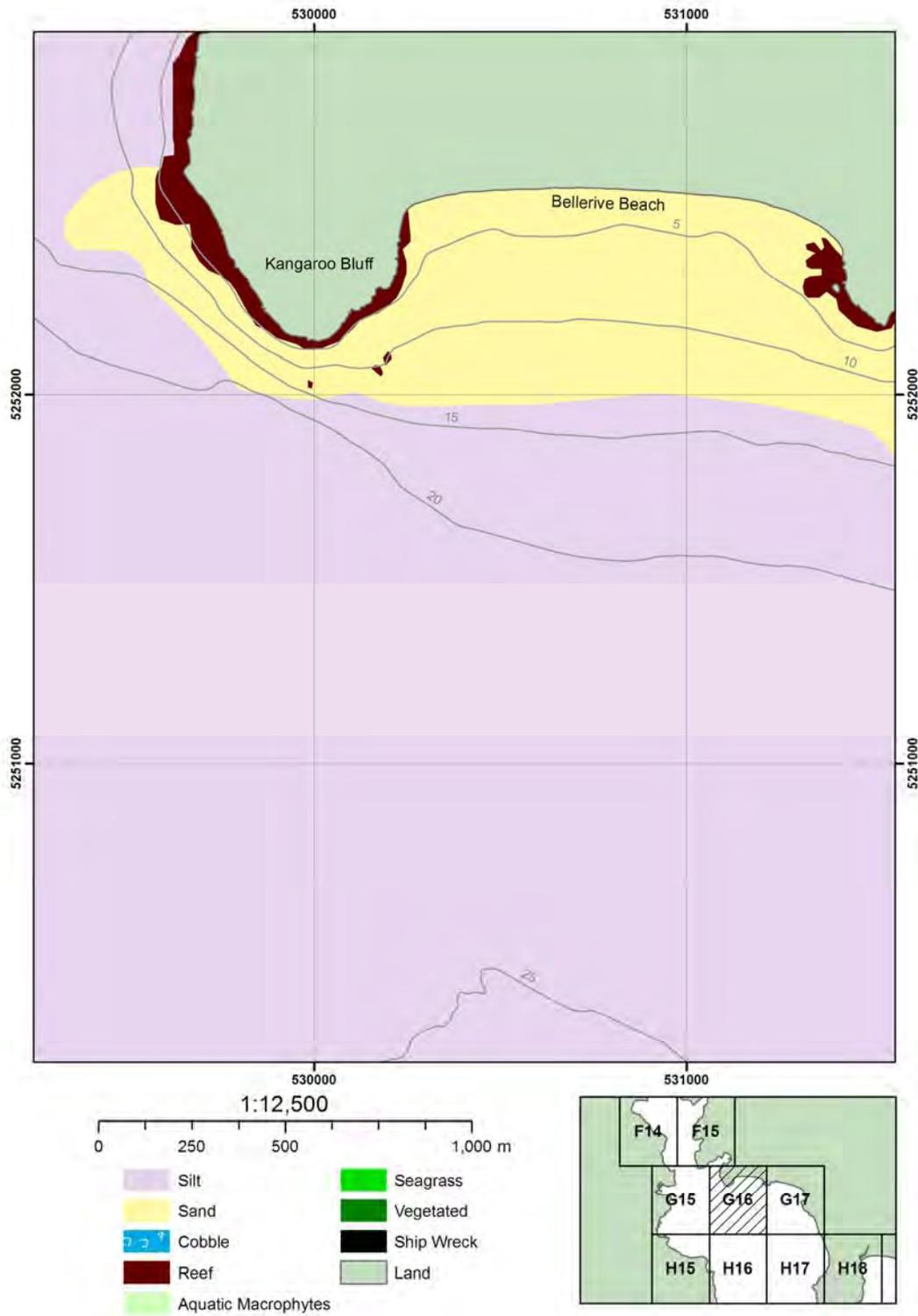


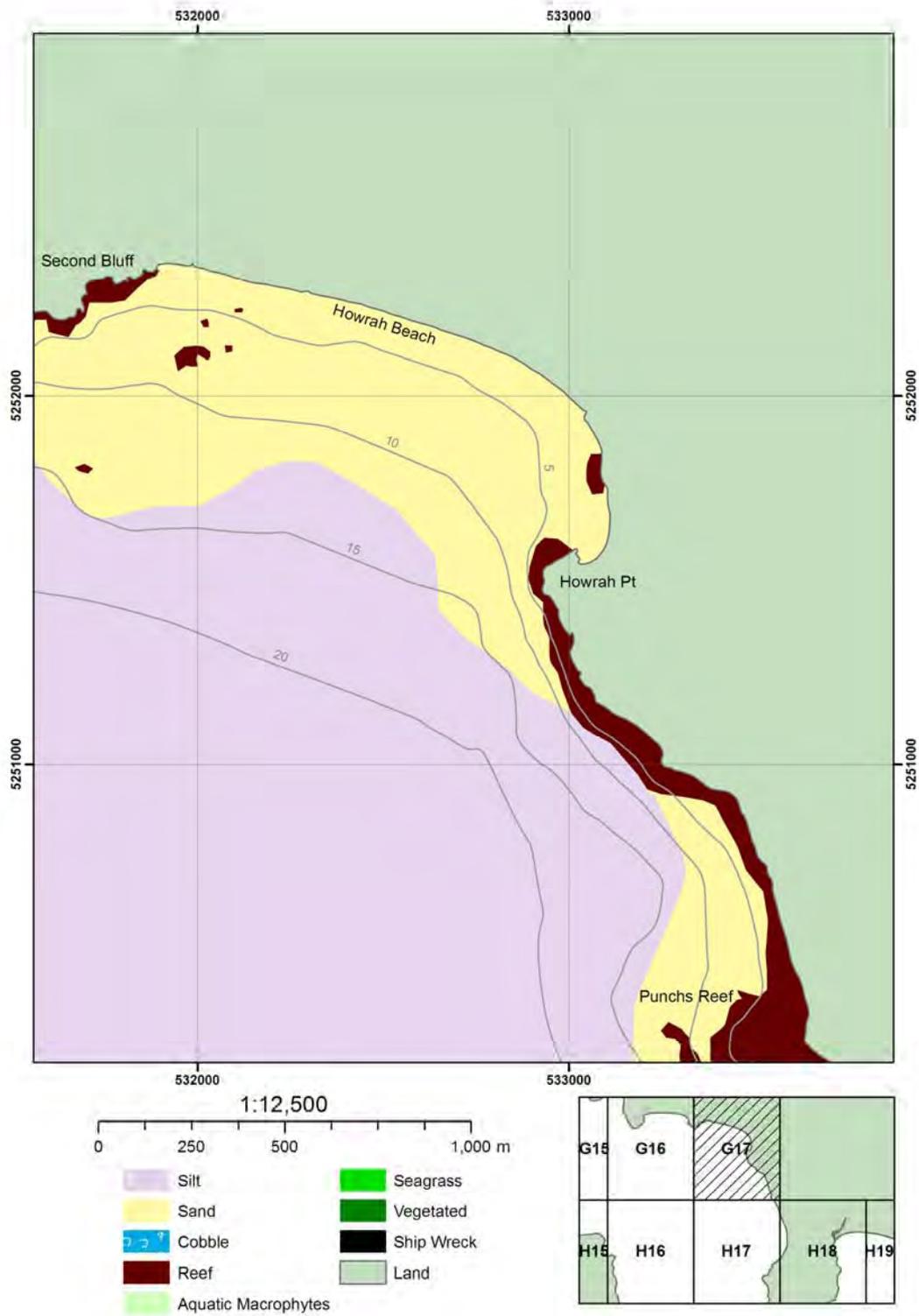


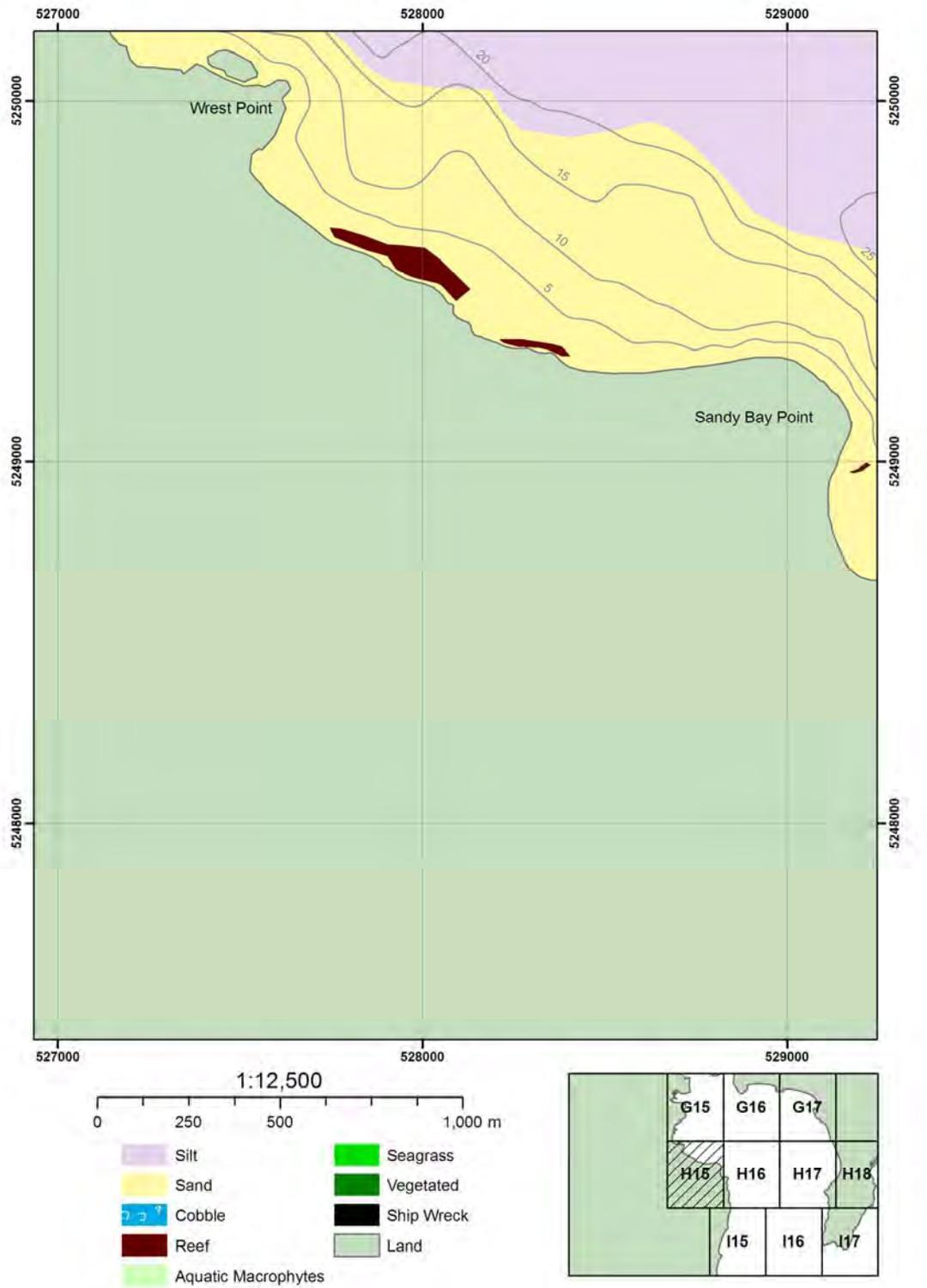


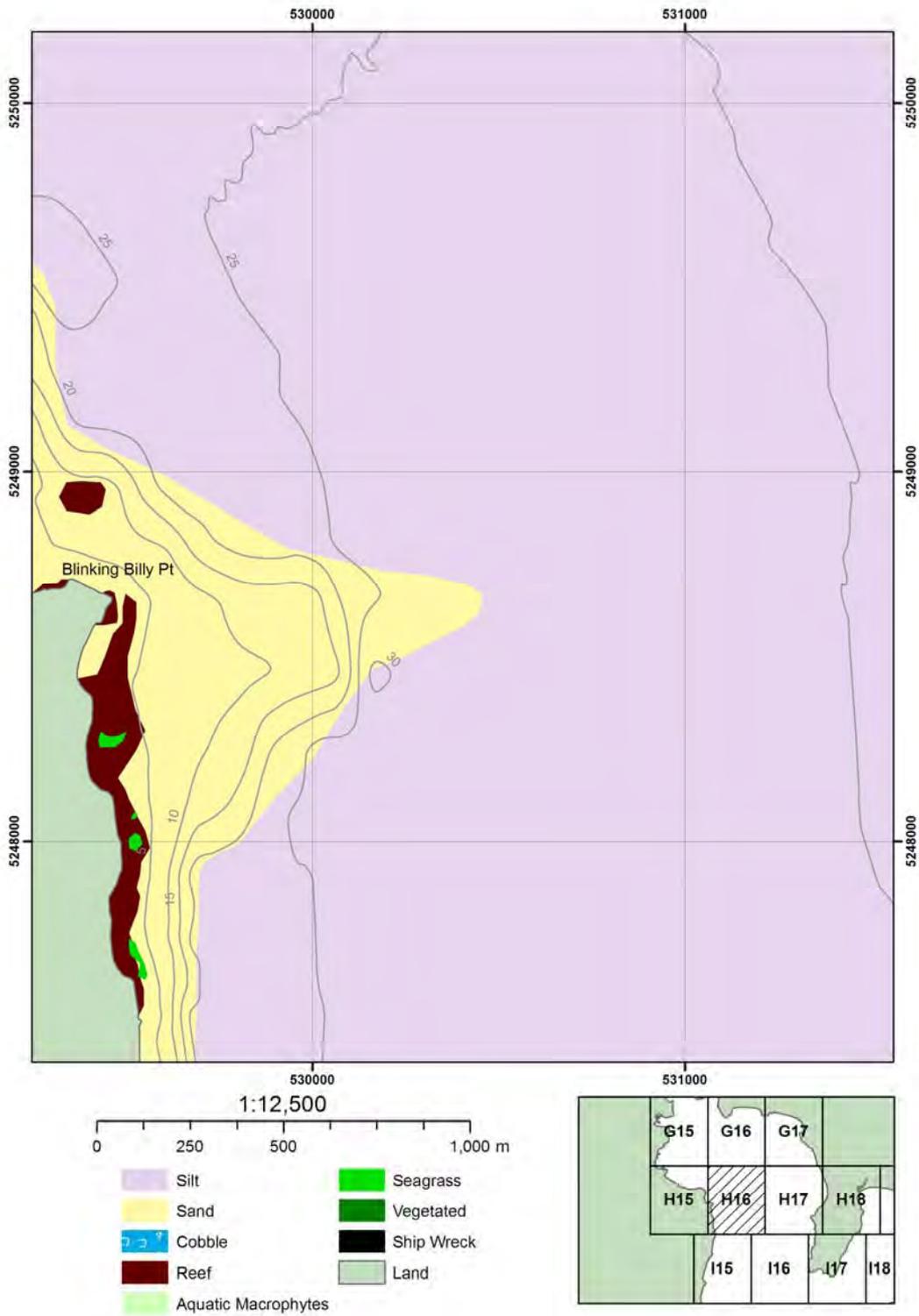


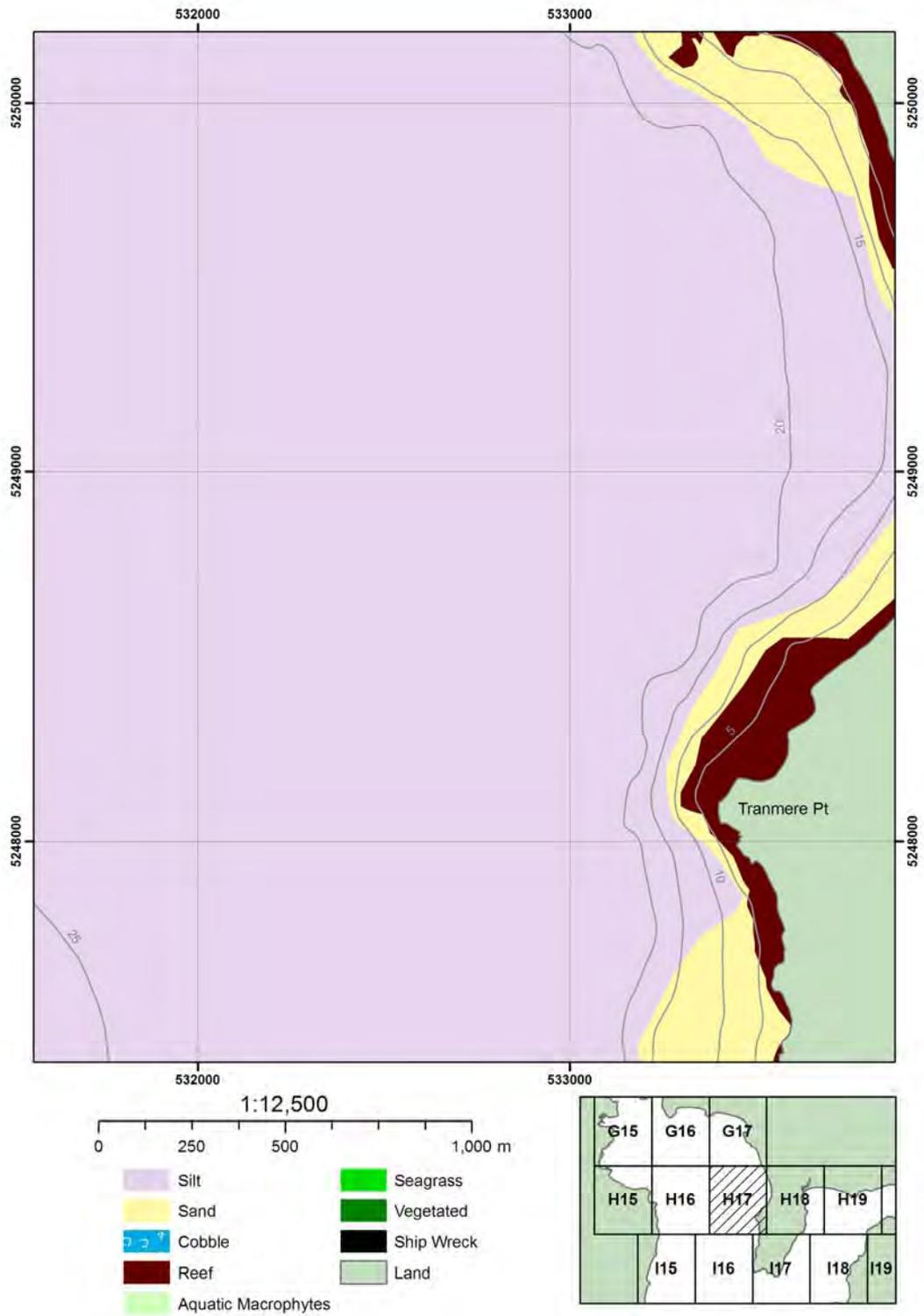


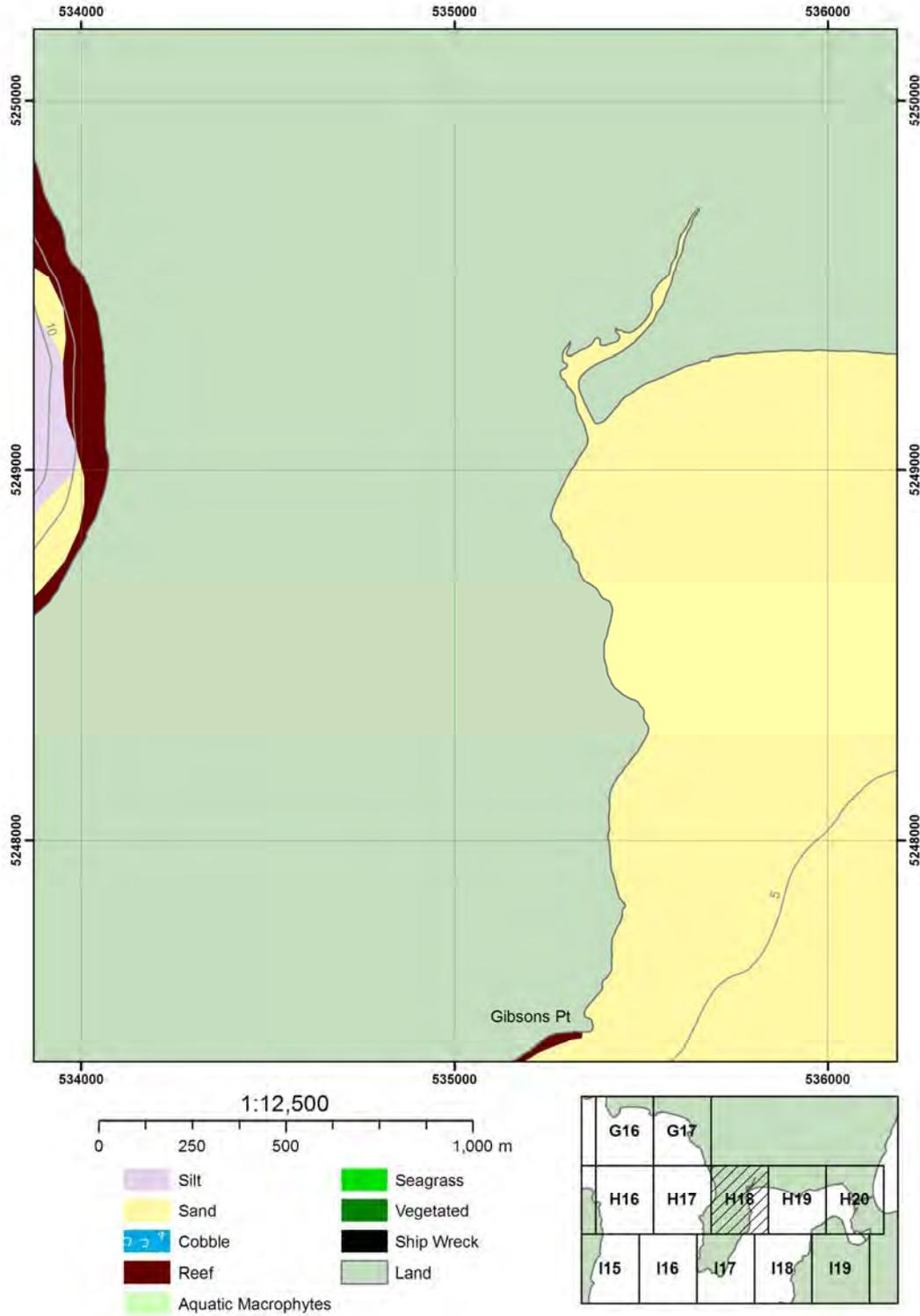


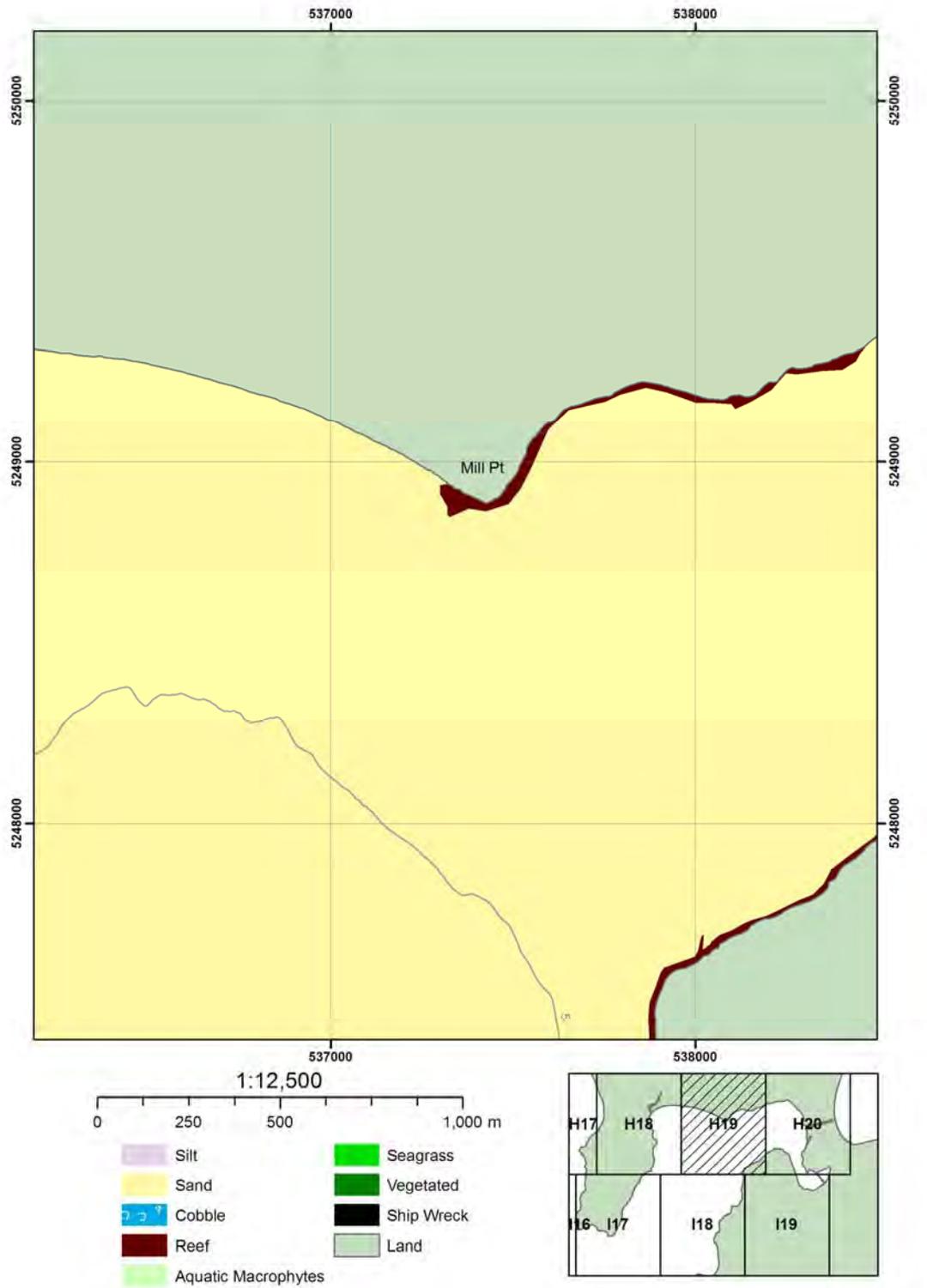


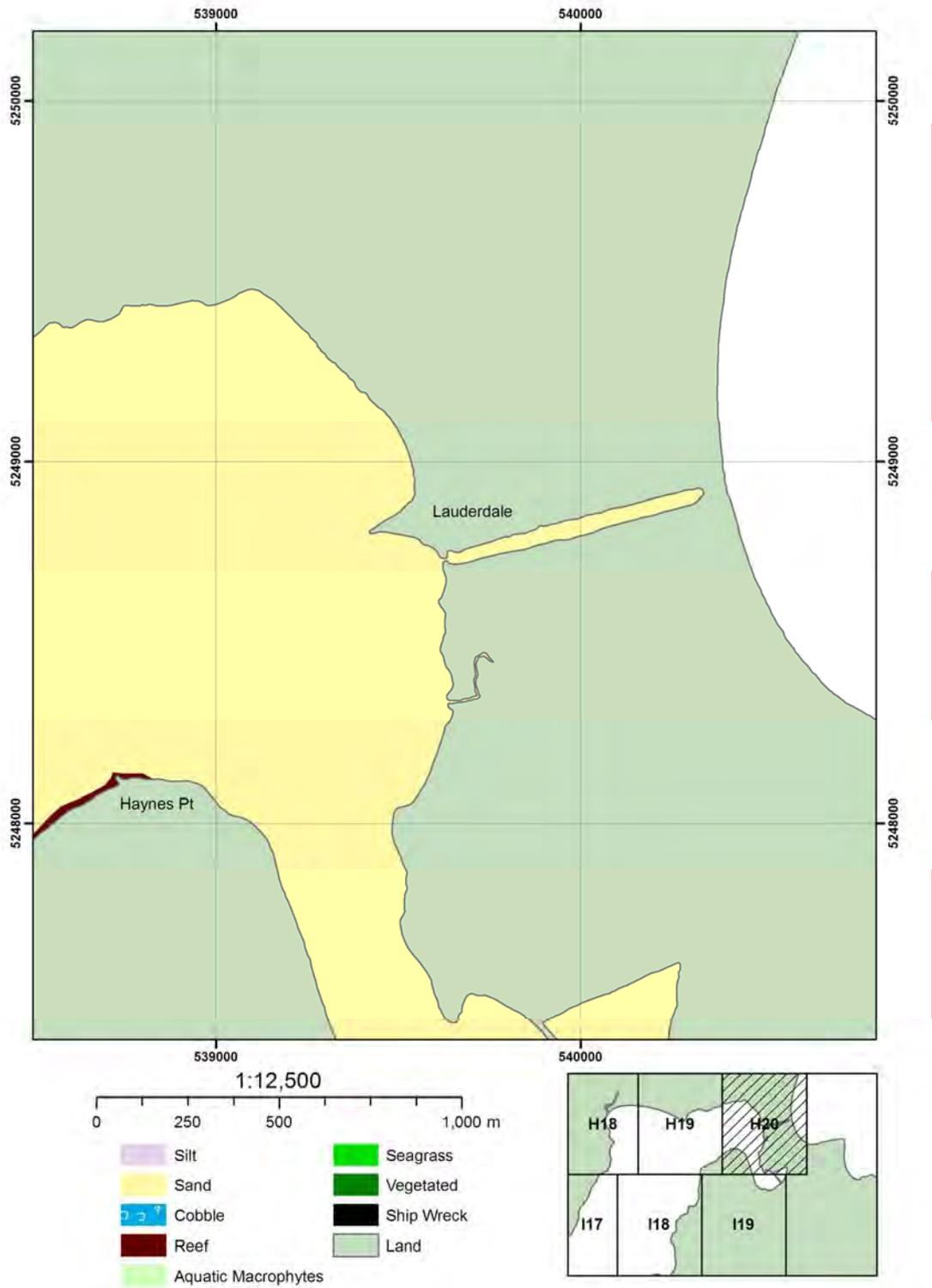


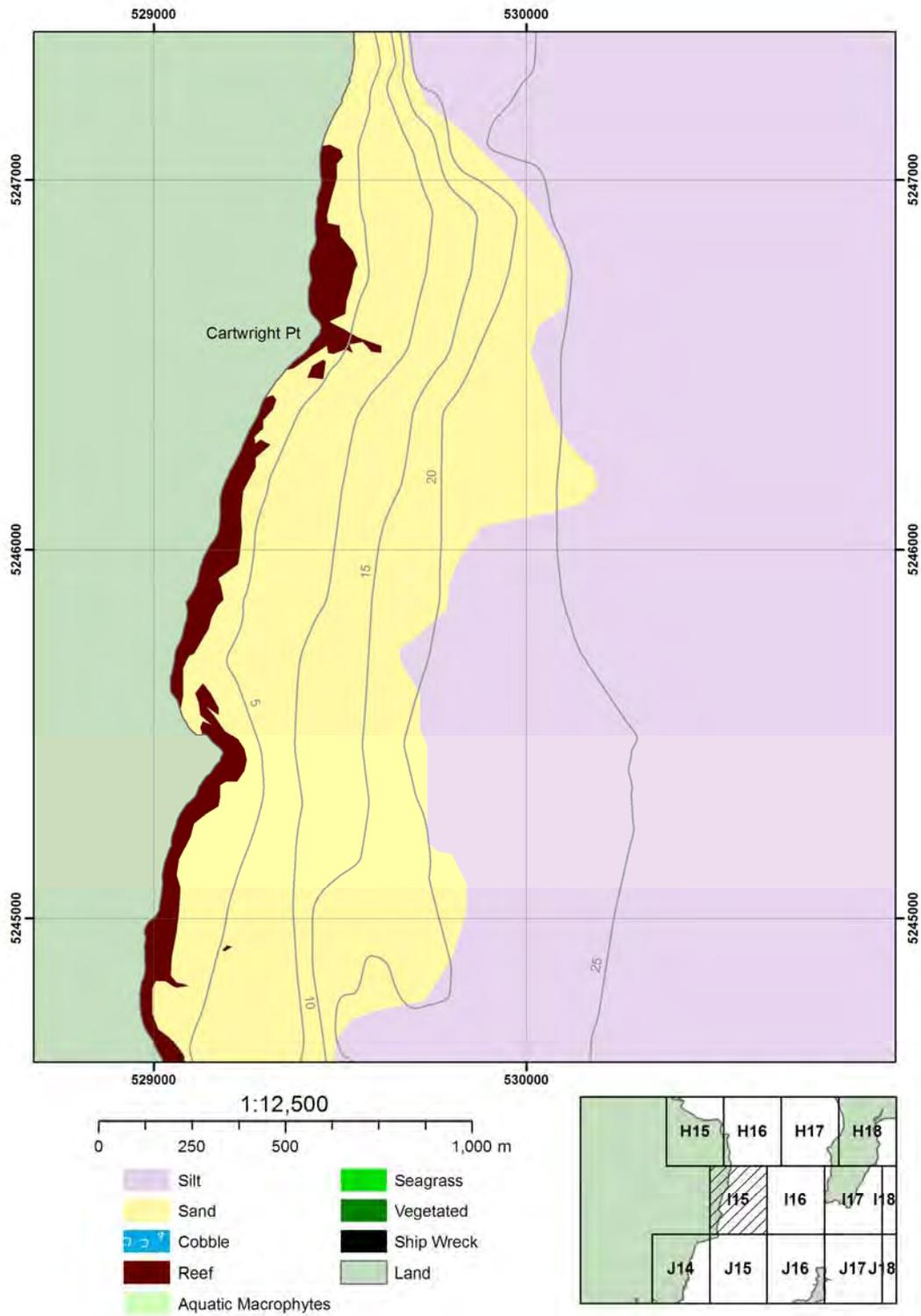


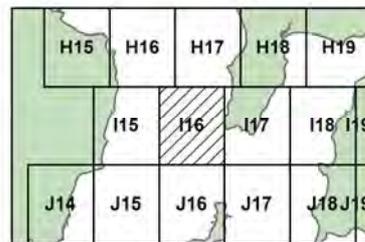
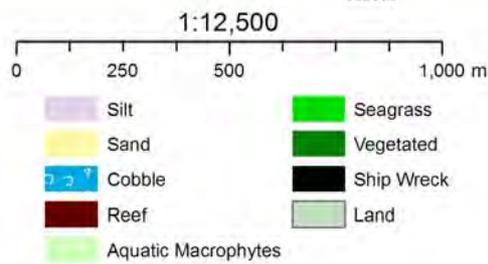
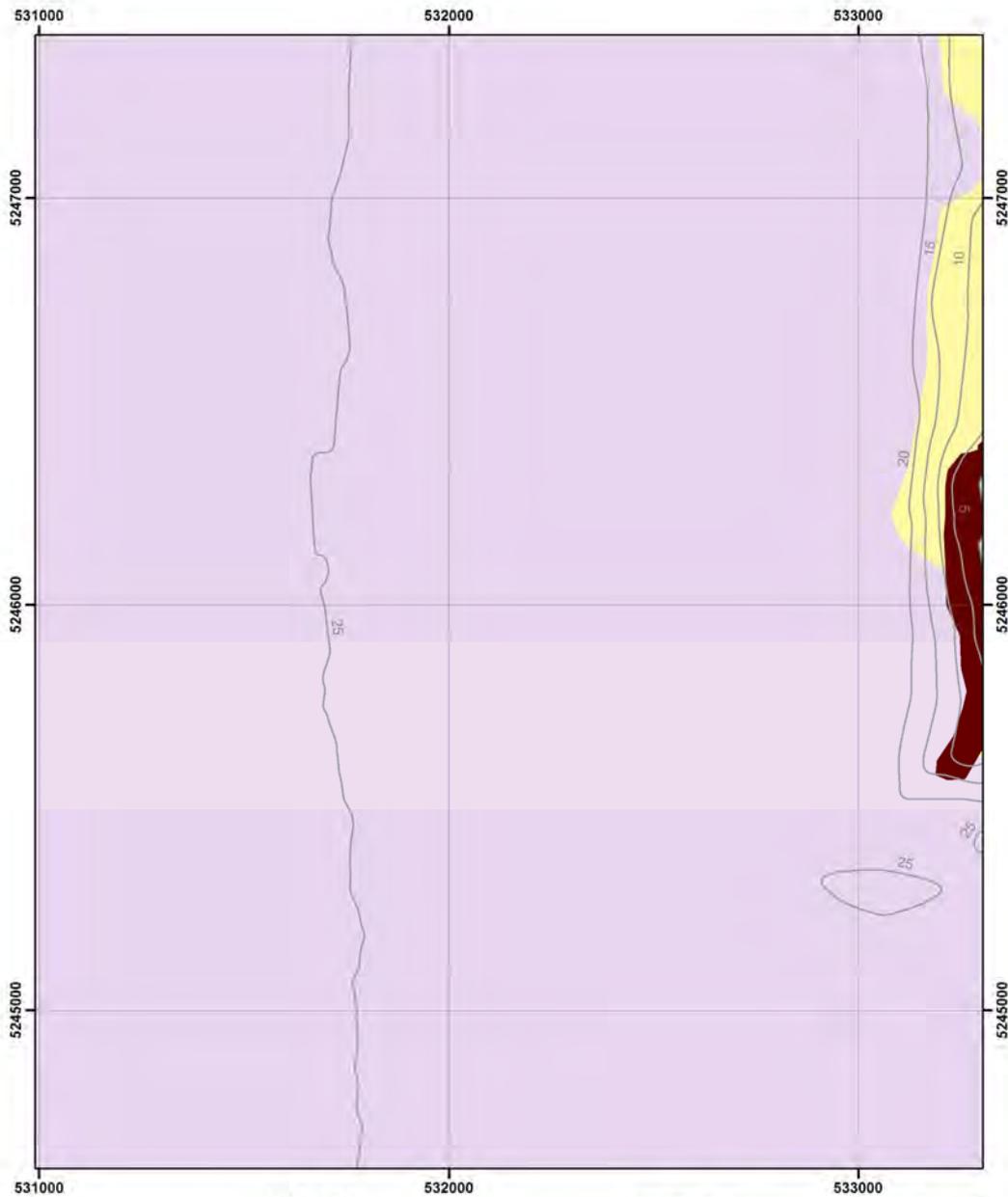


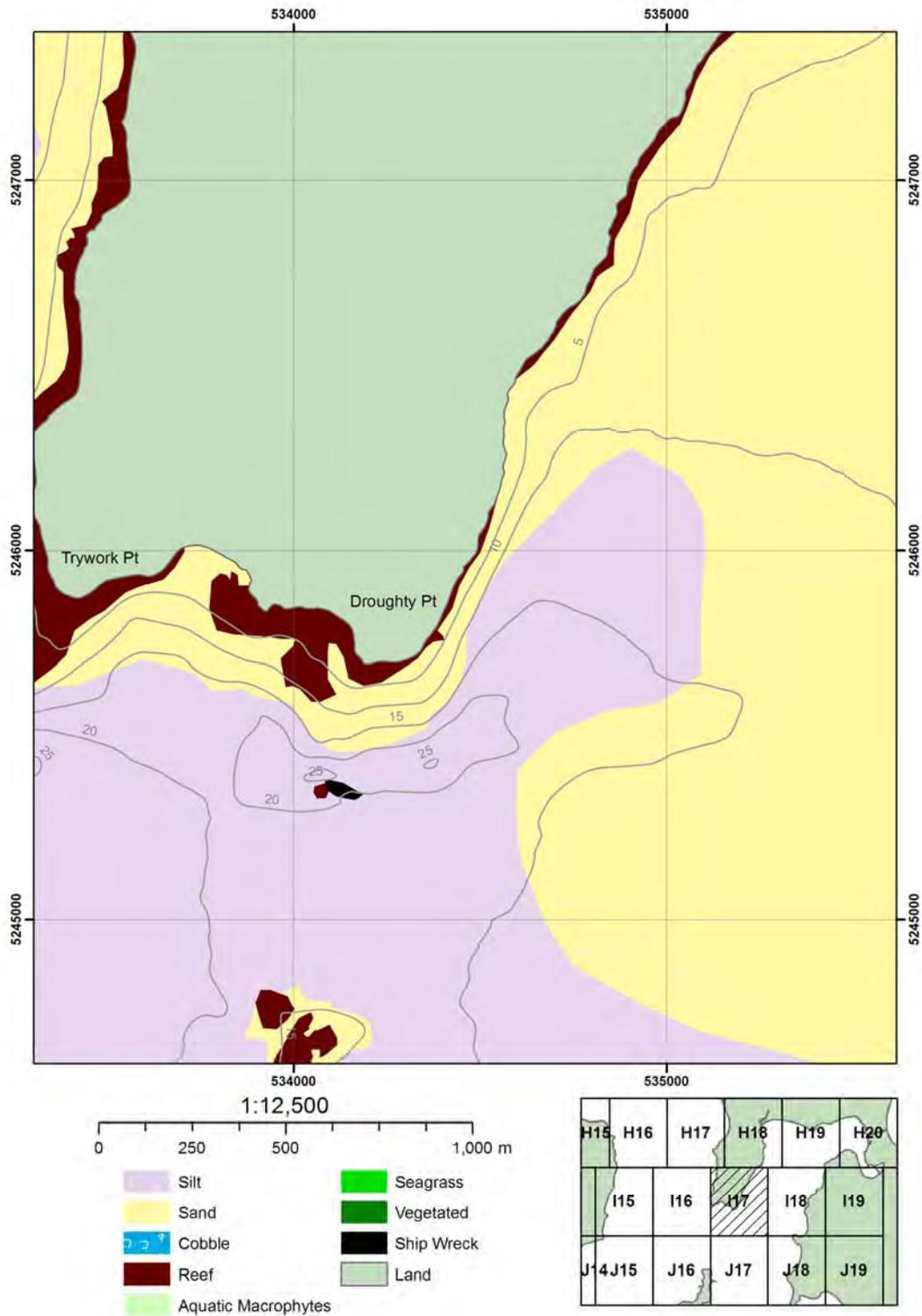


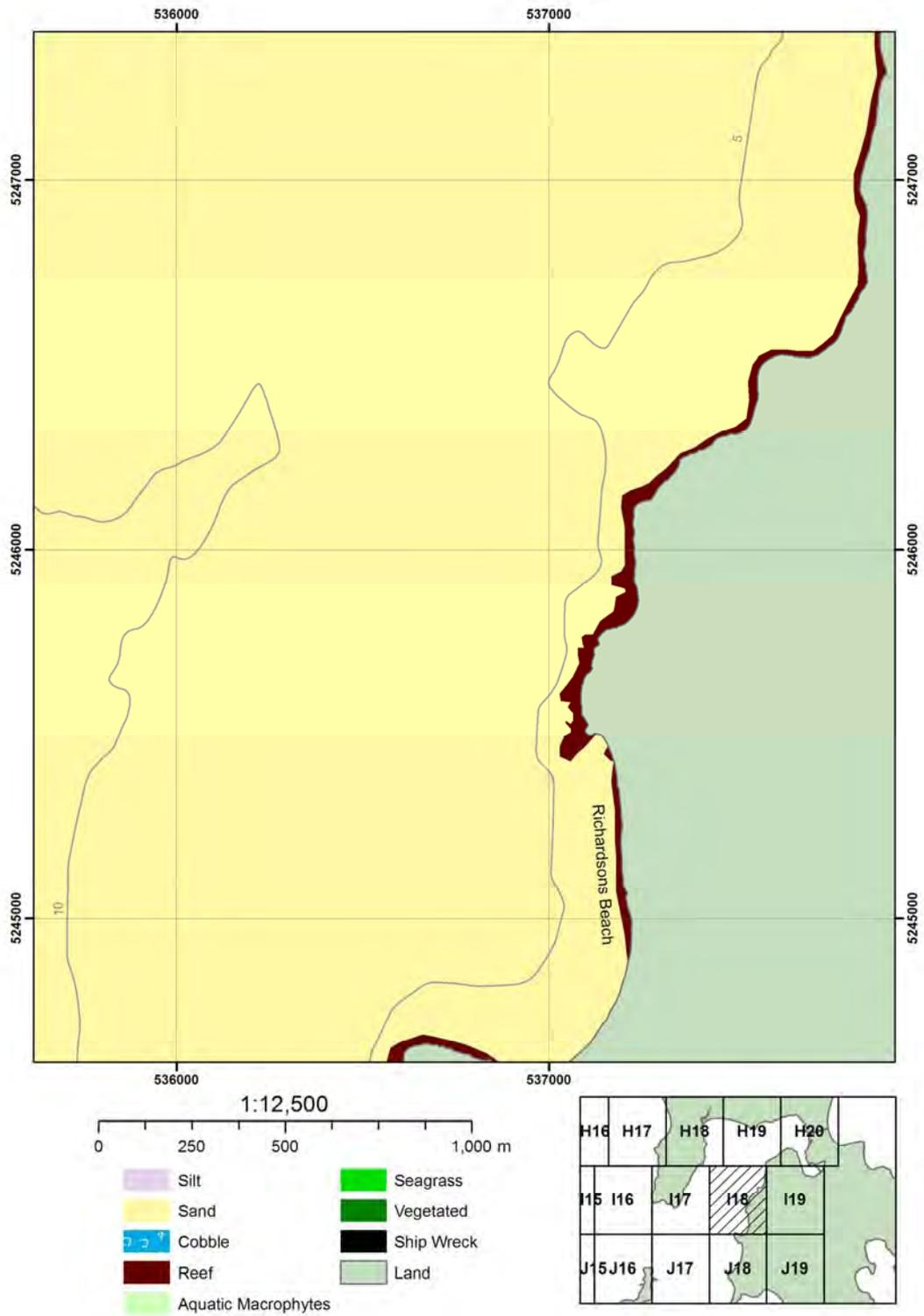


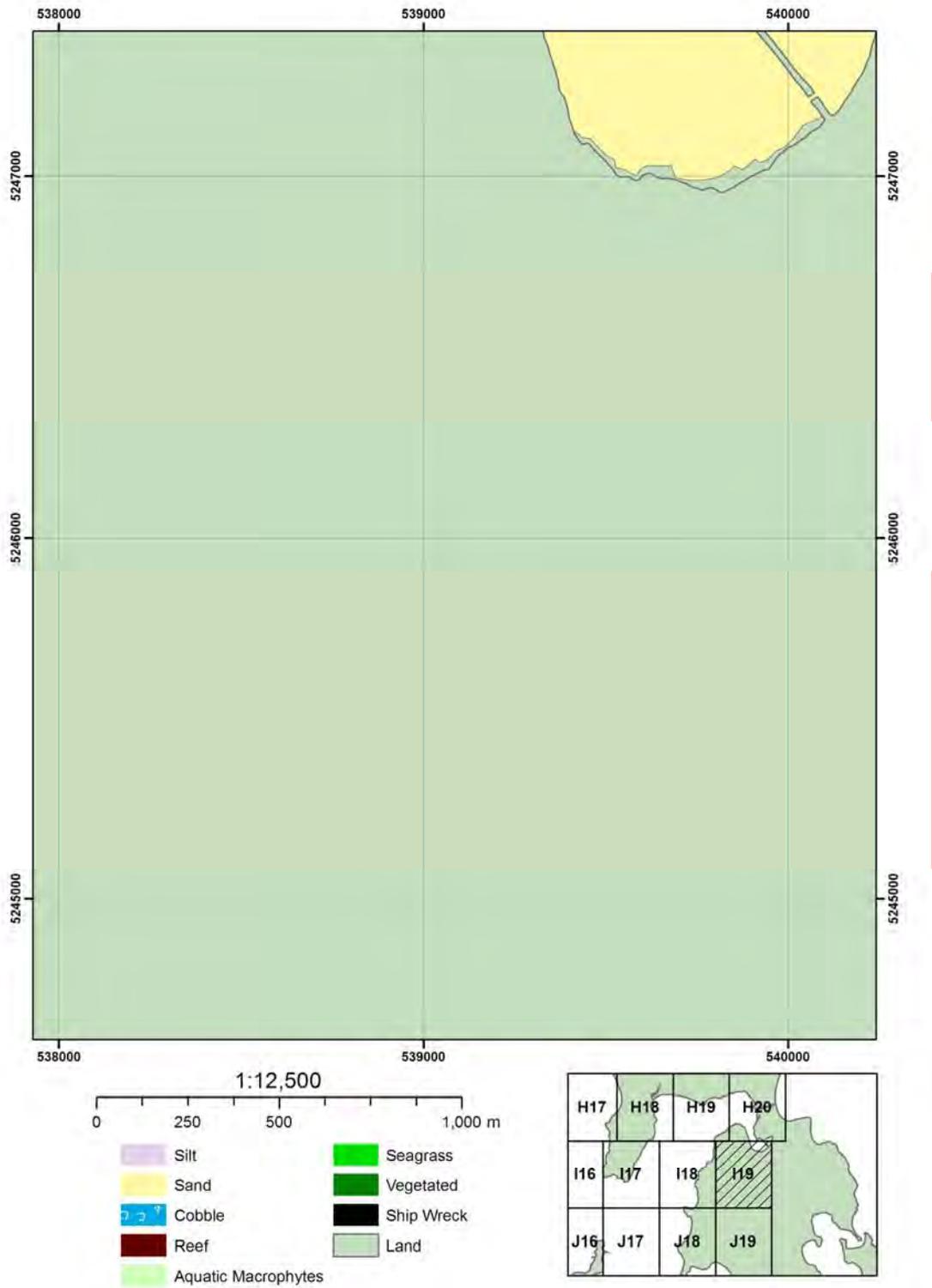


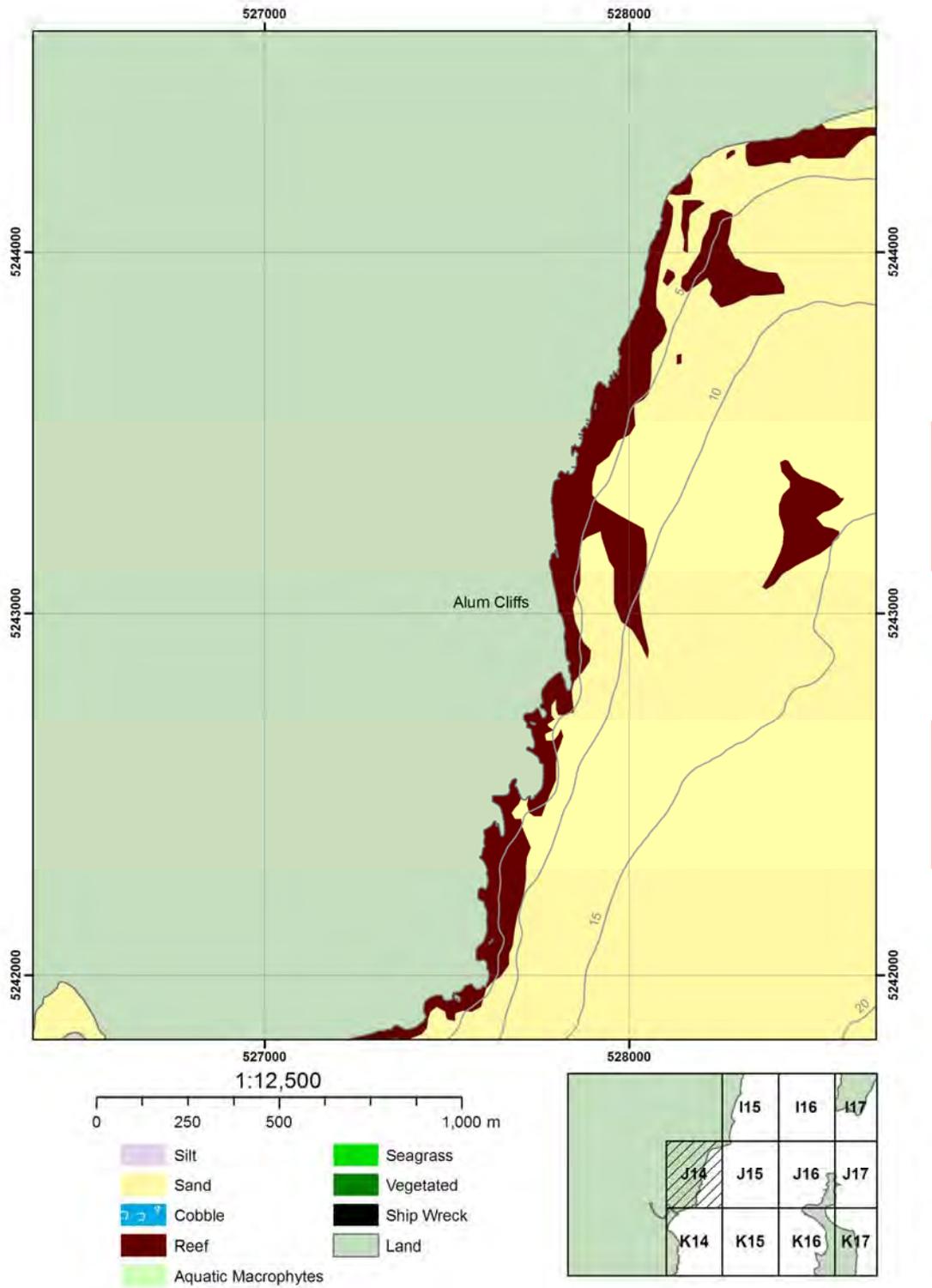


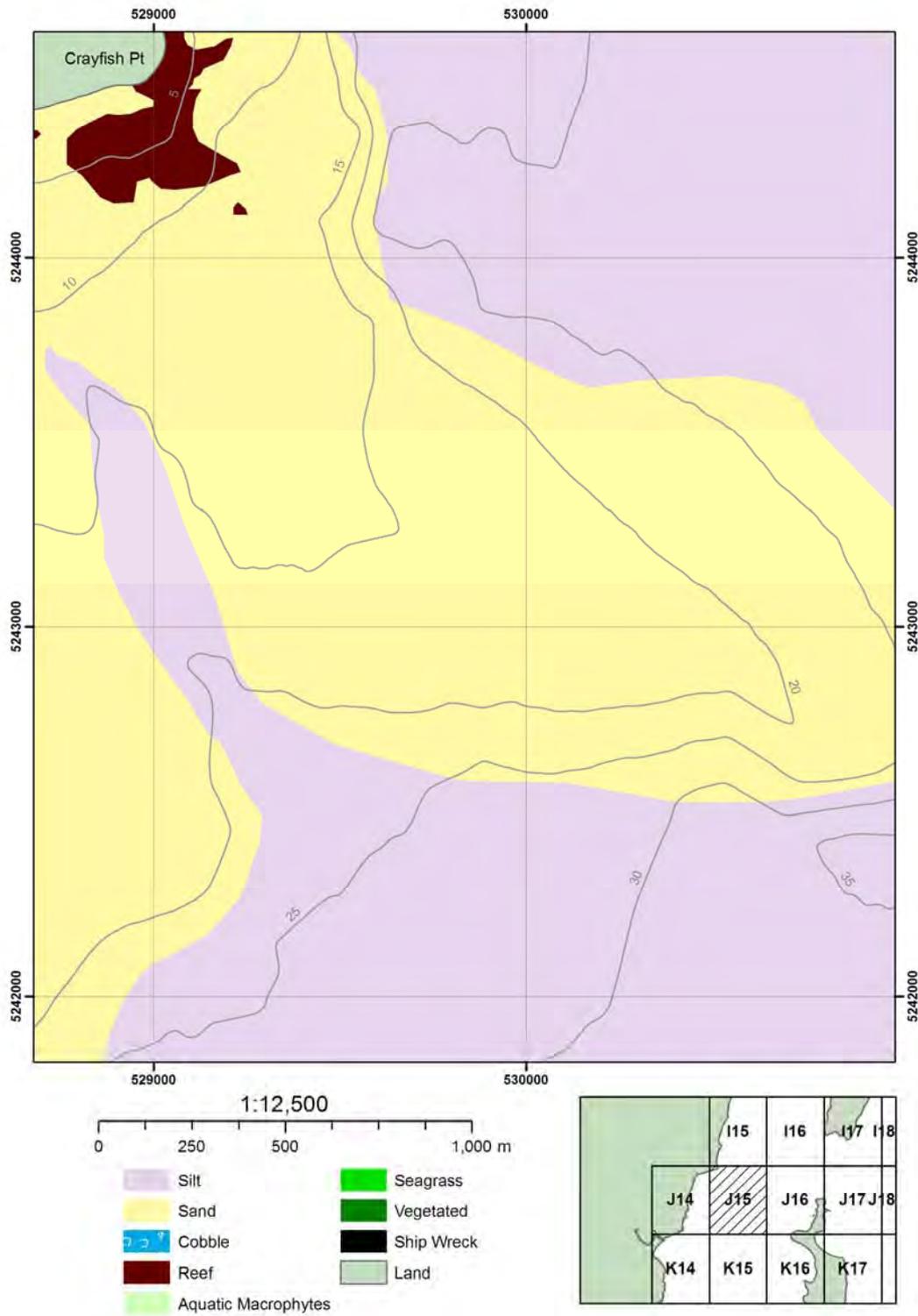


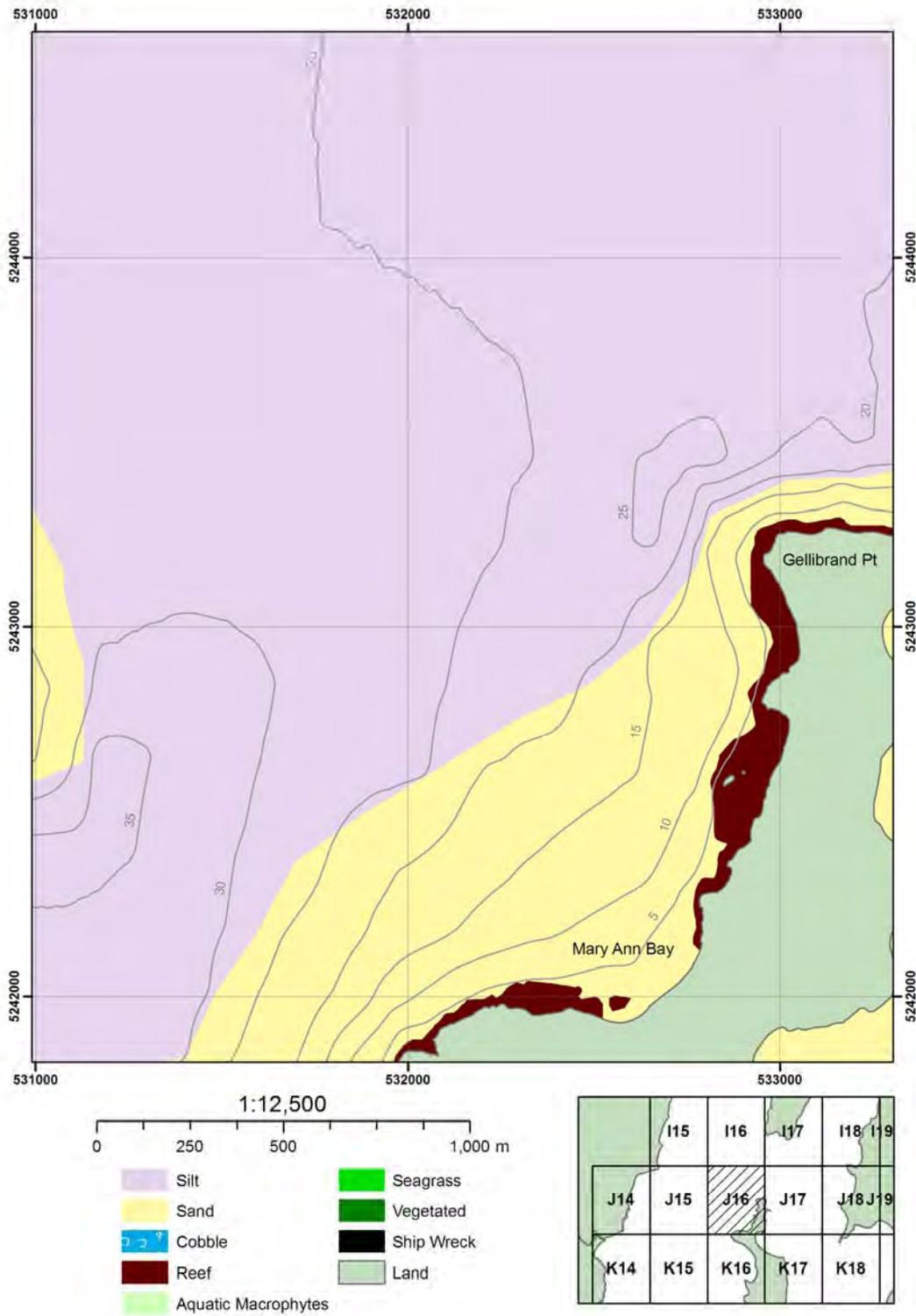


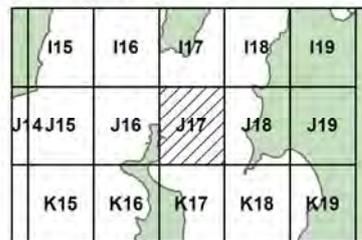
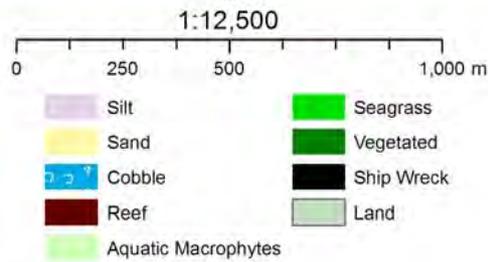
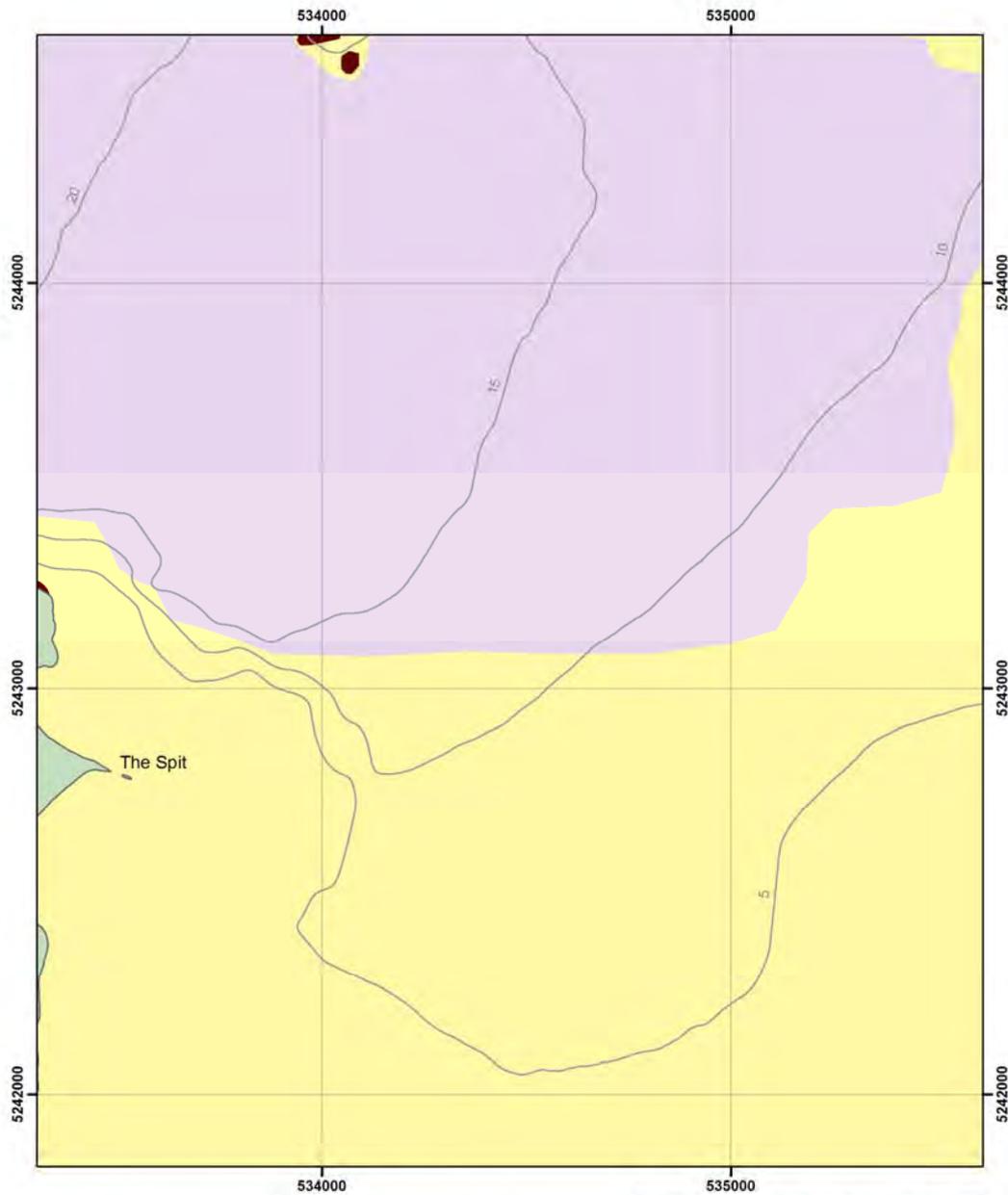


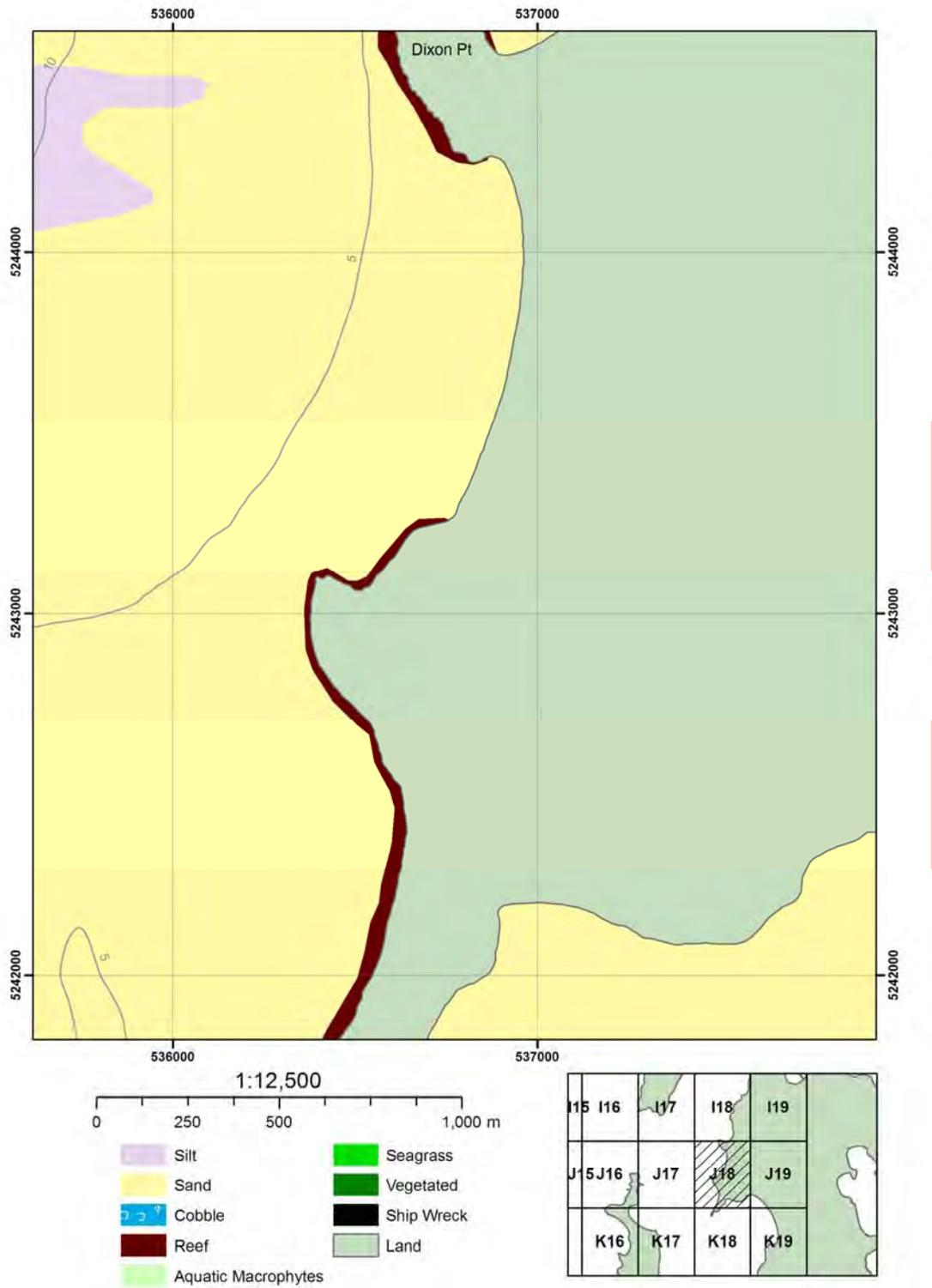


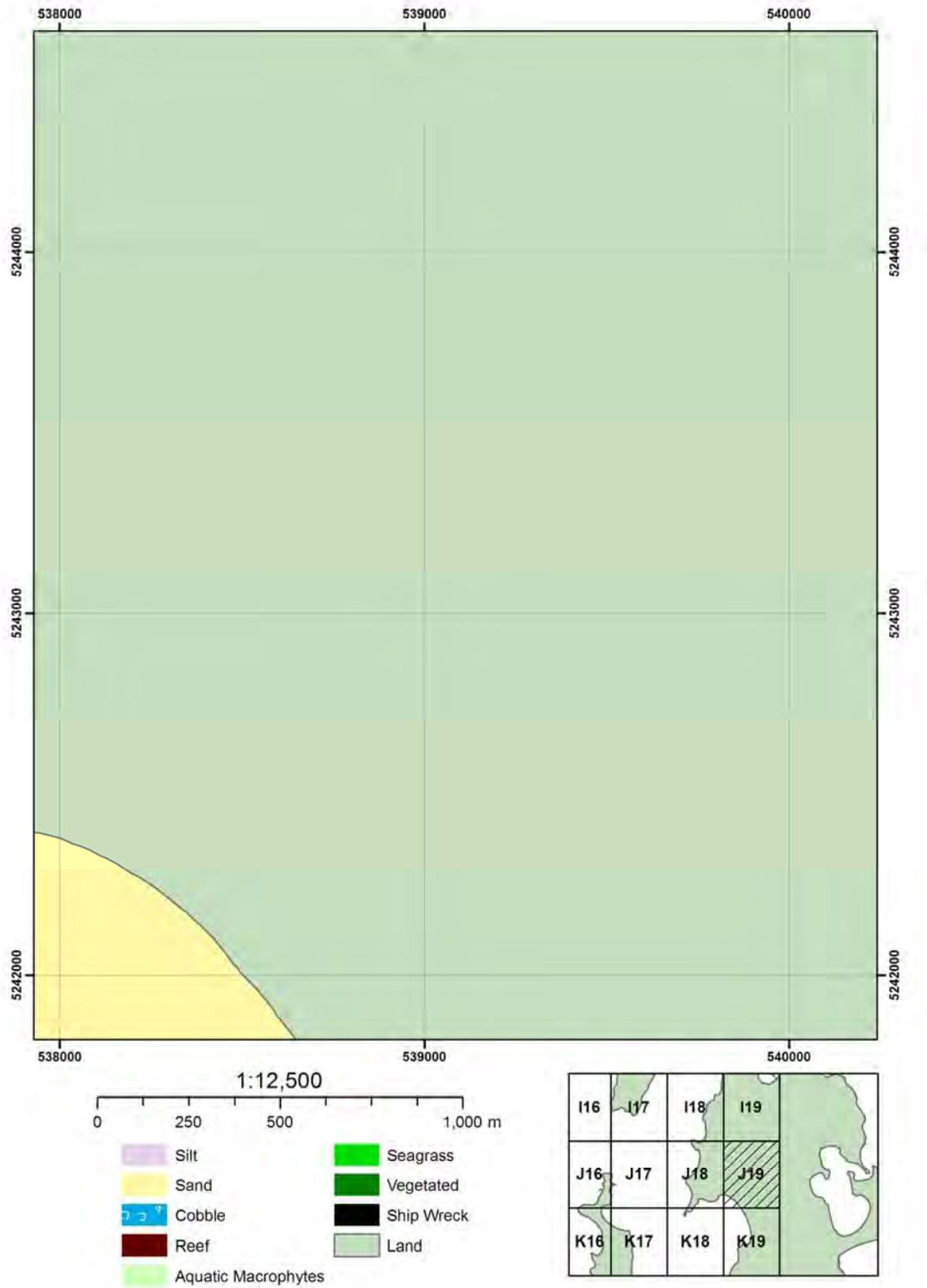


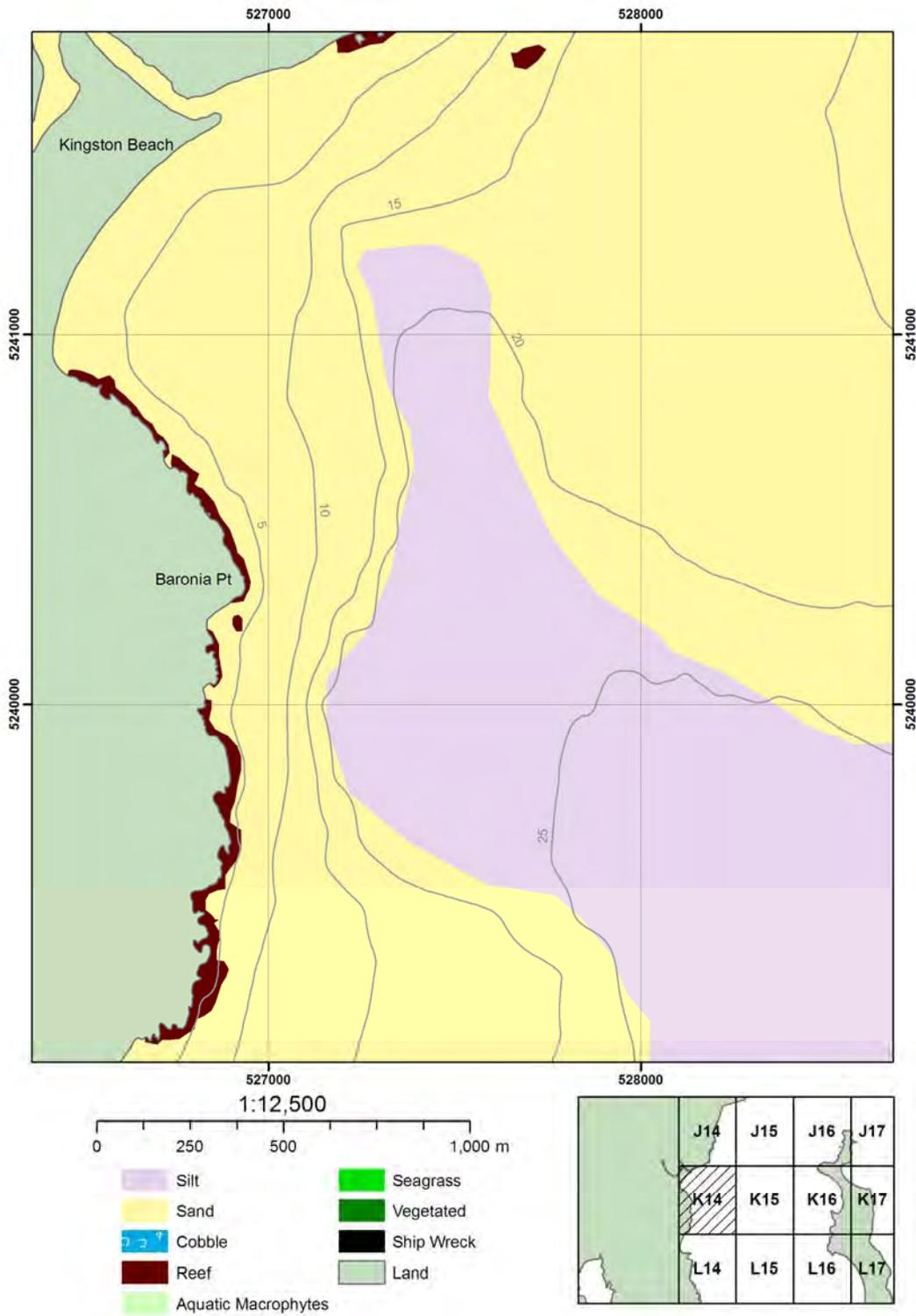


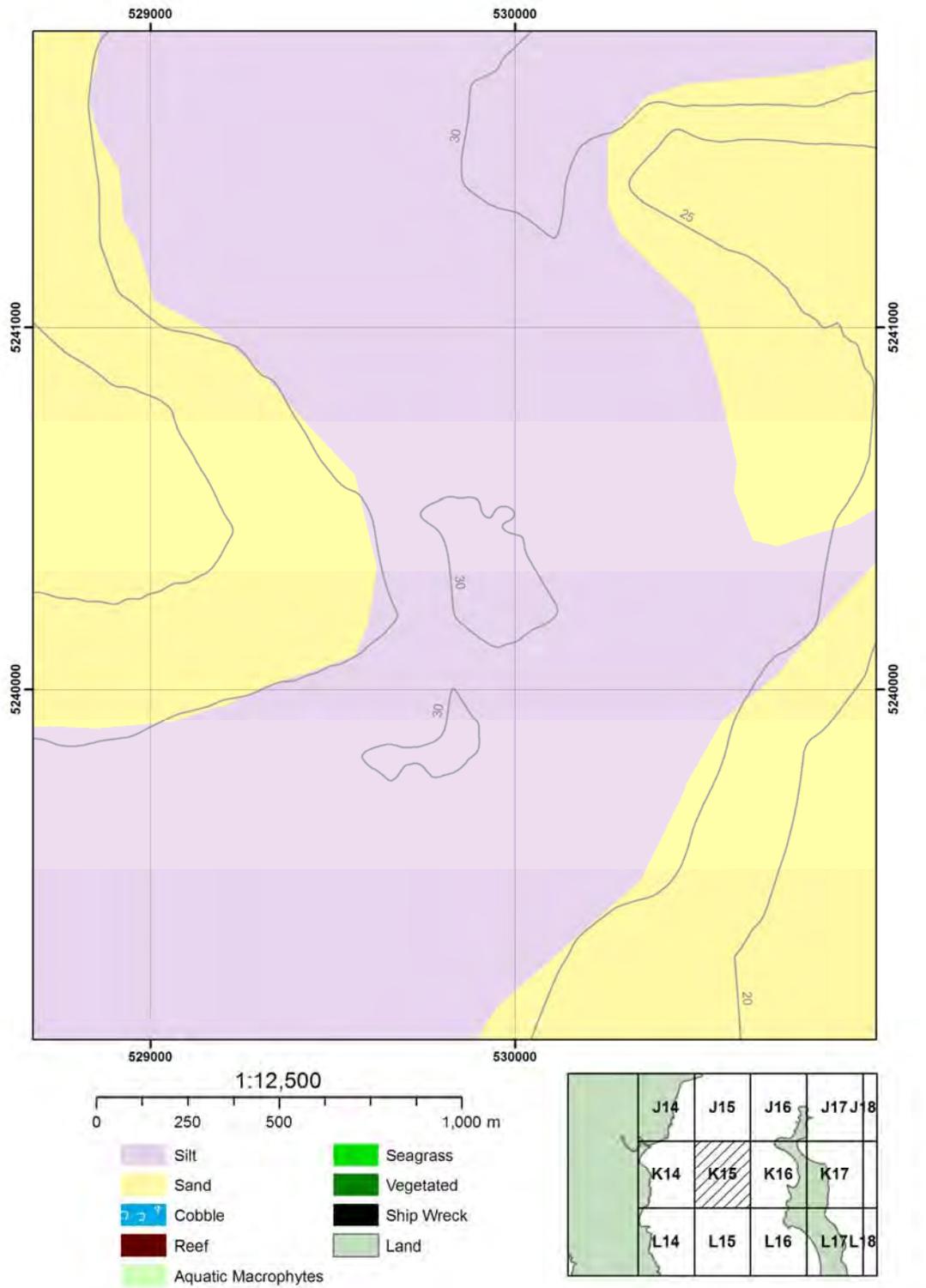


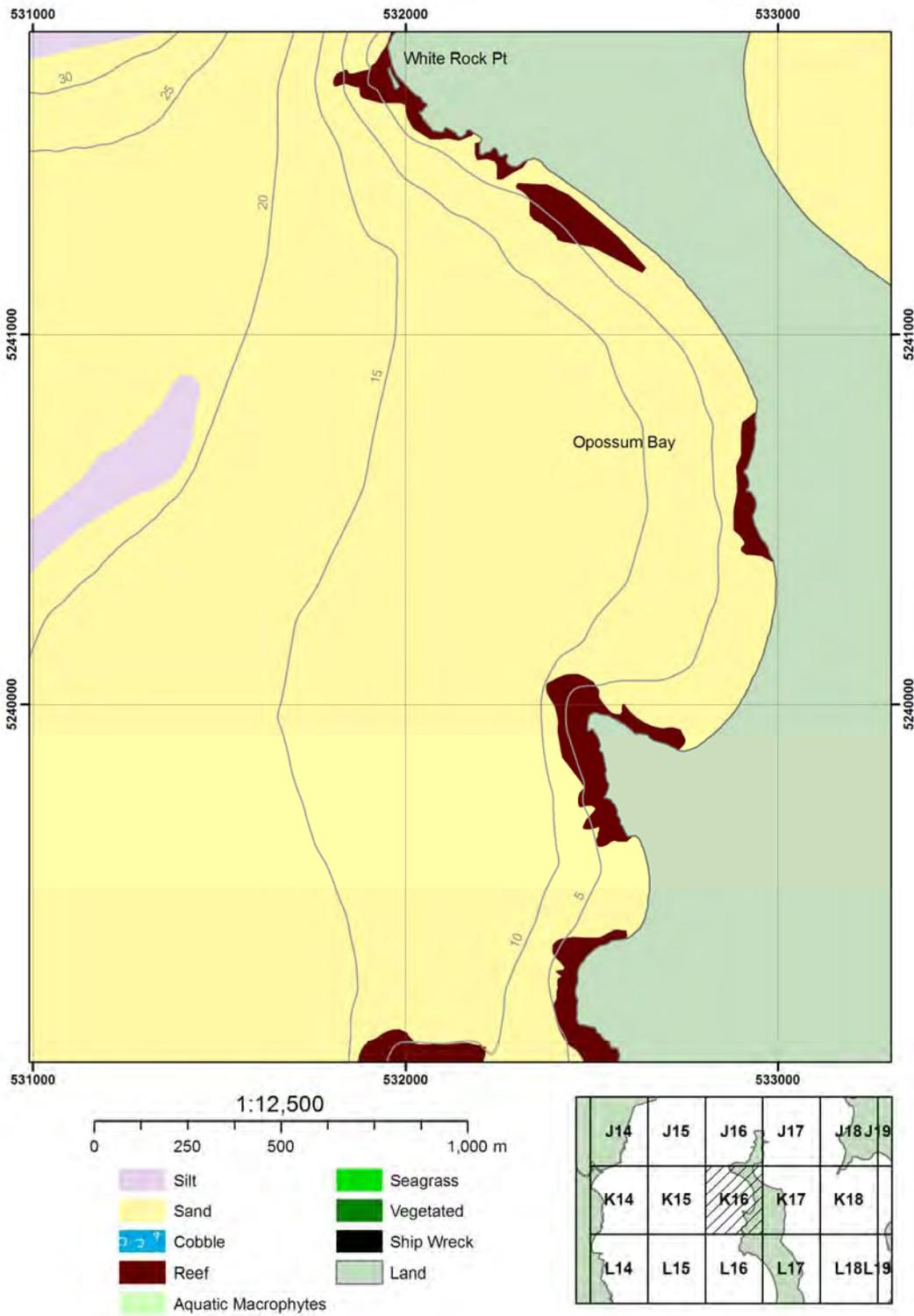


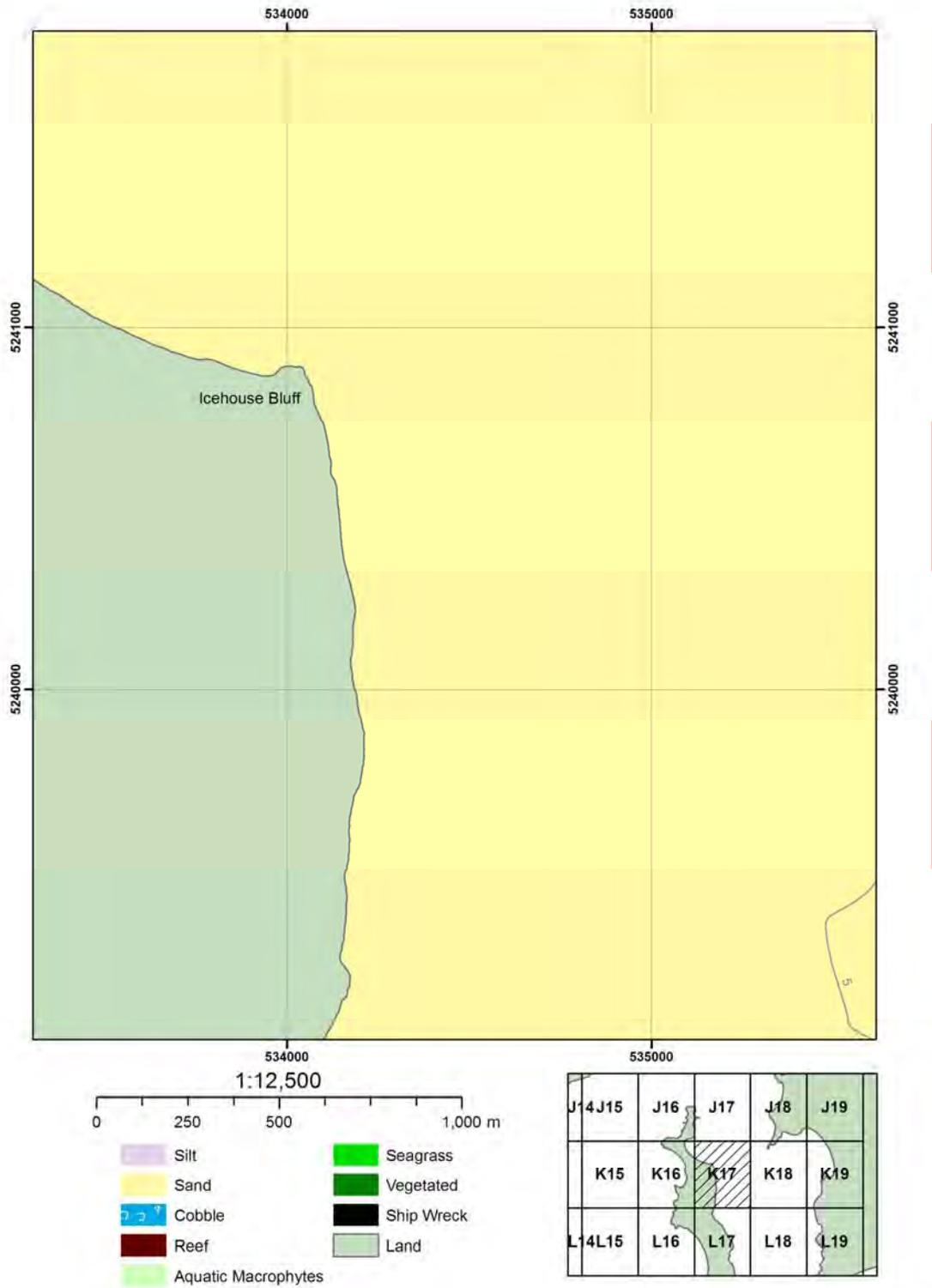


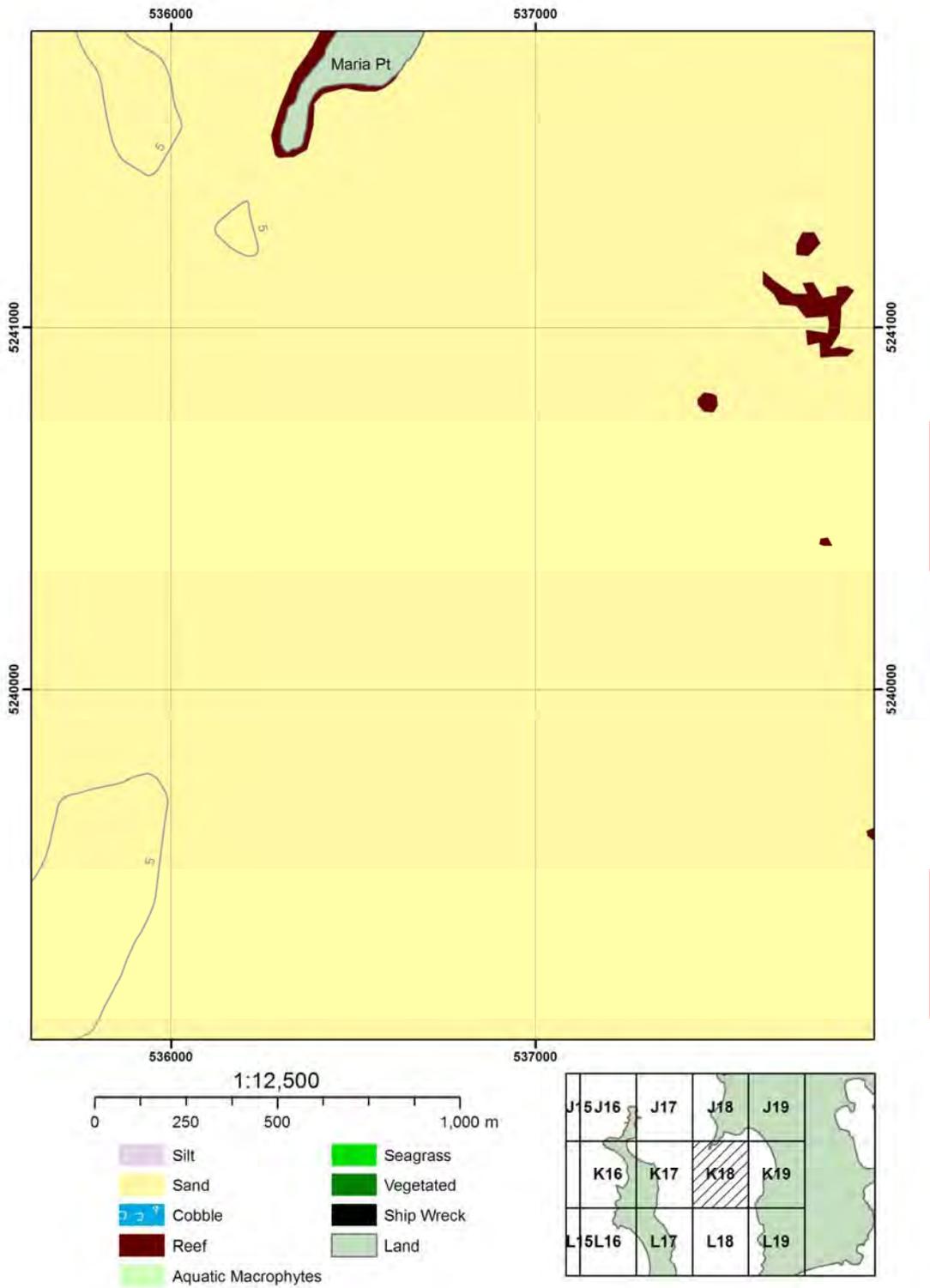


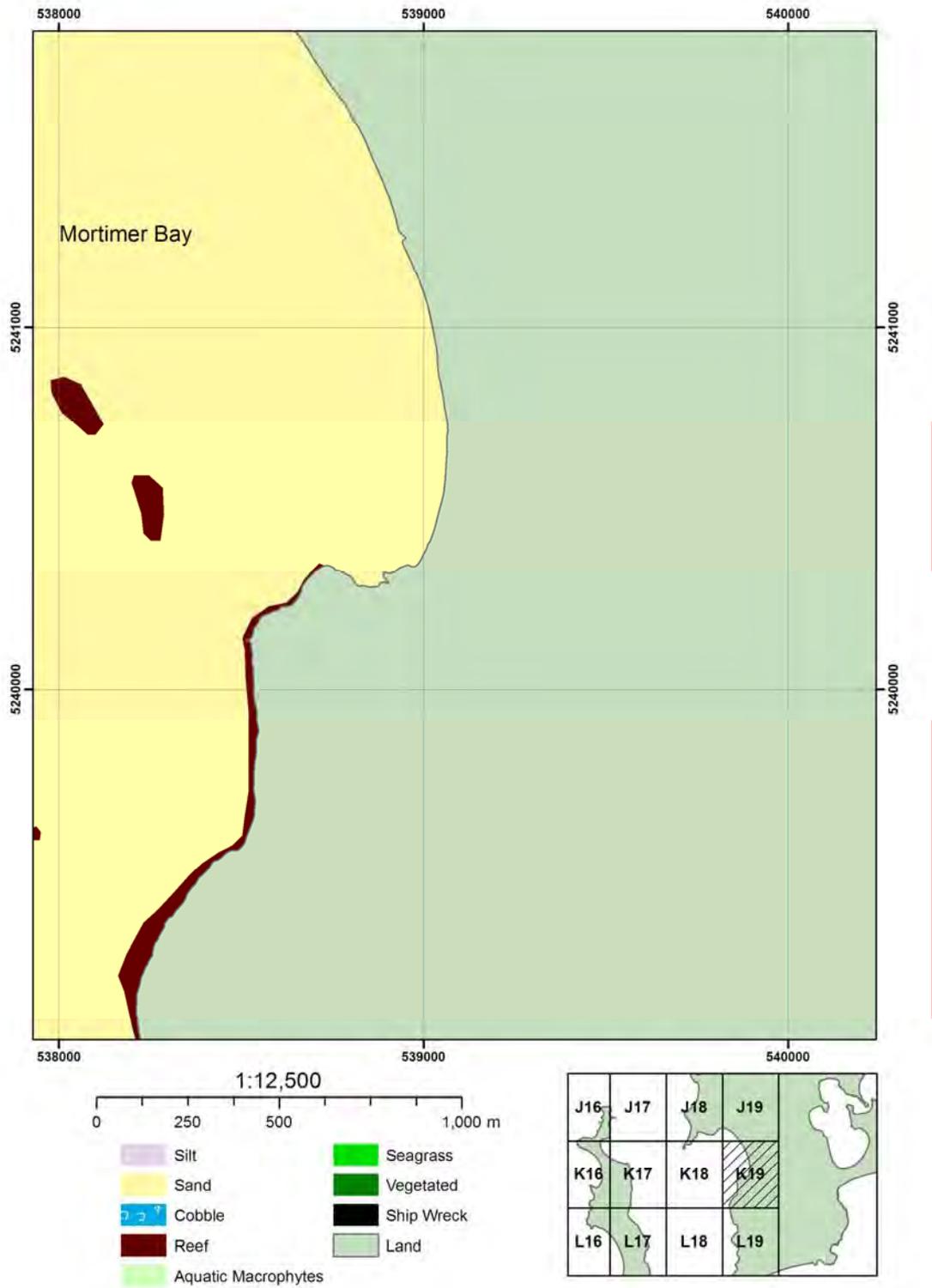


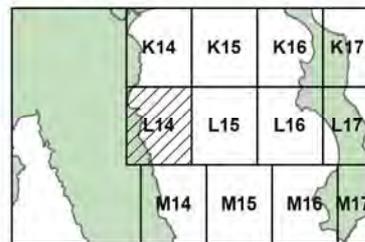
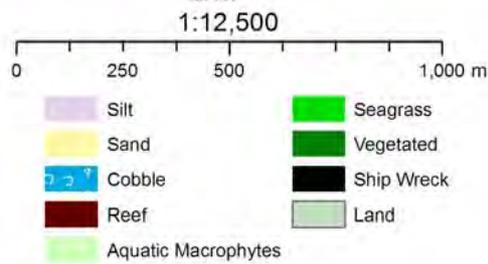
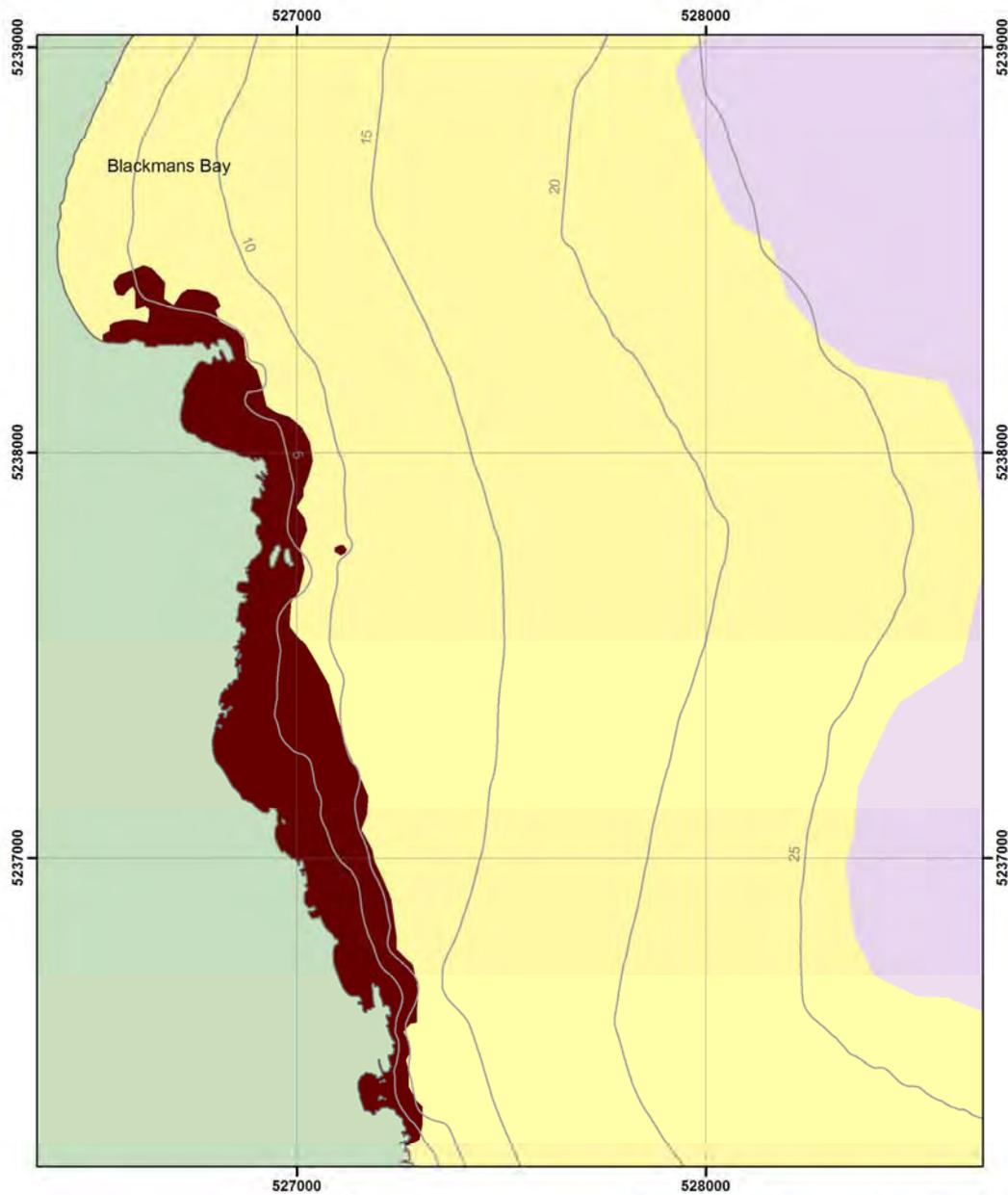


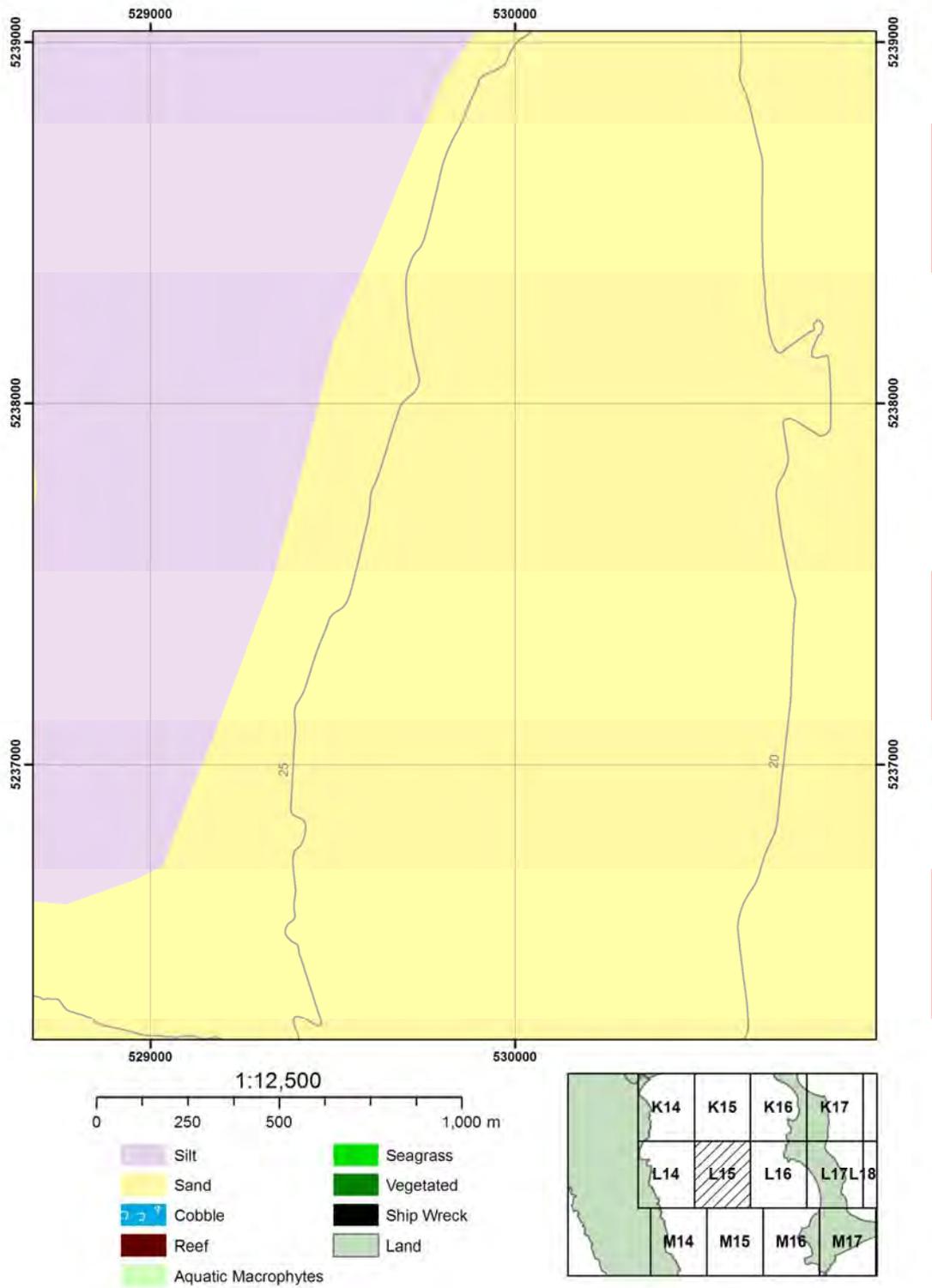


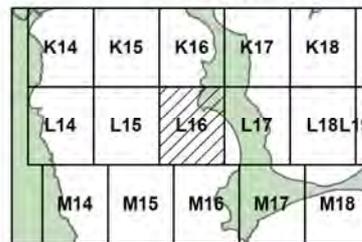
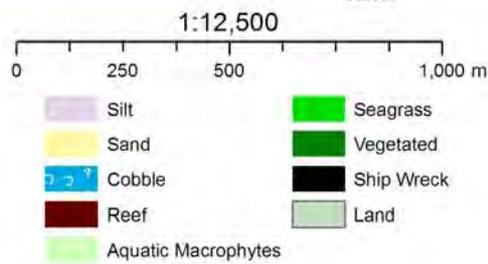
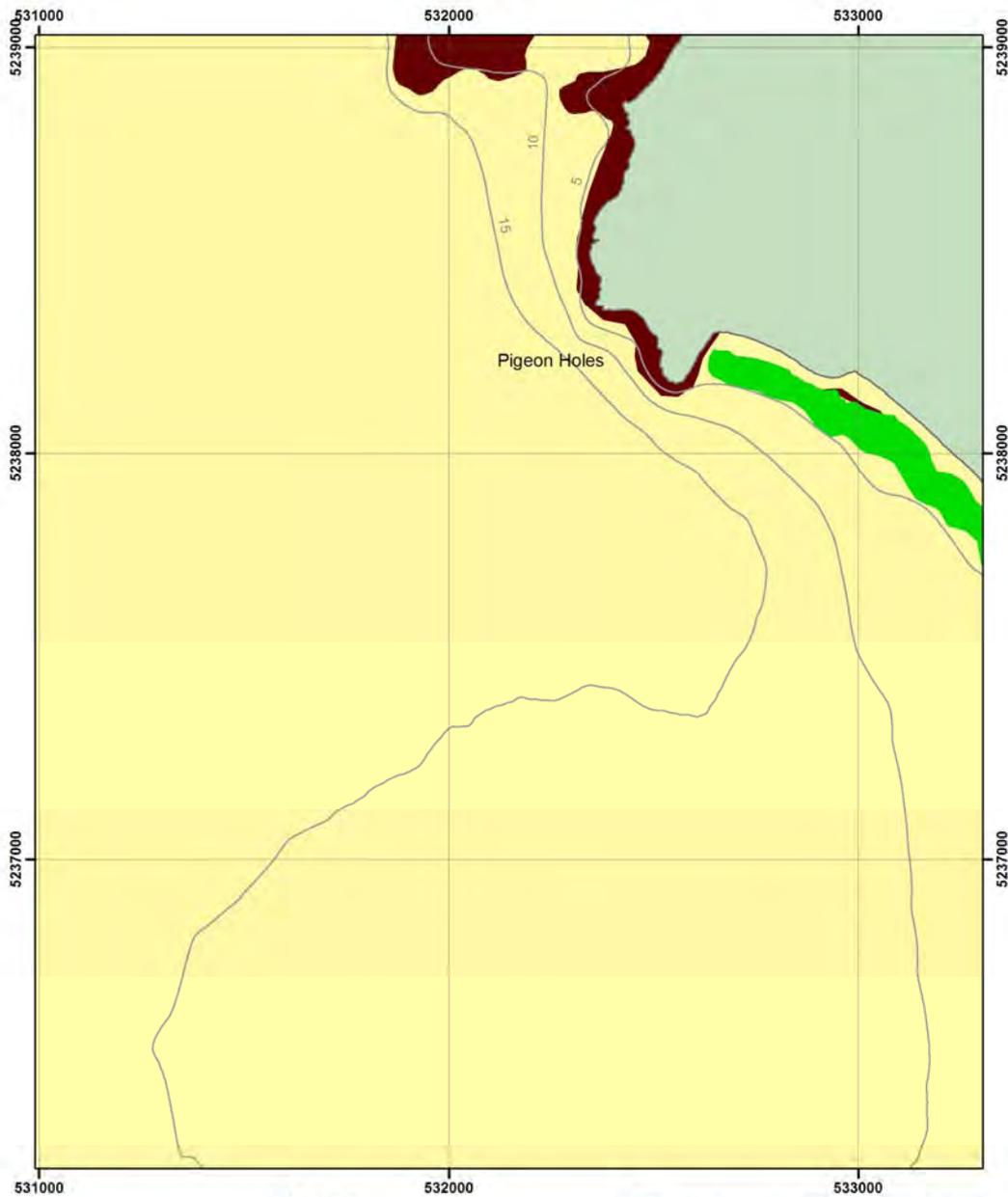


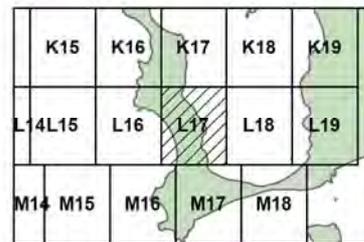
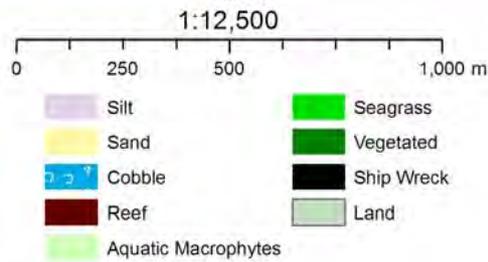
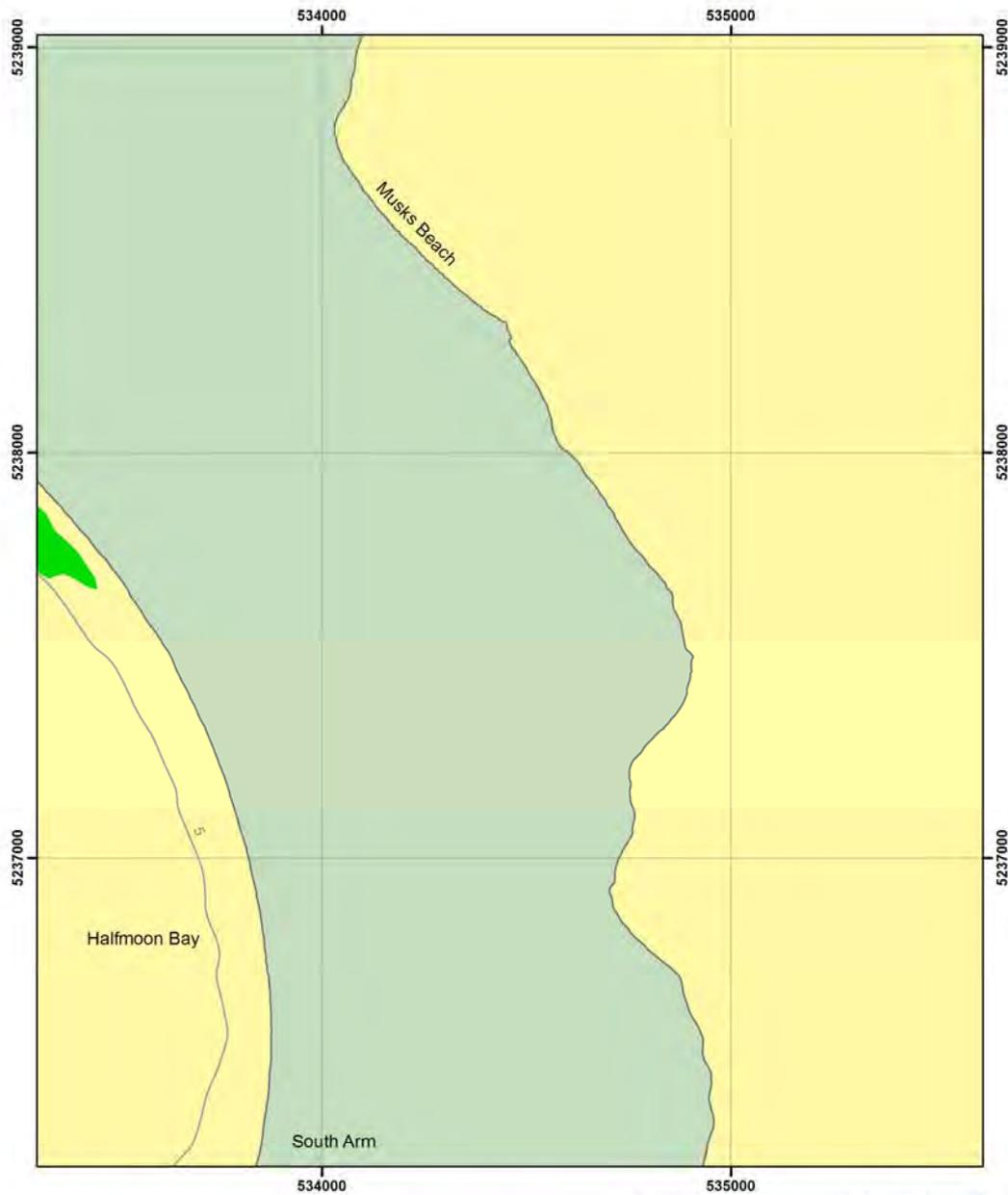


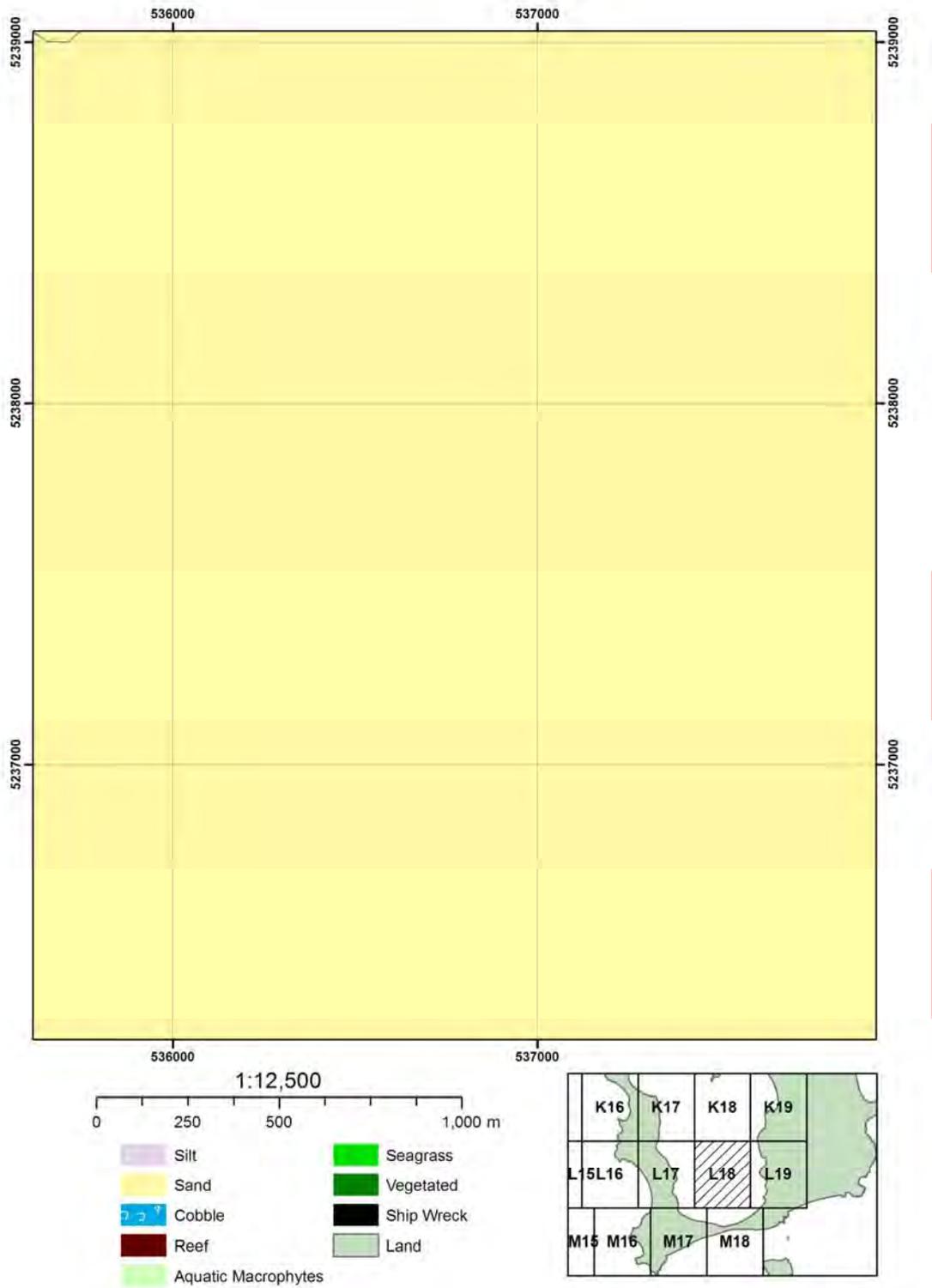


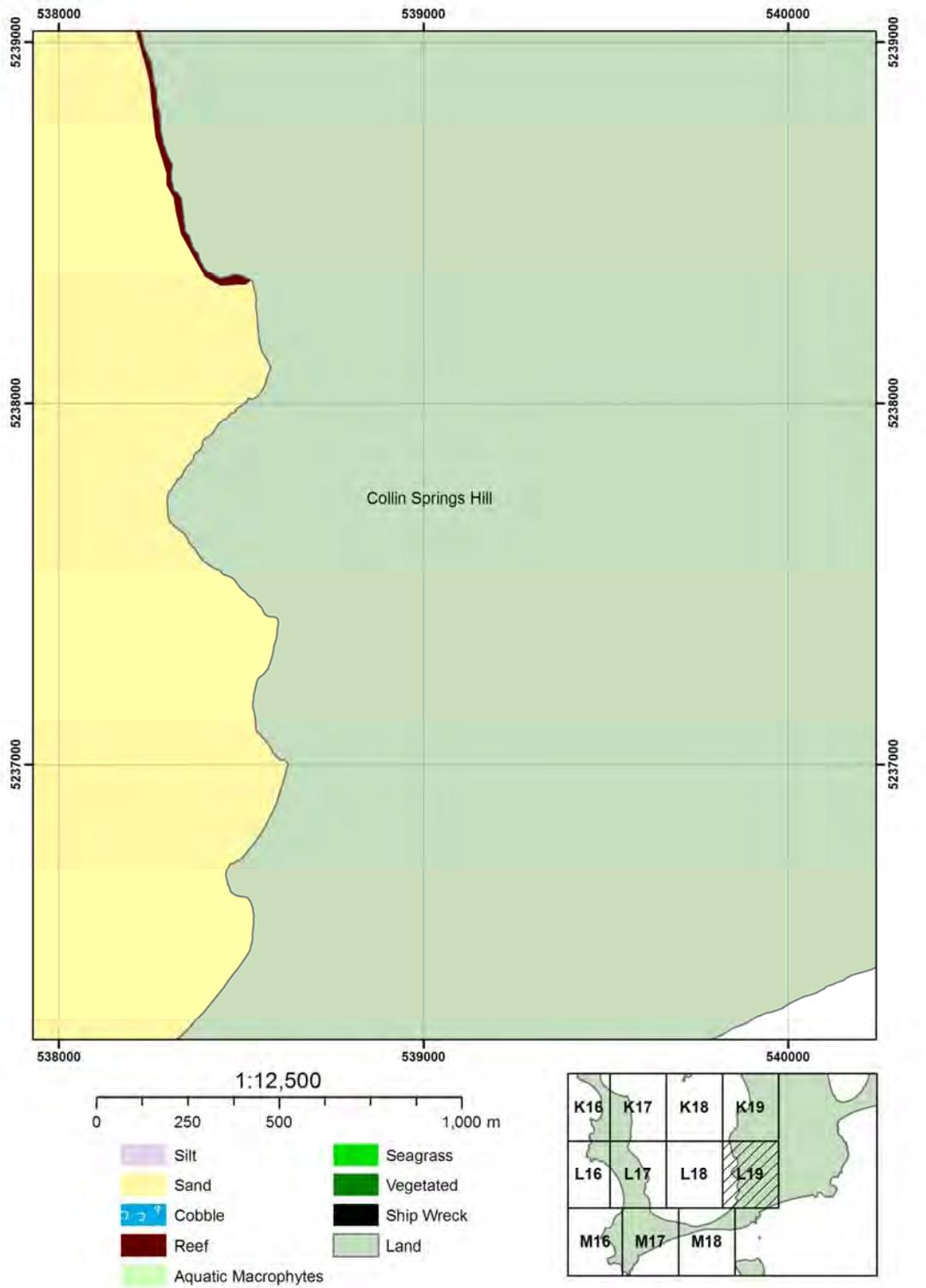


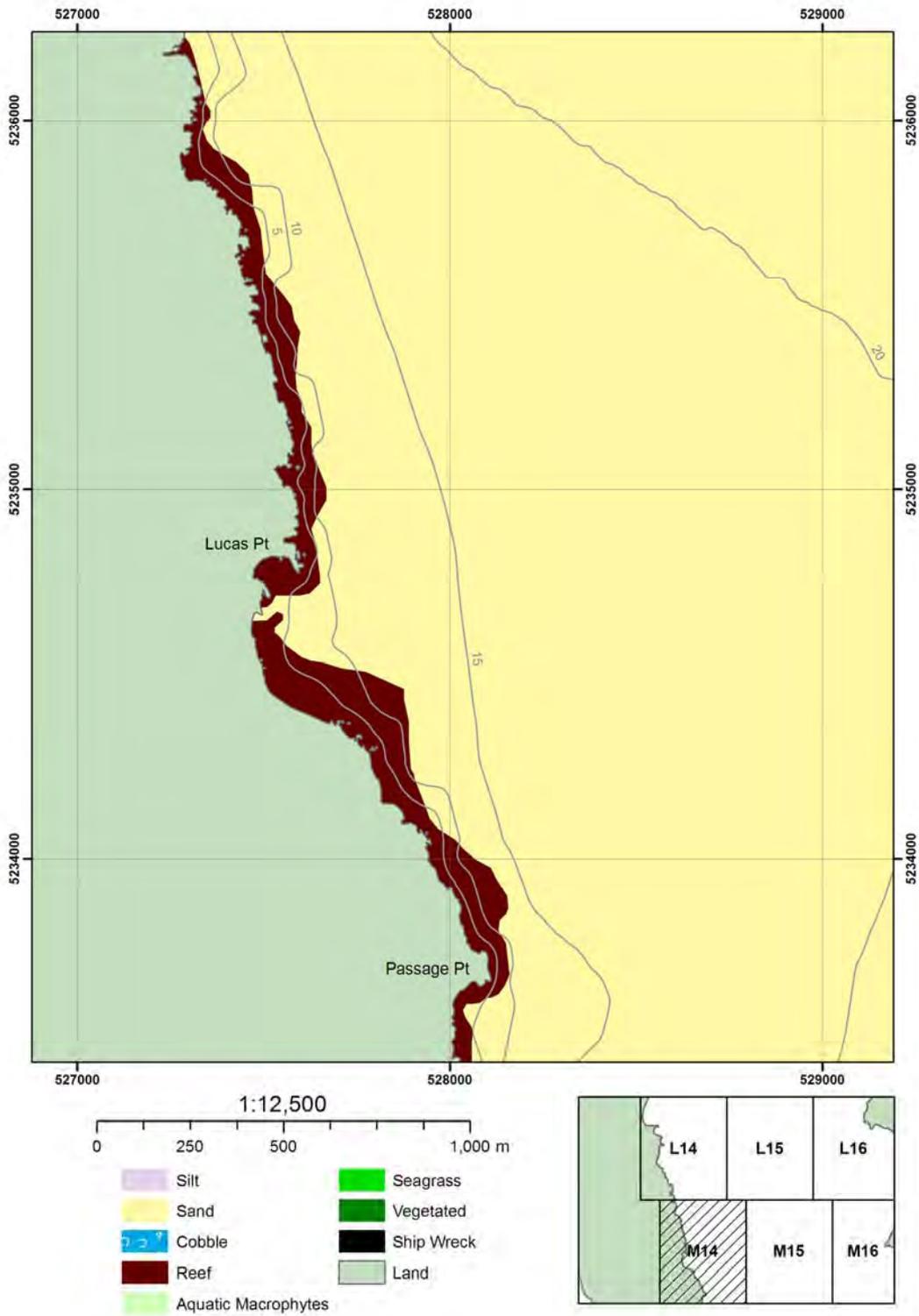


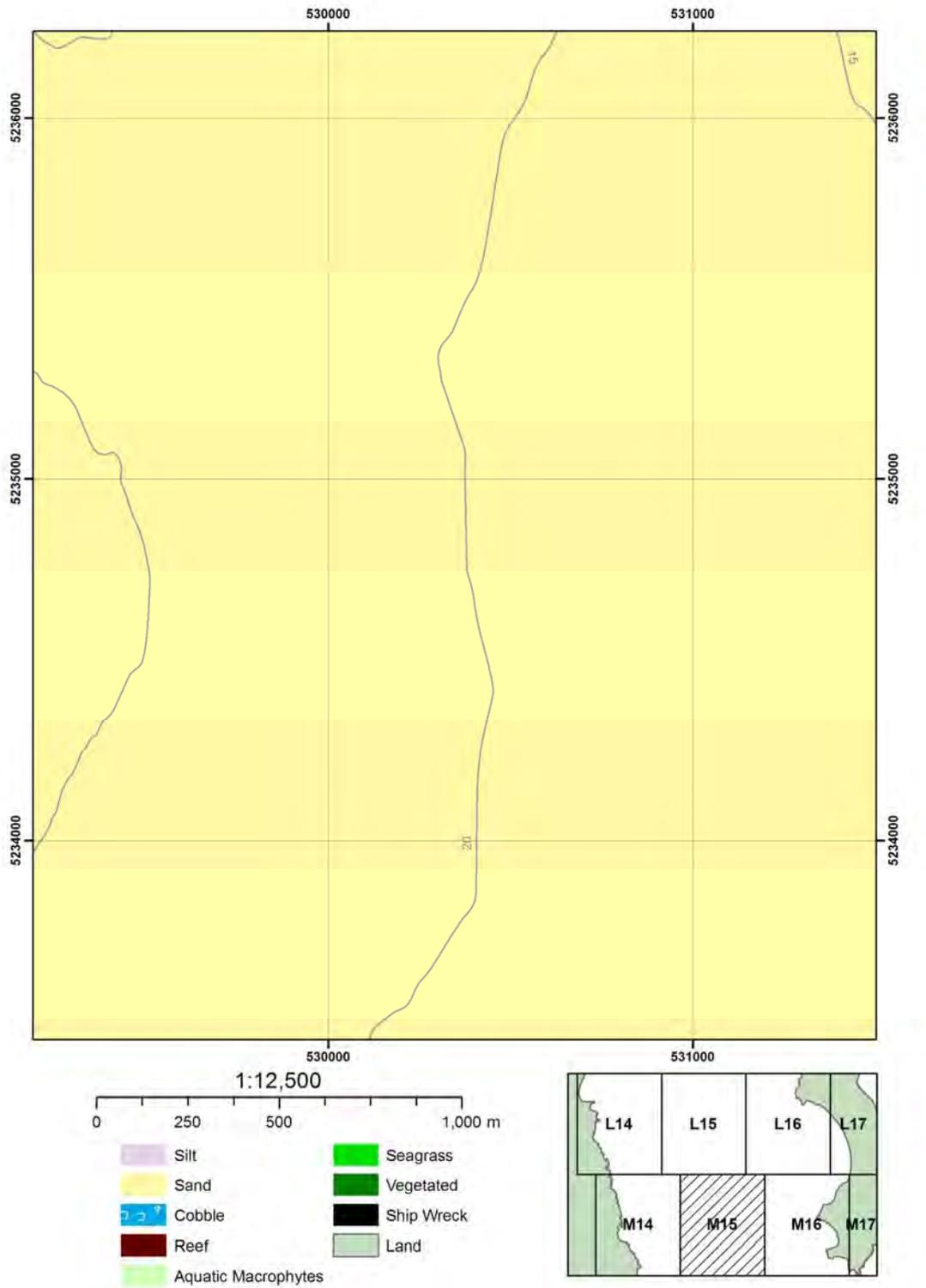


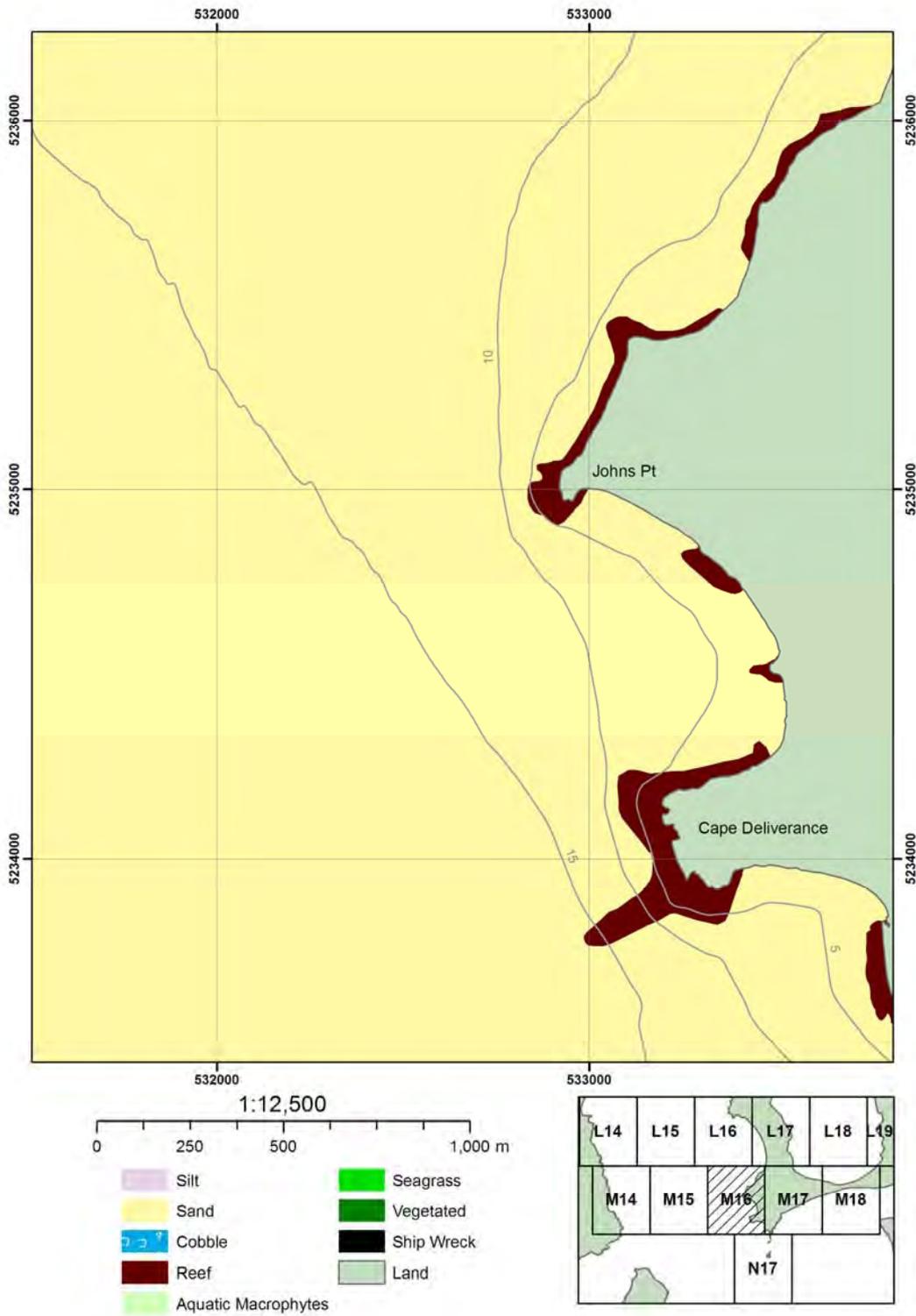


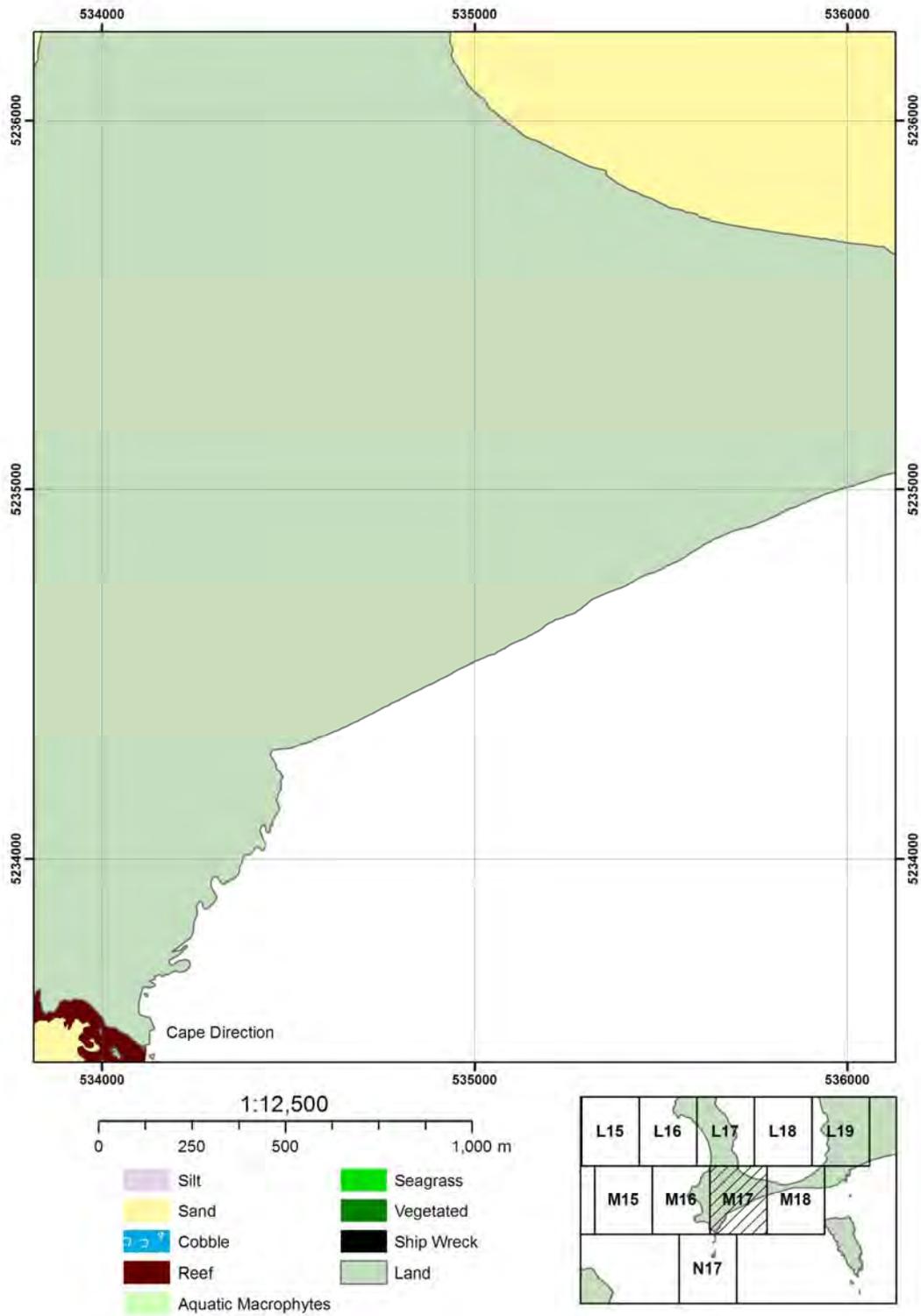


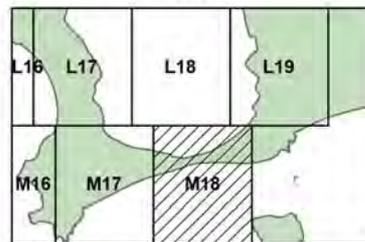
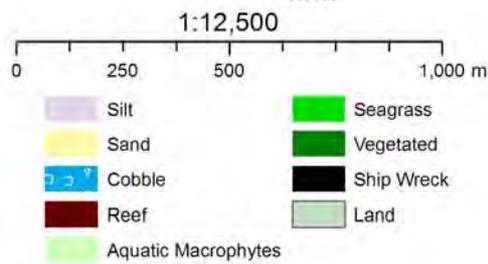
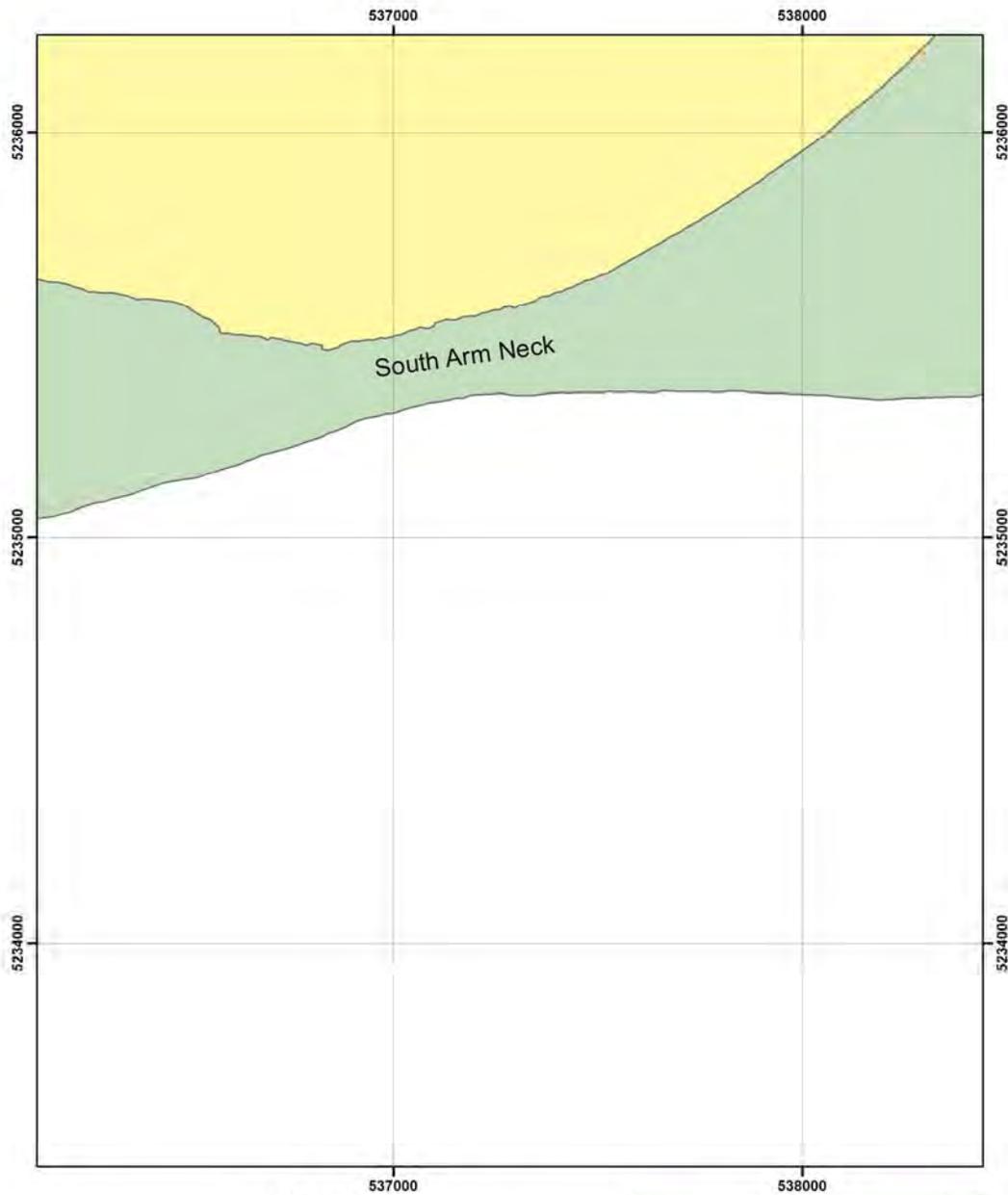


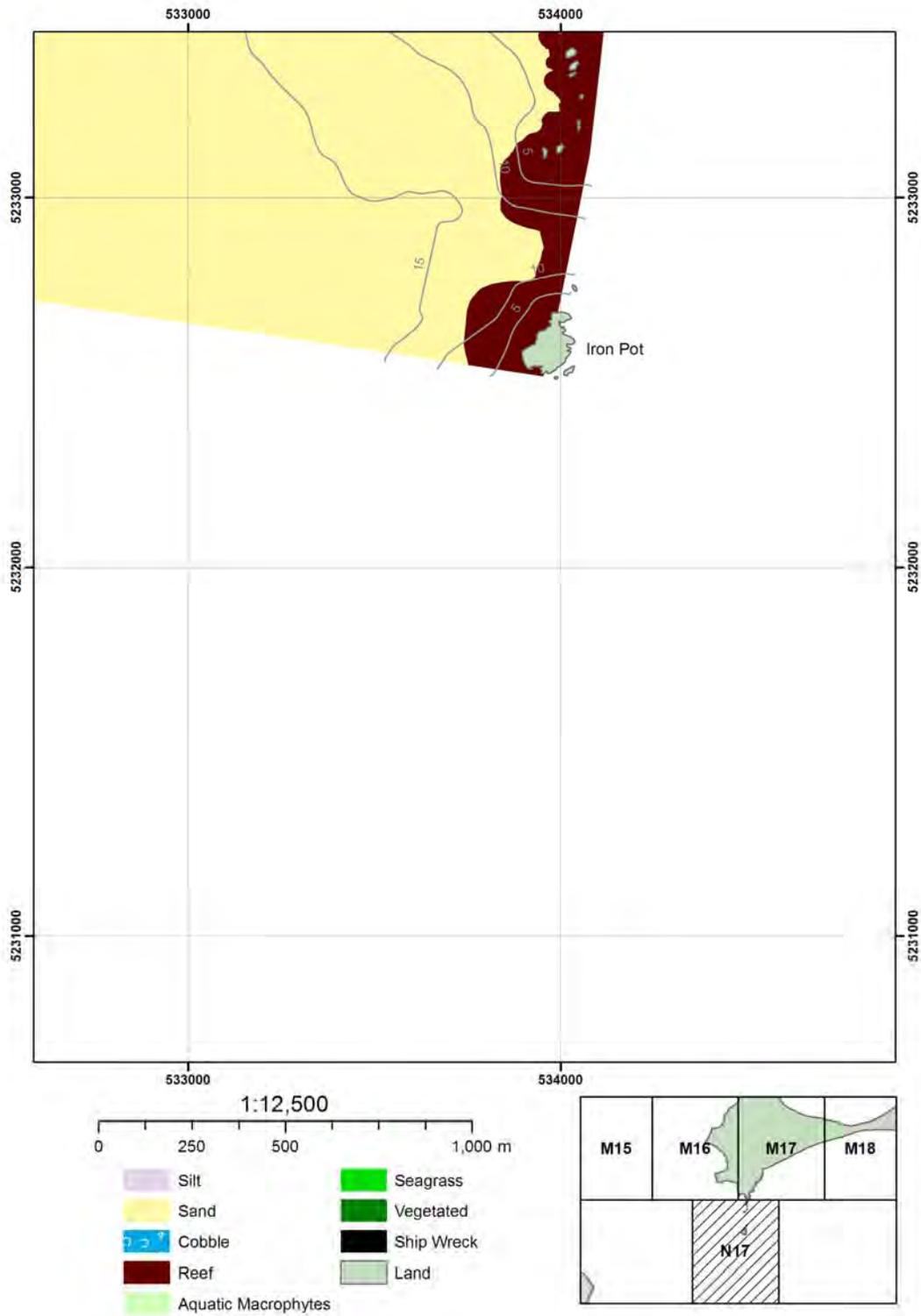












4. Conclusions

A resurvey of the distribution of marine habitats of the Derwent Estuary was conducted from April to June 2007 by SeaMap Tasmania. The initial habitat mapping survey was completed in 2001 by Jordan et al (2001) as part of a NHT project (CMP22338) focusing on the integration of science and management for the development of a monitoring program for the Derwent Estuary.

Comparisons have not been made between the results of this survey and the initial mapping report due to the temporal and technical difficulties in detecting change in benthic marine habitats. Single beam acoustics do not have a high degree of signal fidelity which is due to a number of parameters and this makes comparison between results over different seasons, sea conditions and between different acoustic sounders impossible.

The distribution of several habitat classes have been presented and discussed in this report. The image mapper product and shapefiles attached in Appendices 3 and 4 are for the discrete use of the Derwent Estuary Program and remain the copyright of the Tasmanian Aquaculture and Fisheries Institute. The results of this survey provide natural resource managers, industry and the community with the information needed to contribute to biodiversity conservation and natural resource management of the Derwent Estuary. It provides further information needed to define and measure marine habitat extents in Tasmanian waters and increases our knowledge to improve impact assessments to protect the health and condition of sub tidal marine habitats.

References

- Aquenal (2000) Biological characterisation of the Derwent River main channel and wetlands between New Norfolk and Bridgewater. Report prepared for NSR Environmental Consultants Pty Ltd and Norske Skog Paper Mills (Australia) Ltd.
- Aquenal (2002) Exotic marine pests survey Port of Hobart, Tasmania. Final Report for Hobart Ports Corporation, Pty Ltd. 159 pp.
- Burrough, A. and McDonnell, R (1998) Principles of Geographic Information Systems. Oxford University Press, New York.
- Coughanowr, C. (1997) State of the Derwent Estuary: a review of environmental quality data to 1997. Supervising Scientist Report 129, Supervising Scientist Canberra.
- Edgar, G (1997) Australian Marine Life; the plants and animals of temperate waters. Reed Books, Australia.
- Fuhrer, B.A (1988) Seaweeds of Australia. Edited by Christianson, I.G., Clayton, M.N and Allender, B.M. Reed Books, Australia.

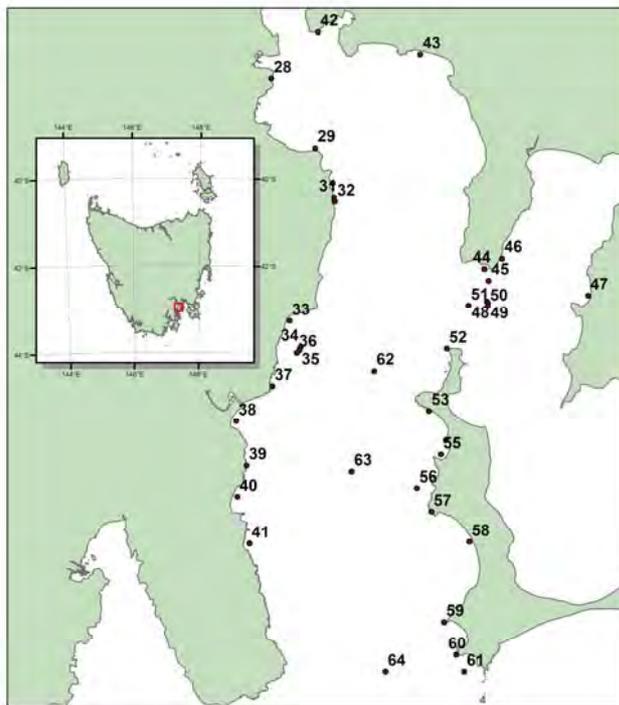
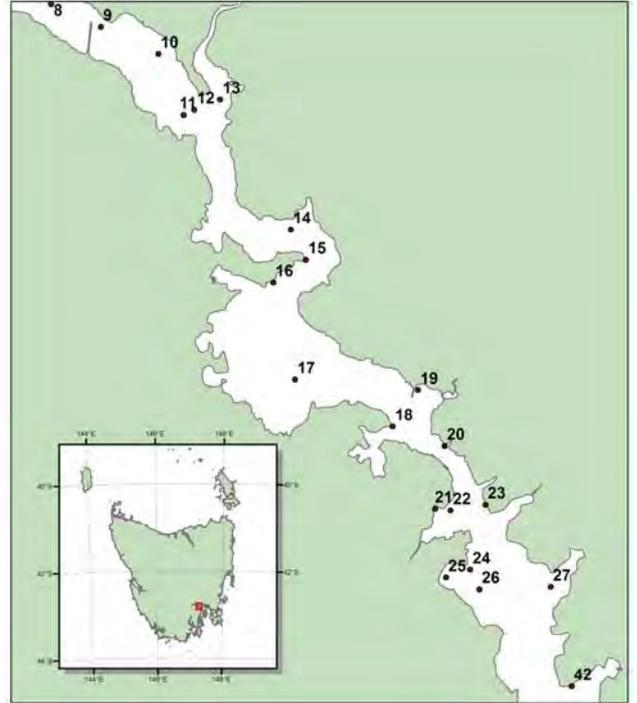
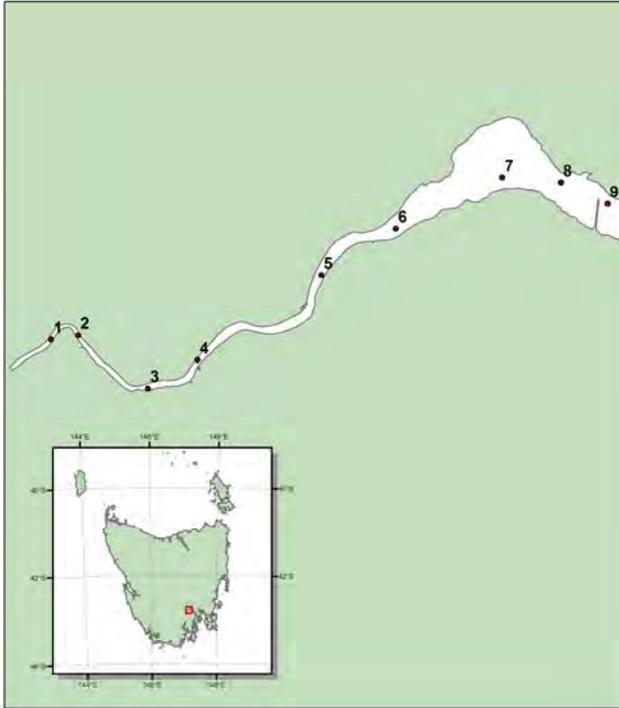
Jordan, A.R., Lawler, M and Halley, V (2001) Estuarine habitat mapping in the Derwent- integrating science and management. NHT Final Report, NHT Project Number CMP22338.

Macleod, C. and Helidoniotis, F. (2005) Ecological status of the Derwent and Huon estuaries. NHT/NAP Project No. 46928. NHT/NAP Final Report. 109 pp.

Morrice, M.G (1995) The distribution and ecology of the introduced northern Pacific seastar, *Asterias amurensis* (Lutken), in Tasmania. Final report to the Australian Nature Conservation Agency, Feral Pests Program, No 35. Tasmanian Museum and Art Galley, February 1995.

Appendix 1: Video Transect Locations

Appendix 1 outlines the location of individual video drops conducted within the estuary and the ID numbers correspond to the site descriptions in Appendix 2.



Appendix 2: Video Transect Descriptions

| Video ID # | Video Name | Latitude | Longitude | Depth | Observation |
|------------|-----------------|-----------|-----------|-----------|---|
| V01 | UD_20070529_V08 | -42.77292 | 147.06818 | 5 - 7 m | Reef with thick silt covering, occasional submerged logs. Some small unidentifiable fish |
| V02 | UD_20070529_V07 | -42.77205 | 147.07590 | 6 - 8 m | Silt with some reef patches. No algal growth. Some small unidentifiable fish possibly <i>Pseudaphritis urvili</i> |
| V03 | UD_20070529_V06 | -42.78324 | 147.09600 | 6 - 7 m | Reef with patches of silt. Very little light penetrating the upper layers of the water column. No algal growth and few signs of fauna, some unidentifiable fish |
| V04 | UD_20070529_V05 | -42.77724 | 147.11022 | 5 - 7 m | Silt, with bacterial mat in deeper water |
| V05 | UD_20070529_V04 | -42.75899 | 147.14580 | 5 - 6 m | Silt |
| V06 | UD_20070529_V03 | -42.74918 | 147.16709 | 0.5 - 6 m | Silt onto a sparse bed of seagrass (<i>Heterozostera tasmanica</i>) |
| V07 | UD_20070529_V02 | -42.73807 | 147.19770 | 0.5 - 6 m | Silt onto a sparse bed of seagrass (<i>Heterozostera</i>). Seagrass with large amount of associated brown algae |
| V08 | UD_20070529_V01 | -42.73913 | 147.21447 | 0.5 - 5 m | Silt onto <i>Ruppia</i> sp. |
| V09 | MD_20070529_V18 | -42.74370 | 147.22788 | 1 - 6 m | Silt with a small amount of fine shell grit, a few patches of seagrass (<i>Heterozostera</i>) with long blades. Dense seagrass bed at end of transect |
| V10 | MD_20070529_V17 | -42.74906 | 147.24341 | 1 - 3 m | Dense <i>Heterozostera</i> with long blades. Sediment fine silt with some small burrows |
| V11 | MD_20070529_V16 | -42.76133 | 147.25023 | 1 - 2 m | Silt with some seagrass (<i>Heterozostera</i>) and large amounts of epiphyte and associated algae |
| V12 | MD_20070529_V15 | -42.76029 | 147.25316 | 3 - 4 m | Silt with few features |
| V13 | MD_20070529_V14 | -42.75829 | 147.26010 | 1 - 2 m | Seagrass with large amount sediment cover. Relatively long blades and some patches of epiphyte growth |
| V14 | MD_20070529_V13 | -42.78422 | 147.27932 | 1 - 3 m | Silt with oysters growing on it onto seagrass (<i>Heterozostera</i>) |
| V15 | MD_20070529_V12 | -42.79023 | 147.28340 | 2 m | Silt with oysters onto seagrass (<i>Heterozostera</i>). Some <i>Patriella</i> sea stars observed |
| V16 | MD_20070529_V11 | -42.79482 | 147.27460 | 1 - 14 m | Silt with lots of shell grit onto oyster beds with some seagrass in shallow (<i>Heterozostera</i>). <i>Asterias</i> is found here on the silt and oysters |
| V17 | MD_20070529_V10 | -42.81433 | 147.28056 | 3 m | Silt with lots of burrows. Some mollusc tracks, little visible fauna |
| V18 | MD_20070529_V08 | -42.82375 | 147.30699 | 3 - 7 m | Silt with large amounts of dead oyster shell onto reef with some living oyster. Both sea stars <i>Asterias</i> and <i>Patriella</i> are found here along with some <i>Myxicola</i> polychaete |
| V19 | MD_20070529_V09 | -42.81637 | 147.31382 | 0.5 - 3m | Silt onto reef with oyster and <i>Asterias</i> sea star. The reef has sparse algal cover of mainly red algae. The silt has some <i>Asterias</i> and <i>Patriella</i> sea stars |
| V20 | MD_20070529_V07 | -42.82766 | 147.32107 | 1 - 15 m | Silt onto reef with dense population of oysters. The sea star <i>Patriella</i> is found |

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| | | | | | on the silt here, while <i>Astrerias</i> is on the reef |
| V21 | MD_20070529_V05 | -42.84026 | 147.31859 | 1 - 2 m | Silt onto seagrass (<i>Heterozostera</i> sp.) The sea star <i>Patiriella</i> sp. occurs on the silt at this location |
| V22 | MD_20070529_V06 | -42.84057 | 147.32276 | 2 - 6 m | Barren reef with light cover of red alga onto silt. Both sea stars <i>Patiriella</i> sp. and <i>Asterias</i> sp. are on both the reef and silt |
| V23 | MD_20070529_V04 | -42.83940 | 147.33216 | 4 - 19 m | Silt up to reef at the base of Bedlam Walls. <i>Asterias</i> is present on the silt and reef. The sea star <i>Patiriella</i> sp. is also present on the reef. Little algal growth on the reef with only sparse red alga and turfing browns |
| V24 | MD_20070529_V03 | -42.85253 | 147.32810 | 3 - 6 m | Silt with oyster shells on to cobbly reef with <i>Asterias</i> . The silt is densely populated with <i>Myxicola</i> sp. polychaete. The reef has limited algal growth with only turfing browns and some red algae |
| V25 | MD_20070529_V02 | -42.85410 | 147.32160 | 1 m | Cornelian Bay. Seagrass bed (<i>Heterozostera</i> sp.) Some sea stars (<i>Asterias</i> sp.) present |
| V26 | MD_20070529_V01 | -42.85645 | 147.33063 | 6 - 9 m | Silt with lots of filamentous brown algae. The sea star <i>Asterias amurensis</i> . and the polychaete <i>Myxicola</i> sp. are present |
| V27 | MD_20070524_V01 | -42.85590 | 147.34991 | 10 m | Silt with many small to medium burrows, a few <i>Asterias</i> |
| V28 | MD_20070529_V19 | -42.88881 | 147.33865 | 4 - 8 m | Silt with shell grit, a few rocks and tyres. Numerous burrows and <i>Myxicola</i> fan worms on sediment in deeper water, <i>Asterias</i> and <i>Patiriella</i> sea stars also present |
| V29 | SB_20070509_V01 | -42.90786 | 147.35482 | 3 - 9 m | Sand with patches of algal growth including filamentous red/brown and <i>Ulva</i> . Numerous <i>Asterias</i> , small burrows and <i>Myxicola</i> sp. polychaete fan worms |
| V30 | TR_20070509_V03 | -42.91737 | 147.36124 | 3 - 5 m | Dense <i>Heterozostera</i> with relatively short blades, and associated mixed red algae and <i>Ulva</i> . Sand generally bare leading into reef with <i>Cystophora</i> , mixed red algae |
| V31 | TR_20070509_V02 | -42.92127 | 147.36179 | 2 - 5 m | Dense <i>Heterozostera</i> with some <i>Cystophora</i> and mixed red algae. Into patchy reef with low cover of <i>Ecklonia</i> , <i>Cystophora</i> and mixed red algae |
| V32 | TR_20070509_V01 | -42.92248 | 147.36210 | 2 - 7 m | Dense <i>Heterozostera tasmanica</i> to 4 m depth, becoming sparse to 6 m. Occasional patches of reef amongst seagrass with <i>Ecklonia</i> , <i>Cystophora</i> , <i>Caulocystis</i> , <i>Sargassum</i> , mixed red algae and <i>Ulva</i> |
| V33 | KB_20070504_V04 | -42.95516 | 147.34573 | 2 - 5 m | Reef comprising barren sand scoured rocks on sand edge in shallow water. In deeper water algal cover includes <i>Caulerpa</i> and mixed red algae in patches, with increasing amounts of <i>Cystophora</i> , <i>Carpoglossum</i> , <i>Acrocarpia</i> |

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| | | | | | and <i>Ecklonia</i> . Small amounts of <i>Codium</i> sp., some <i>Undaria pinnatifida</i> |
| V34 | KB_20070504_V03 | -42.96227 | 147.34967 | 13 - 14 m | Bare sand with a few New Zealand screw shells, moving onto low relief reef. Algal cover low to medium, with a combination of <i>Ecklonia</i> , mixed red algae, <i>Cystophora</i> and <i>Acrocarpia</i> . Some coralline algae and the occasional sponge |
| V35 | KB_20070528_V01 | -42.96325 | 147.34930 | 14 m | Sand with fine shell grit, some patchy reef with <i>Ecklonia</i> and coralline algae |
| V36 | KB_20070528_V02 | -42.96386 | 147.34836 | 12 - 14 m | Reef with little algal cover, small patches of coralline algae, majority covered with invertebrate sediment matrix, a small amount of <i>Ecklonia</i> also present. Numerous <i>Asterias</i> and dead screw shells within reef structure. Sand with fine shell grit and numerous <i>Asterias</i> |
| V37 | KB_20070504_V02 | -42.97290 | 147.33944 | 4 - 10 m | Reef with a dense algal cover in shallow water decreasing with depth to become relatively barren at depth. In less than 5 m algae dominated by a mix of <i>Cysophora</i> sp. and <i>Acrocarpia</i> sp., with small amounts of <i>Lessonia corrugata</i> and <i>Ecklonia radiata</i> on more exposed rocks and ledges. Small amounts of mixed red algae and <i>Ulva</i> sp. also present in the shallow depth range. <i>Carpoglossum confluens</i> more common in 5 – 6 m. Below 6 m algae becoming more sparse with a mix of red algae, occasional <i>Undaria pinnatifida</i> plant, and the stalked ascidian <i>Pyura</i> sp. Below 7.5 m generally barren with occasional tufts of red algae and <i>Undaria</i> . Light sediment cover on deeper reef with a few sponges on deep reef margin. Occasional New Zealand screw shell (<i>Maoriculpus roseus</i>) on reef |
| V38 | KB_20070504_V01 | -42.98252 | 147.32622 | 2 - 6 m | Bare sand with ripples |
| V39 | KB_20070504_V05 | -42.99483 | 147.33010 | 3 - 6 m | Reef comprising large boulders with mixed algal cover. Major components of the algal community include mixed red algae, <i>Ulva</i> , <i>Cystophora</i> , <i>Ecklonia</i> , <i>Acrocarpia</i> , and <i>Lessonia</i> . Small amounts of <i>Undaria</i> and <i>Sargassum</i> were also present as was the stalked ascidian <i>Pyura</i> sp. |
| V40 | KB_20070504_V06 | -43.00333 | 147.32674 | 3 - 7 m | Bare sand with ripples, some shell grit |
| V41 | KB_20070504_V07 | -43.01624 | 147.33125 | 5 - 6 m | Reef with a mixed algal community including <i>Carpoglossum</i> , <i>Acrocarpia</i> , <i>Ecklonia</i> , <i>Caulerpa</i> , <i>Cystophora</i> and mixed red algae. <i>Macrocystis pyrifera</i> also present |
| V42 | SB_20070509_V02 | -42.87604 | 147.35570 | 2 - 7 m | Reef with a mix of <i>Ecklonia</i> , <i>Ulva</i> , <i>Acrocarpia</i> , <i>Codium</i> and coralline algae in depths less than 3 m. Below 3 m substrate a mix of barren rocks and shell. Small amount of mixed red algae and also <i>Myxicola</i> worms. Below 5 m depth |

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| | | | | | more consistent rock with occasional mixed red algae and a small amount of <i>Ecklonia</i> and <i>Undaria</i> |
| V43 | BR_20070510_V01 | -42.88202 | 147.39317 | 3 - 6 m | Sand with patches of shell and shell grit. Some patches of mixed red algae and a small amount of <i>Codium</i> . A few <i>Myxicola</i> sp. polychaete worms and numerous <i>Asterias amurensis</i> |
| V44 | RB_20070417_V01 | -42.94058 | 147.41709 | 2 - 15 m | Reef with <i>Ecklonia</i> and <i>Cystophora</i> in 2 - 2.5 m. Sparse algae below 2.5 m mainly mixed red algae, <i>Ulva</i> , <i>Ecklonia</i> and <i>Codium</i> . Very little algae below 5m. A few sponges below 7 m and some dead New Zealand screw shells |
| V45 | RB_20070501_V01 | -42.94383 | 147.41867 | 15 - 20 m | Silt with occasional sponge. Finger sponge and zoanthids on bridge section. Some New Zealand screw shells on sediment and <i>Holothurians</i> |
| V46 | RB_20070501_V04 | -42.93782 | 147.42348 | 2 - 13 m | Reef to 3 m depth, with <i>Codium</i> , filamentous brown and red algae. Sand below 3m with a mixture of fan worms, <i>Asterias</i> , <i>Ulva</i> , <i>cunjevoi</i> (<i>Pyura</i> sp.), mixed red algae and <i>Codium</i> . Burrows in deeper water |
| V47 | RB_20070417_V03 | -42.94777 | 147.45517 | 1 - 4 m | Sand with <i>Asterias</i> and fan worms |
| V48 | RB_20070501_V03 | -42.94954 | 147.41807 | 11 - 13 m | Barren rock with some sponge and occasional patches of coralline algae. <i>Asterias</i> , New Zealand screw shells, holothurians and fan worms (<i>Myxicola</i> sp.) present |
| V49 | RB_20070501_V02 | -42.94995 | 147.41850 | 13 - 14 m | Silt with fan worms (<i>Myxicola</i> sp.), dead New Zealand screw shells and <i>Asterias</i> sp. |
| V50 | RB_20070417_V02 | -42.95091 | 147.41829 | 14 - 17 m | Silt with <i>Asterias</i> and New Zealand screw shells. Lots of burrows in deeper parts |
| V51 | RB_20070514_V01 | -42.95071 | 147.41129 | 20 m | Silt with burrows |
| V52 | OP_20070514_V01 | -42.96260 | 147.40341 | 1 - 7 m | Reef with <i>Ecklonia</i> , <i>Cystophora</i> and mixed red algae in less than 2 m depth. In 2 - 3 m depth occasional patches of <i>Ecklonia</i> and mixed red algae, and lesser amounts of <i>Cystophora</i> and <i>Codium</i> . Sediment below 3m with <i>Asterias</i> , <i>Cunjevoi</i> and some <i>Myxicola</i> sp. fan worms |
| V53 | OP_20070528_V01 | -42.97950 | 147.39699 | 3 - 6 m | Sand with light cover of diatoms. Patches of cobble with some filamentous red alga. More extensive patches of cobble also with small amounts of <i>Cystophora</i> , <i>Carpoglossum</i> and <i>Zonaria</i> but generally barren. Occasional dead screw shell |
| V54 | OP_20070528_V02 | -42.98761 | 147.40323 | 3 - 6 m | Small band of <i>Heterozostera tasmanica</i> on edge of reef. Reef generally barren with some <i>Cystophora</i> and mixed red algae. Moving into sand with some sparse seagrass and diatom cover |
| V55 | OP_20070528_V03 | -42.99154 | 147.40145 | 2 - 6 m | Sand substrate with a small amount of |

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| | | | | | dead cockle shell. Patches of <i>Heterozostera</i> with light epiphyte and associated algae, including filamentous red algae and <i>Ulva</i> . Light diatom growth on sediment, and some Cunjevoi. Numerous <i>Asterias</i> in deeper areas |
| V56 | OP_20070528_V04 | -43.00080 | 147.39269 | 7 - 12 m | Reef covered with sediment and invertebrate matrix in deeper parts and small amounts of coralline and red algae. In shallower water <i>Ecklonia</i> dominates with small amount of filamentous red algae and <i>Carpoglossum</i> . Sand patches with fine shell grit and some dead screw shell in gutters. Sand on outer margin with <i>Asterias</i> |
| V57 | OP_20070528_V05 | -43.00722 | 147.39804 | 2 - 6 m | Reef with dense cover of <i>Ecklonia</i> in shallow. Coralline, mixed red algae, <i>Cystophora</i> and <i>Ulva</i> also present. Rapidly onto sand with a few sparse blades of <i>Heterozostera</i> |
| V58 | SA_20070528_V01 | -43.01552 | 147.41204 | 2 - 5 m | Sand with sparse <i>Heterozostera</i> , some associated filamentous red algae. Some <i>Myxicola</i> fan worms amongst seagrass and light diatom cover |
| V59 | SA_20070528_V02 | -43.03738 | 147.40287 | 3 - 10 m | Reef with dense <i>Carpoglossum</i> , mixed red algae, <i>Ecklonia Ulva</i> , <i>Acrocarpia</i> , <i>Cystophora</i> and <i>Sargassum</i> . Into sand with patches of shell grit and cunjevoi |
| V60 | SA_20070528_V03 | -43.04640 | 147.40748 | 3 - 8 m | Reef with <i>Acrocarpia</i> , mixed red algae, <i>Carpoglossum</i> , <i>Cystophora</i> , <i>Ecklonia</i> . <i>Carpoglossum</i> more dominant on deeper reef. Bare sand on outer margin of reef |
| V61 | SA_20070528_V04 | -43.05107 | 147.41041 | 13 m | Bare sand with small amount of shell grit, into patches of dense shell grit |
| V62 | LD_20070528_V03 | -42.96873 | 147.37680 | 20 - 34 m | Silt with fine shell grit and numerous New Zealand screw shells. A few tracks in sediment. Some <i>Asterias</i> |
| V63 | LD_20070528_V02 | -42.99637 | 147.36867 | 30 m | Silt with a few small burrows and occasional small patches of filamentous algae. <i>Asterias</i> |
| V64 | LD_20070528_V01 | -43.05116 | 147.38145 | 16 m | Bare sand with some shell grit. Some <i>Asterias</i> |

Appendix 3. Image Mapper CD

The Image Mapper CD located at the back of this report links the marine habitat maps and contours with all of the video files recorded.

Appendix 4. Derwent 2007- Habitats and Bathymetry

CD 2 located at the back of this report contains the ESRI shapefiles for the habitats and bathymetry of the Derwent Estuary in MGA94 Zone 55 projection. These shapefiles are for the exclusive use of the Derwent Estuary Program. The metadata for these data layers is inclusive on the CD.